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Keynote Speech

A shape of Agent-based modeling to come

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Recent rapid progress of computer and network technologies makes us possible to easily implement Agent-based simulation models. Such models help us to carry out experimental studies for social complex systems with both machine agents and human subjects.

Using such models, we are able to operationalize the concepts and ways of thinking of traditional management sciences. By the word operationalize, we mean that a) social and organizational systems are observed by human experiments and computer simulations and b) with both machine- and human- readable documentations, they are comprehensively and consistently understood for human experts and students related to management sciences. The talk will explore different perspectives of agent-based modeling in this endeavor.

Keynote Speech

Human motion capture for disability management, rehabilitation and physiotherapy

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Approximately 15% of the world population lives with some form of disability and 4% experience significant functional difficulties. While the numbers are significantly higher, the support and services available for disabled living in economically challenged countries are much to be desired as opposed to their affluent counterparts.

With the rapid progression in consumer electronic devices and associated software development environments, the ability to provide services and advent of assistive devices for disability management has become realistic more than ever before. Treatments in a number of movement disorders can significantly be enhanced by regular and objective assessment of the movement disability in a more cost effective and robust form. Despite the existence of affordable and effective sensing mechanisms for speech and subtle finer finger movements, extracting vital features of significance to the manifestation of the condition in a signal processing or information science context still remains a challenge. This indeed is essential in reaching objective measures that accurately represent diagnostically significant features as well as those that are inherently linked to severity of the condition.

Any development of clinically relevant technology demands establishing confidence in clinical usage to promote the uptake. When deriving subjective measures, careful attention is required to ensure a crucial balance between the correlation with the current practice as well as the enhanced likelihood of uncovering new and vital information. In a signal or information processing context this indeed eventuates to capturing features that replicate the manual clinical observations as well as emphasizing other features that are significant yet unlikely to be captured manually. The fundamental issues that underpin this somewhat contrasting objective is based on the fact that expert clinical assessments are inherently subjective while on the other hand it remains as the ground truth that other objective measures are destined to be compared with.

Non-contact measurement of respiratory patterns for monitoring sleep apnea, Asthma and fine finger movements necessary for rehabilitation can be captured using a number of readily available devices. In this talk, wearable and non-wearable sensor use in the capture and quantification of movement disabilities will also be discussed with particular reference to applications in neurological conditions such as Parkinson's disease and Cerebellar ataxia.

LIST OF PAPERS

Theme 1: Smart Computing

Theme 2: Systems Engineering

Real time joint angle measurement method using multiple wearable sensors

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Abstract

With the advent of wearable products, many wearable devices have come to the market that are trying to understand human behavior. A key challenge of this would be to understand human body motion as the human body can be modelled as an articulated system with complex joint movements. This paper contributes with a real-time joint angle measurement method with multiple wearable sensors using quaternions, which describes the orientation and rotation in 3D world. The study propose two approaches solving this: (1) quaternion vector rotation based joint angle calculation, (2) gravity vector based joint angle calculation. Each approach has its limitations and a real world application might be able to fuse both methods to get a reasonable output. In this method, we place multiple wearable inertial measurement units (IMU) in known locations of the body, calibrate them to remove errors of placement and calculate real time joint angles based on sensor outputs.

Keywords: Iinertial measurement unit, Joint angle measurement, Quaternions, Wearable sensors,

Introduction

Understanding human behavior through human motion is gaining attraction in multitudes of fields such as athletics training, movie making and health status diagnostic (Chen, 2013). In special occasions this has helped to analyze complex human behaviors such as identifying unique walking patterns (Piorek et al., 2017). This specially needs understanding of the 3D kinematics of human joint angles. The traditional methods of estimating the 3D joint angular kinematics are based on data provided by optoelectronic stereo photogrammetric systems (OSS). These systems are expensive and are limited by the volume of capture (Picerno et al., 2008). Some authors calculate limb angle by using Euler angle based methods (Roetanberg et al., 2009) where famous gimbal lock becomes a problem. To overcome this restriction, a combination of IMU sensors can be used. While IMU sensors can be fixed to different body segments of the human body, they give abstract data with respect to the earth coordinate system but not related to each other. On the other hand, representing the orientation of a given sensor in the 3D world becomes complex as there can be complex movements. This becomes a limitation to calculate joint angles in an articulated complex system such as human body in real time.

While Eular angles are used to represent orientation (Seel et al., 2014) they introduce a limitation known as gimbal lock (Chen, 2013). As a better approach, the study selects quaternions to represent the 3D orientation of a rigid body in 3D space. Using quaternions as the representation method, methods of calculating a joint angle in 3D space in real-time is proposed.

Methodology

Two methods are porposed to find the joint angle in an articulated. Human body being a complex articulated bone system, both methods can be used to calculate joint angles. The first method is quaternion vector rotation method.

Vector Rotation Method

Quaternion is a four dimensional number system that can be used to represent rotations in 3D space (Alavi et al., 2016).

$$Q = q_0 + q_1 i + q_2 j + q_3 k$$

Where

$$i^2 = j^2 = k^2 = ijk = -1$$

Here i, j, k are complex orthogonal basis vectors. And a unit quaternion has a magnitude of 1 which is defined as,

$$|Q| = \sqrt{(q_0{}^2 + q_1{}^2 + q_2{}^2 + q_3{}^2)} = 1$$

Supposing V is a vector in 3D space,

$$V = x_i + y_j + z_k$$

V can be expressed in quaternion form as,

$$[0, V] = 0 + x_i + y_j + z_k$$

Then the rotation of vector V by a given quaternion Q can be write as

$$V' = Q * V * Q^{-1} \tag{1}$$

Where V' is the rotated vector and Q^{-1} is the inverse of V.

In this method, first, bone vectors were defined according to joint position. Then the quaternion vector rotation of the free-defined vector was applied (for an example arm position vector V = (0,-1 0)).

Then this equation was applied to both lower arm sensor and upper arm sensor reading.

$$V_1' = Q\_joint1 * V_1 * Q\_Joint1^{-1} \tag{2}$$

$$V_2' = Q\_joint2 * V_2 * Q\_Joint2^{-1} \tag{3}$$

V1 and V2 are the rotated vectors from the upper arm quaternion and lower arm quaternion respectively. The angle between the two vectors θ, can be calculated by using dot the product.

$$\theta = \frac{\cos^{-1}(V_1'.V_2')}{|V_1'|*|V_2'|} \tag{4}$$

Gravity Vector Method

The second method calculates the joint angle using a gravity vector based method. In this method, gravity vector direction was calculated relative to the current sensor position by using quaternion. This method is more accurate than the previous one, but it only can measure the angle variation in vertical axis.

Let Q be a quaternion
Q = (qw, qx, qy, qz) $Q = q_0 + q_1 i + q_2 j + q_3 k$

Then the gravity vector is derived [5] using the following equations.

$$G_x = 2 * (q_1 i * q_3 k - q_0 * q_2 j)$$
$$G_y = 2 * (q_0 * q_1 i - q_2 j * q_3 k)$$
$$G_z = (q_0 * q_0) - (q_1 i * q_1 i) - (q_2 j * q_2 j) + (q_3 k * q_3 k)$$

Gravity Vector $\quad G = (G_x, \text{Gy}, \text{Gz})$ (5)
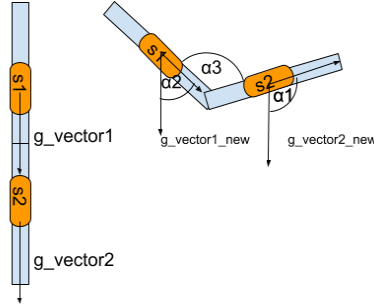
Figure 1: Gravity vector variation relative to the sensor

Figure 1 describes the gravity vector variation relative to the sensor. Dot product of the two gravity vectors were calculated to get angle between two limb (body parts).

$$\theta = \frac{\cos^{-1}(\text{g\_vector1\_new} \cdot \text{g\_vector2\_new})}{|\text{g\_vector1\_new}| * |\text{g\_vector2\_new}|}$$ (6)

By using equation (6), limb angle θ can be calculated accurately.

Implementations

In order to verify the functionality of the methods an IMU based sensor system was designed and developed. BNO 055 module was selected as the preferred IMU sensor as it contains 9 degrees of freedom with inbuilt fusion algorithm between 3 sensors, accelerometer, magnetometer and gyroscope.
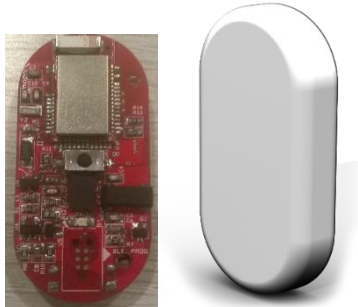
Figure 2: Gravity vector variation relative to the sensor

Results

Sensors were placed in two locations on the arm and the angle in the elbow joint was analyzed in both methods. Figure 3 and Figure 4 shows sample arm measurement data. Figure 3 illustrates the arm angle variation using quaternion vector rotation and the Figure 4 shows the arm angle variation by using gravity vector method. With the constraints of two methods, each method will need to be applied case by case.
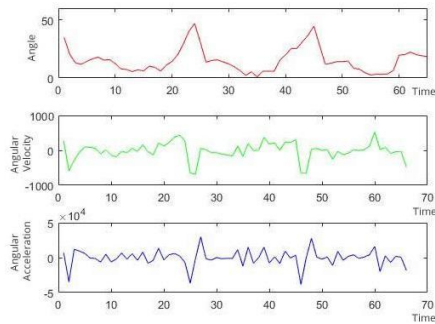
Figure 3: Arm elbow angle, angular velocity and angular acceleration variation plots for quaternion vector rotation method.
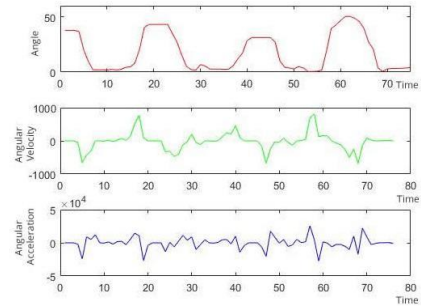
Figure 4: Arm elbow angle, angular velocity and angular acceleration variation plots for gravity vector rotation method.

Conclusion

While gravity vector rotation method gives better results in angle identification in real-time it can be used only to identify movements in the vertical plane. Yet vector rotation method can be used to calculate joint angles in any plane, though it cannot detect pronation and supination. Hence, the suggested two methods will need to be used in fusion or a case by case basis. For example, if the elbow joint movement in the vertical plane such as in weight lifting exercise needs to be identified, both methods would be ideal. While this study discusses on two main methods of achieving the objectives, the fusion of the both algorithms should open up further research opportunities to improve the real-time joint angle calculation process.

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Abstract No: SC-02   **Smart Computing**

Systems engineering approach to smart computing: From farmer empowerment to achieving sustainable development goals

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Abstract

Smart Computing aims to combine advances in Information and Communication Technologies to create smart systems to make human life better thus, providing a new approach to address many complex and challenging problems faced today by humanity. The study developed a solution to one such problem, uncoordinated agriculture production using Smart Computing which otherwise will lead to wide fluctuation of market prices, waste and farmers getting trapped into a poverty cycle. This was done using a bottom up approach. Using systems thinking in Systems Engineering and the insights gained from the bottom up approach the study derived a top-down approach as a way of guiding the process to solve other similar humanitarian challenges. The evolved top-down process consist of 3 broad steps; a) Root Cause analysis and development of a conceptual solution drawing on learnings from multiple disciplines, b) Development of an artefact based on Smart Computing technologies to implement the conceptual solution, and c) Development of a Closed Loop Control system to continuously monitor and manage the inputs identified in the conceptual solution using the artefact developed to achieve the desired outputs.

Keywords: Agriculture, Digital knowledge ecosystem, Smart computing, Systems engineering, Sustainable Development Goals (SDGs)

Introduction

Smart Computing is an effective method to integrate the capabilities of computer hardware, software, social media and communication networks together with digital sensors, smart devices, internet technologies, big data analytics, computational intelligence and intelligent systems to realize various innovative applications. Smart Computing can be broadly classified into two major areas: how to design and build smart computing systems and how to use computing technology to design smart things and make human life better. Thus, Smart Computing can be used to provide new solutions to many challenges faced by humanity. The United Nations have formulated 17 global goals and classified them as Sustainable Development Goals (SDGs), which are aimed to transform the world we live in by 2030. "No Poverty" and "Zero Hunger" are two of these goals. To achieve these goals, a multi-disciplinary approach is needed, while for it to be effective it should be easily scalable to reach the billions of people across different continents irrespective of the countries development status. This is a very complex challenge.

The lack of a suitable framework to handle the complex multi-disciplinary nature of these applications is hindering finding effective long term solutions to these issues. What we see today is a very large number of "apps" providing point solutions to various human needs rather than an integrated system to solve a complex human problem. This paper presents an approach to utilise Smart Computing to develop a multi-disciplinary solution to a complex problem using Systems Engineering approach to make human life better.

Methodology

Systems engineering is an interdisciplinary field of engineering and engineering management that focuses on how to design and manage complex systems utilising systems thinking principles. It is also acknowledged that adopting a socio-technical approach to system development leads to systems that are more acceptable to end users and deliver better value to stakeholders (Baxter and Sommerville, 2011).

The study used the insights gained by developing a mobile based information system for farmers in Sri Lanka (Ginige et al., 2014) to derive an approach to effectively use Smart Computing to develop a multi-disciplinary solution to a complex humanitarian problems. Effective coordination of agricultural production is a major problem in developing countries characterised by small land holdings. One major symptom of an uncoordinated agriculture domain is overproduction of some crops while some others are in short supply, leading to widely fluctuating market prices, waste, food insecurity and trapping farmers into a poverty cycle. The mobile based solution that was developed to address this complex problem later evolved into a Digital Knowledge Ecosystem (Ginige et. al., 2016). This development happened using a bottom up approach. Using the insights gained and System thinking, a top-down approach as a way of guiding the process to solve other similar humanitarian challenges was developed.

The study identified the need for the following three broad steps to develop a top down approach to create a solution to some of the complex humanitarian challenges.

a) Development of a conceptual solution based on root cause analysis at both systems and user levels.
b) Development of an artefact based on Smart Computing to implement the conceptual solution identified in a) above.
c) Creation of a closed loop control system using the artefact developed in b) to coordinate the overall system.

Based on systems thinking, within each broad step one can identify activities to effectively combine knowledge from multiple disciplines to achieve the required outcomes as illustrated in Table 1, Table 2 and Table 3, below.

Table 1: Root cause analysis and development of a conceptual solution

Symptoms:	Over and undersupply of crops
Theory:	Economic theory says this happens when demand and supply is not properly matched.
Remedy:	Need to change how farmers select crops to grow so that a better match between supply and demand can be met
Requirement:	Farmers' crop selection behaviour needs to be changed.
Theory:	Empowerment Theory says to bring about a behaviour change we need to empower the person. People can be empowered by providing choices and other information that can help them to achieve goals meaningful to the individual.
Analysis:	Through interviews it was found farmers select crops that will give them the maximum revenue. Farmers use last season market prices and their knowledge about crops to make this selection. This tends to majority selecting the same crop.
Conceptual Solution:	Farmers need to be provided with a list of crops that will grow in their farm and current production levels of these crops for them to make informed decision to achieve required crop diversification.

Table 2: Developing a mobile based artefact - Smart computing solution

Requirement:	Develop an artefact to implement the conceptual solution
Solution part 1:	Farmers can ask what crops will grow in my farm using a mobile phone which will also provide the geo-coordinates. Thus using a GIS system, the corresponding agro-ecological zone and the corresponding climatic and soil parameters can be obtained. Crop information can be organised into an ontological knowledgebase so that it can be queried based on climate and soil parameters to get a list of crops that will grow in that farm as shown in Figure 1b.
Solution part 2:	To optimise revenue, farmers also need to find out the cost of production. For this an expense calculator can be provided. Farmer can enter the planned extent. The system can find the required fertilizer, pesticides and other inputs for the selected crop and extent and display this information to the farmer. Farmer can make an informed decision as shown in Figures 1c and 1d.
Solution part 3:	The system now has information from some farmers what they are planning to grow and the extent. From published statistics number of farmers in a region can be obtained. Once statistically significant planned production quantities are available the system can use predictive modelling to predict the expected harvest. Based on historical patterns the demand for different crops can be computed. By taking the ratio of predicted production and demand it is now possible to compute the degree of market saturation. This information can be shown to farmers using a colour coding scheme to achieve the required crop diversification. In Figure 1b, the crops in green, yellow and red are low, medium and high in production respectively, compared to the overall demand. White indicates there are not enough samples to predict.

Table 3: Creating a closed loop control system

Problem:	At present coordination of agriculture production happens through an open loop system where fertilizer subsidies and guaranteed purchase prices are used as inputs to modify crop selection by farmers. Until the harvest comes to the market it is not clear how the inputs affect the output. Thus, there are no corrective actions taken for potential deviations. The result is continuing mismatch between supply and demand leading to wide price fluctuations (Figure 2).
Theory:	Control systems theory says if there are external influences to a system it is necessary to have a closed loop system to maintain the output at the desired level. In this case the external factors are farmer selection of crops to grow, weather, timely availability of inputs, availability of money to purchase the inputs.
Solution:	Implement a closed loop control system that will monitor the predicted production using the mobile artefact developed earlier and dynamically modify the inputs to the system (Figure 3).

Results

Figure 1 shows important user interfaces of the mobile artefact developed using Smart Computing techniques.

Figure 1a: Main Menu
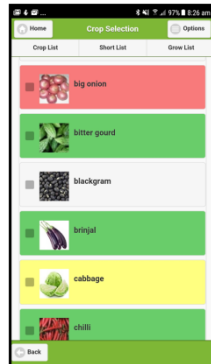
Figure 1b: Crops that will grow in "My Farm"
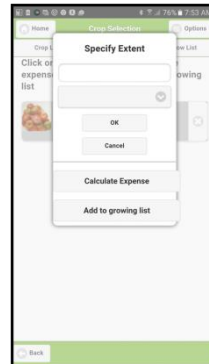
Figure 1c: Calculating expenses
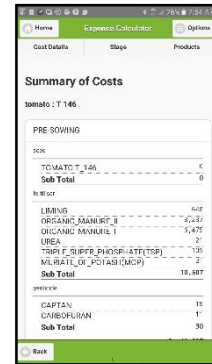
Figure 1d: Summary of costs

Figure 2 shows the current open loop system in use for coordinating agriculture production and Figure 3 shows the possible transformed closed loop system.
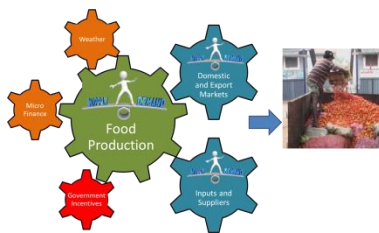
Figure 2: Open loop system
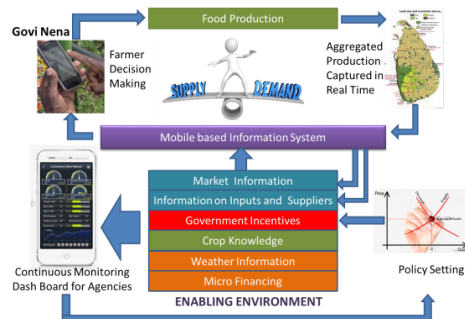
Figure 3: New closed loop system

Conclusion

This paper presents an approach based on Smart Computing and Systems Engineering to achieve some of the SDGs goals. The solution is based on three broad steps a) Root cause analysis and development of a conceptual solution drawing on learnings from multiple disciplines, b) Development of an artefact, based on Smart Computing technologies to implement the conceptual solution, and c) Development of a closed loop system to continuously monitor and manage the inputs identified in the conceptual solution using the artefact developed to achieve the desired output.

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Handwritten signature verification

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Abstract

A number of biometric methods can be used to authenticate a human identity such as using fingerprint detection, face detection, iris inspection and voice recognition. The verification of the signature of a human is the most prominent and prevalent method among those. The banking and insurance sector manually uses this verification method. It is a critical biometric attribute, which may differ from time to time due to the age and emotional state of the person. Because of the absence of the time feature of the signature, offline signature verification has a risk than online signature verification. The paper introduces six features for an alternate solution. They include scale and rotation invariant such as signature pixel ratio of concentric circles and number of cross points while others are rotation variant such as baseline slant angle, aspect ratio, normalized area and slope of the line connecting center of gravities of left and right halves of the bounding box of the signature. Back-propagation neural network is used to train and test the signature images. Experimentation and results of this methodology presents the possibility of using this system in relevant sectors.

Keywords: ANN, Feature extraction, Forgeries, Image processing, Offline signature verification

Introduction

Signature of a particular person is a unique behavioral biometric feature used to identify a particular individual. The identity is crucial in most sectors but is very important in the finance and banking context. Many advantages are there for using personal signature as the primary authenticity because the signature is not needed to be stored in a particular place. Therefore, the signature cannot be stolen and not forgotten, as in the case of using passwords. However, the use of human signature is not a completely fool proof mechanism. Mimicing of someonelse's signature is a frequent issue that is faced by organizations. There are three types of forgeries, namely random, simple and skilled (Zaher & Abu-rezq, 2010). The forger has no idea about the name and the style of the signature in random forgery and it take less effort to identify it. In simple forgery name of the signature is known without knowing the style of it and this is most widespread. The forger has the name and the style of the signature in skilled forgery and this is most difficult to identify. However, there are three methods according to the data acquisition variations to identify and verify personal signature, which are called online, offline or hybrid signature verifications. In online signature verification, dynamic features, such as pressure, angle, number of pen lifts and time taken are taken are measured with the help of a digitizing tablet and a pen (Kumar & Dhandapani, 2016). For simplicity and user friendliness use of offline signature verification process is most common.

The following approaches are used for signature verification. Euclidean distance between questionable signature image and corresponding template (Zaher & Abu-rezq, 2010); Window-formed skeleton (Zimmer & Ling, 2003); Circle Masking Model (CCM) (Kumar & Dhandapani, 2016); Longest Common Subsequence algorithm (Salama & Hussein, 2016); Cumulative Distribution Function (CDF) (Devnath & Islam, 2016). Twenty five percent of of a data set in an offline signature

database was used to test the classifier and ultimately in verifying the owner of the signature, with the signature classified as genuine or forgery (Shah et al., 2016).

Methodology

Proposed methodology has several stages such as image acquisition, preprocessing, feature extraction, training and testing. Those are the most high-level phases in the methodology.
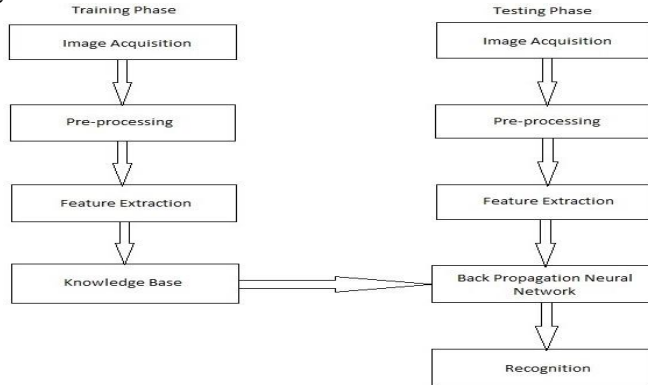
Figure 1: Architectural design

Image acquisition is common for training and testing phases, but in the training phase a set of images are loaded to the system as eight genuine signatures and eight forged signatures while only one signature is going to be loaded in the testing phase for a particular user. Signature portions are loaded to the system as image files. All training and testing signature images need to be preprocessed. Therefore, image preprocessing step is also common for training and testing phases. The input for this step is a signature image and output from this step is a preprocessed image, which can be used to extract features from it. The image should be passed through few preprocessing techniques. Those are resizing, inversion, raw averaging, mean filtering, binarization and erosion. Signature image is thinned using Zhang & Suen (1984) thinning algorithm. Strokes of the signature are thinned into one pixel thickness.

For signature pixel ratio of concentric circles the center of gravity and the maximum radius which covers the whole signature are calculated. Subsequently, eight concentric circles are drawn with different radius, with one eighth of the outer most radius used as the smallest radius and one eighth part for the current radius is added as the radius of the next circle until the outer most circle is reached. Each circle is drawn separately because, each circle is filled with maximum value of the pixel (255) and then applied the 'AND' operation with the signature image to have the pixels covered by the particular circle area. After calculating signature image pixels of each circle, ratio of those values is found with the ratio being the desired feature for the system. This is a scale and rotation invariant feature. Baseline is the imaginary line about which the signature is assumed to rest. The angle of inclination of this line to the horizontal is called the Slant Angle. To determine the slant angle, the ratio of the maximum horizontal projection to the width of the projection is maximized over a range of values of angle of rotation. The aspect ratio is the ratio of width to height of the signature. The bounding box, which coordinates the signature is determined and the width and height are computed using these coordinates. Normalized area is the ratio of the area occupied by signature pixels in the area of the bounding box. The study divides the signature image within its bounding box into left and right halves and separately determine the center of gravity of the two halves. It was observed that

that the slope of the line joining the two centers can serve as an attractive feature to distinguish signatures. A signature pixel which is having at least three neighboring signature pixels can be a cross point. This feature is scale and rotation invariant and discriminative to distinguish a particular signature.

In training phase, Artificial Neural Network (ANN) can be used as a machine learning technique to predict a solution. Learning ability can be used to automate the decision making process. ANN is the artificially representation of the human brain. Human brain has number of interconnected neurons. Likewise, ANN has interconnected neurons, which are connected through synopses. Weight updates occur based on the difference between actual output and desired output. In this training process, a back propagation neural network is used.

Testing phase is used to get the status of a person's signature as a genuine one or forged one by using the system. This phase similar steps in training phase such as image acquisition, preprocessing, feature extraction. A feature vector of test signature image is created and then it inputs to our neural network to validate.

Results

The experiment is applied to 8 genuine test signature images and 8 forged test signature images of 25 persons in the testing phase. The False Rejection Rate (FRR) and False Acceptance Rate (FAR) was used to obtain an idea about the accuracy of the offline signature verification mechanism. Confusion matrix is a matrix to evaluate the performance of a classification model. This shows the number of correct and incorrect predictions made by a classification model compared to the actual outcomes in the data. For the experimentation, we used set of genuine signatures and set of forged signatures of each particular user. According to confusion matrix, Positive Predictive Value, Negative Predictive Value, Sensitivity, Specificity and Accuracy are calculated based on the results that were achieved.

Table 1: Performance measurements

FRR	FAR
25% (average)	12.5% (average)

Table 2: Derivations from confusion matrix

Positive Predictive Value	Negative Predictive Value	Sensitivity	Specificity	Accuracy
75.00% (average)	77.00% (average)	85.71% (average)	77.77% (average)	81.25% (average)

When 8 genuine test signatures and 8 forged signatures of a person was tested using the system, a 25% average FRR was obtained. Noted that it is a higher value than expected. A 12.5% average for FAR was obatined. However, when considering the security factors, it is reasonable that FRR > FAR. According to the confusion matrix, the system had 75.00% for average Positive Predictive Value, 77.77% for average Negative Predictive Value, 85.71% for average Sensitivity, 77.77% for Specificity and 81.25% for average Accuracy. It is noted that these values may be different and more accurate if a larger data set is used during training phase. Figure 2, below shows the accuracy graph with individual accuracy of signature verification for 25 users.
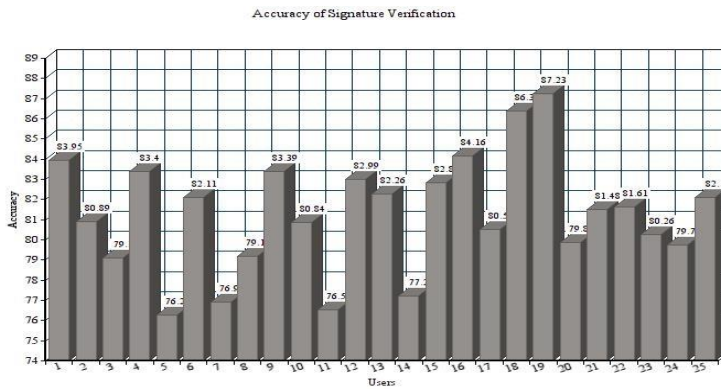
Figure 2: Accuracy graph

Conclusion

As the primary authentication mechanism in a selected domain, the offline signature verification technique based on pixel ratio of concentric circles, baseline slant angle, aspect ratio, normalized area, slope of the line connecting center of gravities of left and right halves of the bounding box and number of cross points can be used effectively. The major steps of signature recognition module are designed, implemented and experimented. This research helps in detecting the exact person and it provides more accurate method of verifying signatures. The study achieved almost a 75-85% accuracy for its test data.

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Remote access for personal cloud devices

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Abstract

With the developments in cloud computing, there have been raising concerns towards the privacy of content stored in the cloud. People tend to steer towards personal cloud devices as they improve the locality of data by holding such cloud devices in the vicinity, in order to ensure data privacy. These devices are mostly found in the form of Network-attached Storages (NAS) that are accessible within the local network. Although there are gains in security and privacy, numerous drawbacks exist among personal cloud devices when compared to cloud-based solutions. One major drawback is the remote access to content and sharing of content with remote users. A popular method of sharing media to remote users is the generation of a link, which is globally accessible through a centralized server. The proposed solution implements a link sharing mechanism, an online cross platform file browser and a remote access control mechanism which uses end-to-end encrypted tunnels to communicate in a peer-to-peer manner. This solution makes use of WebRTC which utilizes Datagram Transport Layer Security (DTLS) to ensure encrypted delivery of data. The presented text contains the experimental setup, user interfaces and results obtained after evaluating the performance of the proposed system.

Keywords: Cloud computing, Remote access, Personal cloud, Security

Introduction

The concept of cloud computing has influenced human life in many forms. Media storage is one of the most popular cloud services. *Google Drive* (Google Drive, 2018) and *Dropbox* (Dropbox, 2018) are two famous solutions which provide storage facilities in cloud. Although the provided service satisfied many requirements of cloud storage, there is a raising concern towards the privacy of such solutions. In fact, *Google Drive* (Google Drive Terms of Service, 2017) uses customer data to perform analytics and *Dropbox* (Dropbox - Terms, 2016) employs deduplication mechanisms in order to improve the performance of their services. In order to satisfy certain use cases such as synchronization without using online cloud services, solutions such as *Box2box* (Lareida et al., 2013), *Resilio Sync* (Forums - Sync Forums, 2017) and *RSync* (How Rsync Works, 2018) have emerged. *Resilio Sync* and *Box2Box* are two peer-to-peer synchronization services. Even though they support synchronization, no web-based remote access facilities are provided. In contrast, *RSync* provides synchronization only when the devices are physically connected.

The presented solution utilizes peer-to-peer networking technologies within personal cloud devices to provide improved remote access in order to compete with existing cloud service providers. This is achieved by enabling web-based file browsing and globally accessible link sharing. Performance measures demonstrate the performance of the proposed system with competitive scores against that of well-established cloud service providers while maintaining a similar user experience. Furthermore, with the utilization of DTLS via the adoption of WebRTC as the transport layer technology, all the communications related to file transmission are secured end-to-end.

Methodology

The system utilized Angular File Manager (Street, 2017) in order to render the front end to the users. The connector to the back end is modified to support a live WebSocket to the central server and a peer-to-peer WebRTC (WebRTC, 2018) data channel to fetch files from the personal cloud device.
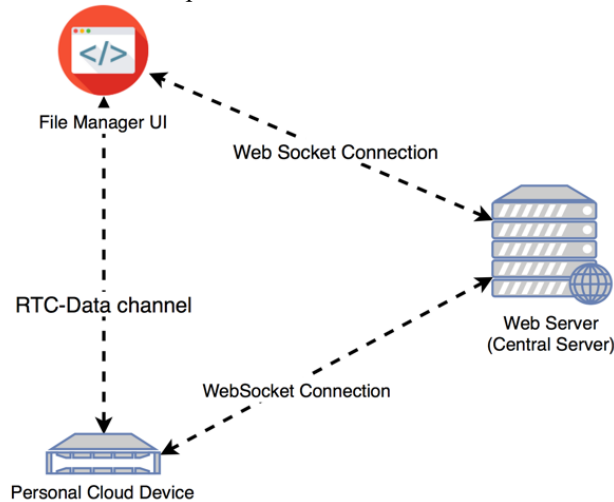
Figure 1: High-level design of the solution

Figure 1 demonstrates the high-level design of the solution. The personal cloud device will register in the central server once it is connected to a local area network (LAN) connection which has Internet. Afterwards, the central server will register the personal cloud device as an online resource linked with the particular user credential that belongs to the owner of the device.

The remote users are provided with an Angular 4 (Angular, 2018) HTML5 web application. This provides the authentication interfaces for users to login. Once users are logged in they will be asked to select among the online personal cloud devices (if there are many) linked to their account. Afterwards, the HTML5 web application will start a WebSocket connection with the central server. This connection along with the connection between the central server and the personal cloud device will be used to create a RTC Data channel. There are two types of messages between the HTML5 application and the central server.

a) File Browser Messages

   These are used in order to browse content within the personal cloud device. These messages are simple JSON objects which are relayed from the central server to the personal cloud device in order to avoid delays due to connection initiation overheads that are present in peer-to-peer connections. All the communications happen in a transient manner, while ensuring no data will be stored in the central server. This requires the personal cloud device to be online with an active Internet connection. Furthermore, the messages are authenticated using a token sent along with the messages. Messages having invalid tokens will be dropped at the central server without being relayed to personal cloud devices.

b) File Upload/Download Messages

   These are used to create a peer-to-peer connection using WebRTC followed by the actions to Upload or Download a file.

Figure 2 demonstrates the user interface of the web-based file browser. This is a modified version of the Angular File Manager which supports a WebSocket based connection to the central server and WebRTC file downloads and uploads. Furthermore, following functions are provided for users so that the user experience matches that of common cloud-based storage solutions.

    a)   Compressing files
    b)   Sharing files with other users (users of the same personal cloud device)
    c)   Right click context menu to generate links and share
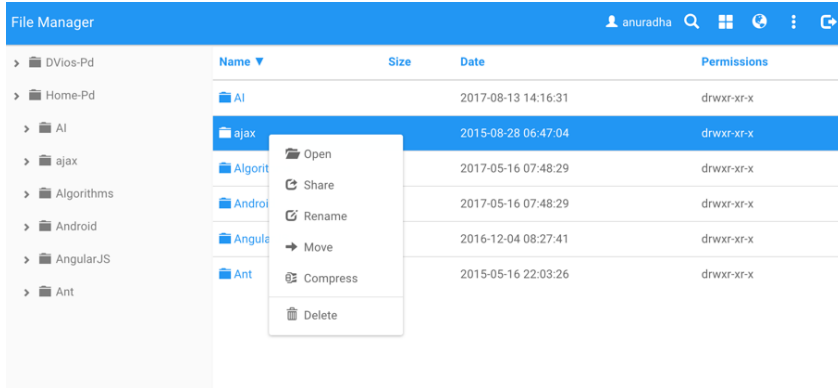
Figure 2: Web-based file browser

The central server and personal cloud devices' kernel uses NeDB (Robinson, 2016) document database in order to manage authentication information and user information. NeDB database provides in-memory efficiency while being reasonably scalable. This database was utilized due to its serverless nature and the low resource footprint. The personal cloud device was implemented on top of an Intel Minicomputer (x64) device running Ubuntu minimal 16.04 and Node JS version 8 LTS.

Results

Table 1 demonstrates a performance comparison the personal cloud device with Dropbox, measured using an Internet connection having a speed of 16MBps (uplink and downlink). Download speed from Dropbox was higher since the upload speed of the personal cloud device was limited by the bandwidth of the Internet connection it is connected to. The use of end-to-end encrypted data transmissions using WebRTC has enabled the personal cloud device to provide better privacy for the user. Furthermore, Dropbox does not provide compression of content from their web explorer and the personal cloud device was capable of performing the task at a reasonable speed.

Table 1: Performance comparison with Dropbox web view

Measure	Dropbox Web View	Web File Explorer of Personal Cloud Device
Response time	520 ms	160 ms
Download speed	12656 kbps	8239 kbps
Upload speed	4920 kbps	8323 kbps
Compress time (100MB File)	N/A	2340 ms

Conclusion

In conclusion, we were able to perform personal cloud device functionality successfully with a competitive level of efficiency compared to existing cloud-based

storage mechanisms. The solution was presented with useful features such as remote access, link sharing and user management compared to existing NAS devices in the market. Furthermore, the performed work proves that personal cloud devices can be improved drastically in order to provide a similar user experience to the end user. Moreover, the personal cloud devices can render content at a greater speed if they are in the same network, due to the locality of the content. Media devices such as tablets, smart televisions and projectors can be connected thus providing a greater entertainment experience while preserving the privacy.

The presented solution adds more value beyond the improved security of the personal cloud devices. This promotes the use of personal cloud devices while increasing the privacy of content without losing the accessibility of the content. Future work consists of extending work as a software bundle which can be installed by any user where a personal computer can be converted to a personal cloud device. This enables cloud-less sharing of content to users.

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Abstract No: SC-05   **Smart Computing**

An optimized solution for mobile robot navigation for dynamic office environments using active simultaneous localization and mapping

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Abstract

It is a very tedious process to develop a methodology for indoor navigation of mobile robots when it comes to environments with dynamic obstacles. So the objective of this research is to find an optimal solution for mobile robot navigation in indoor environments, specifically in an office environment. Instead of traditional line following methods, here an application with fully autonomous navigation plan with active Simultaneous Localization and Mapping (SLAM) techniques is presented. Proper localization, mapping techniques and a location identification method using April tags or labels embedded in the generated map can be used. The research was conducted by using affordable equipment such as wheel encoders, Inertial Measurement Unit (IMU) and a low cost Light Detection and Ranging (LIDAR) sensor and have used Robot Operating System (ROS) as a tool to implement the solution.

Keywords: Indoor navigation, LIDAR, ROS, SLAM

Introduction

Autonomous navigation is a trending topic these days and lots of research has been conducted in this area. When it comes to indoor navigation traditional methods like path following still prevails because further studies should be done before implementing modern approaches. Usage of GPS is hindered in indoor environments and that is a huge barrier for localization. The problem with traditional approaches is that they are heavily dependent on the environment, so when the environment changes the entire system need to be revamped. Simultaneous Localization and Mapping (SLAM) techniques use the environment to localize the robot which is more appropriate for such applications. Since the odometry of the robot which gives the position of the robot is often erroneous, and therefore cannot rely directly on the odometry.

SLAM is the ability of a robot to localize itself in an unknown environment while incrementally building a consistent map of that environment. Nowadays there are many applications based on SLAM including self-driving cars, unmanned aerial vehicles, autonomous underwater vehicles, planetary rovers, newly emerging domestic robots and even inside the human body (Mountney et al., 2006).

The primary software platform that was used to build this system is ROS (Quigley et al., 2009). This platform integrates all the computational and input/output nodes of the robot and is entirely based on Linux. In the ROS community, many developments have been carried out in the field of autonomous navigation. Thrun et al. (2005) describes the basic theories related to autonomous mapping and navigation. Wong and Jarvis (2004) and Zaman et al. (2011) further describes the complexities and procedures of indoor robotics navigation.

Mapping and exploration are crucial for a robot introduced to an unknown environment. Therefore, to make the robot fully autonomous, optimal usage of sensor data and implementation of efficient algorithms for mapping, exploration and path planning which are fit for the purpose is a necessity.

Methodology
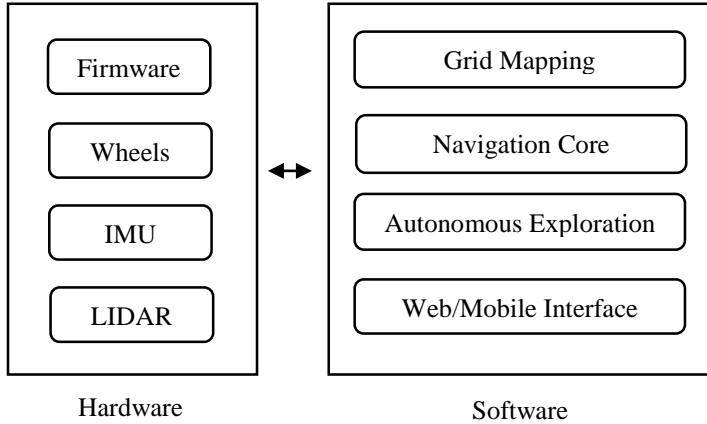
Figure 1: System overview

Initially, the application was modeled using Gazebo Simulator by using a 3D model of an office environment and visualized using rviz (ROS component). This implementation can be divided into several parts such as creating a gazebo model for the robot, integrating the LIDAR plugins available in the ROS community for the model, mapping the environment, using the map and achieving the navigation goals. And finally the actual implementation with the tested software and the actual robot.
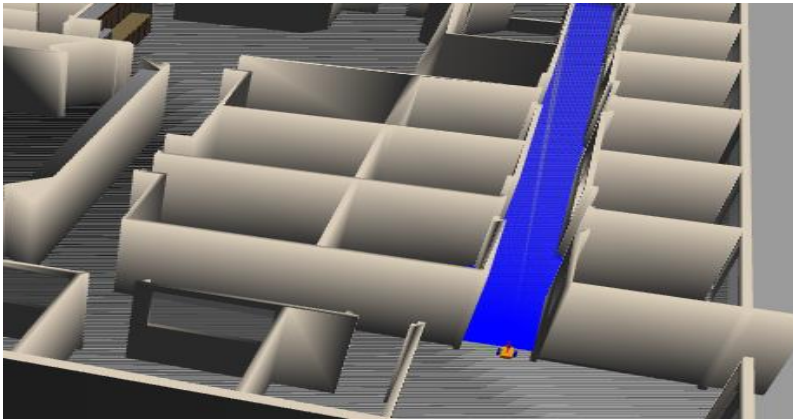
Figure 2: The environment used for the simulation

Office environments are usually homogeneous environments where specific landmarks cannot be found, so landmark extraction techniques cannot be used for localization in an office environment. As the solution grid based mapping technique was implemented and ROS gmapping module was used.

Autonomous navigation was done by implementing techniques such as Adaptive Monte Carlo Localization (AMCL), A* algorithm for where the most optimal distance between the target and the current position is selected. For this purpose, ROS

navigation stack was used by which it implemented. Here a local cost map and a global cost map were built using static map data and sensor data. And then fed into a local path planner and to a global path planner. In the implementation, A* algorithm is used since it's computationally simpler than Dijkstra algorithm. In the rviz map, labels for the destinations of each individual in the office were placed by using rviz Markers. Then the markers can be used as the navigation goals for the robot.

Results

By testing different techniques and methodologies an optimal solution could be implemented with time and resources available. The implemented simulated robot worked well with mapping and Figure 3 shows an intermediary step of mapping the environment. However, some problems occurred with localization. Further modifications to the sensor calibration is needed and that is why the map is not sharp enough. They can be oversome with further work.
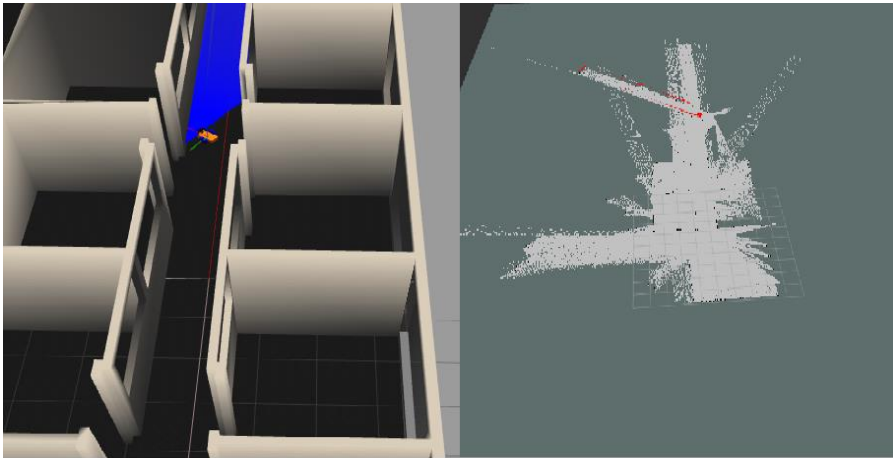
Figure 3: An intermediary step of mapping the environment

The actual robot implemented is shown in Figure 4. In the simulation, Hokuyo LIDAR (lidar-laser-scanner, n.d.) was used for testing the algorithms. Since Hokuyo LIDAR was expensive a Neato LIDAR (neato-s-lidar-module, n.d.) had to be used for the actual implementation. It was compatible enough for the task.

Figure 4: Front view of the robot
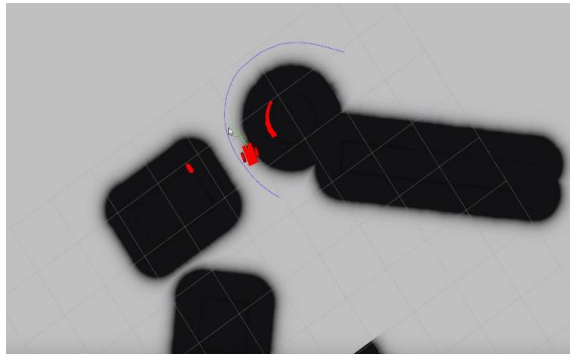
Figure 5: A test scenario of autonomous navigation with one of the gazebo's default environments

While testing the software with the default environments in gazebo, it achieved the autonomous navigation to the defined goals which is shown by the Figure 5. The blue line indicates the global path and the green line indicates the local path.

The motor controller did not support the low Pulse Width Modulation (PWM) frequencies which should be used to smooth navigation and they need to be replaced by compatible motor controllers. A substantial computational power was needed to do all these tasks simultaneously, as a solution Jetson TK1 (jetson-tk1-embedded-dev-ki, n.d.) development kit is used in a distributed environment with a laptop. Then there was the limitation of network bandwidth. Autonomous exploration couldn't be implemented successfully because further adjustments has to be done in order to implement successful loop closing algorithms. So the map should be generated first by controlling the robot manually.

Conclusion

The application was evidently with errors, but with time and further fine-tuning more results can be achieved. Improving loop closing rate is a fact to be considered. And the robot was designed to implement 3D SLAM also, hence 3D SLAM should also be incorporated in future. But overall results of the system are in a satisfactory level because an optimal solution for a robotic assistant which is idle an office environment was implemented which is capable of autonomous navigation from one place to another. And it is a fact to be mentioned that in Sri Lanka these SLAM techniques are not yet established in the academic society. So if this research can minimize that loop hole to a certain level, then it will worth the effort, time and cost.

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A reinforcement learning approach to enhance the trust level of MANETs

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Abstract

A Mobile ad-hoc network (MANET) consists of many freely interconnected and autonomous nodes that is often composed of mobile devices. MANETs are decentralized and self-organized wireless communication systems, which are able to arrange themselves in various ways and have no fixed infrastructure. Since MANETs are mobile, the network topology is changing rapidly and unpredictably. Because of this nature of mobility of the nodes in MANETs, the main problems that occur are unreliable communications and weak security where the data can be compromised or easily misused. Therefore, a trust enhancement approach to a MANET is proposed which is RLTM (Reinforcement Learning Trust Manager), a set of algorithms, considering Ad-hoc On-demand Distance Vector (AODV) protocol as the specific protocol, via Reinforcement Learning (RL) and Deep Learning concepts. The proposed system consists of RL agent, who learns to detect and give predictions on trustworthy nodes, reputed nodes, and malicious nodes and classifies them. The identified parameters from AODV simulation using Network Simulator-3(NS-3) were given to the designed RNN (Recurrent Neural Network) model and results were evaluated.

Keywords: Ad-hoc On-demand Distance Vector (AODV), Mobile-ad-hoc network (MANET), Reinforcement Learning (RL), Recurrent Neural Network (RNN)

Introduction

With the growth of the ubiquitous computing, the concepts of the Internet of Things (IoT) security or Wireless Network security have become an interesting research area through the past two decades. With the improvement of wireless communication technologies Mobile-ad-hoc network (MANETs) play a vital role, but there are some issues due to the direct effect of mobility of the nodes to the network environment such as unreliability of communication and weak physical protection. This may provide an opportunity for an adversary to steal or misuse the data. The reliability of the connectivity depend on the trust of each node. Because of these issues, many studies have been conducted to enhance the trust within MANETs. Jain (2015) defines the trust in Mobile Ad-hoc Networks simply as the adherence of a node to a given specific protocol where it can be an enabler of communication and cooperation. When compared to the infrastructure-based networks, since they have a dynamic topology, error-prone communication media, and energy constraining nodes, MANETs are more liable to malicious attacks and random failures (Li, et al., 2011). In Mobile ad-hoc networks, the corresponding functions such as network management, packet forwarding, and routing are carried by all available nodes without having a set of dedicated nodes for functioning. Therefore, one node can be captured by an adversary which may lead to node misbehaviour or non-cooperated behaviour with the rest of the nodes in the network and aims at damaging other nodes

by becoming a malicious node. Hence, a node in a MANET can be subjected to various types of attacks such as node capture, eavesdropping, worm-hole, Sybil attack, sink-hole and denial of service (Sivagurunathan, 2016). Due to these attacks, valuable confidential data could be compromised, misused, with even the possibility of a total breakdown of the network. Hence, the major arising challenge in MANETs is the need of trust since reliable connectivity is considered as the backbone of a network. The corresponding research work focuses on enhancing the trust level of a MANET using a reinforcement learning mechanism specifying the AODV routing protocol (Perkins, 2003).

Methodology

The proposed approach consists of two major tasks, which are the MANET simulation for the purpose of parameter extraction and the development of deep reinforcement learning agent in order to calculate the trust values. Hence, the developed system RLTM (Reinforcement Learning Trust Manager) can be divided into two sets of algorithms which is Flow monitor for network simulation within NS-3 and the trust prediction Reinforcement Learning (RL) model. The specified routing protocol is Ad-hoc On-demand Distance Vector (AODV).
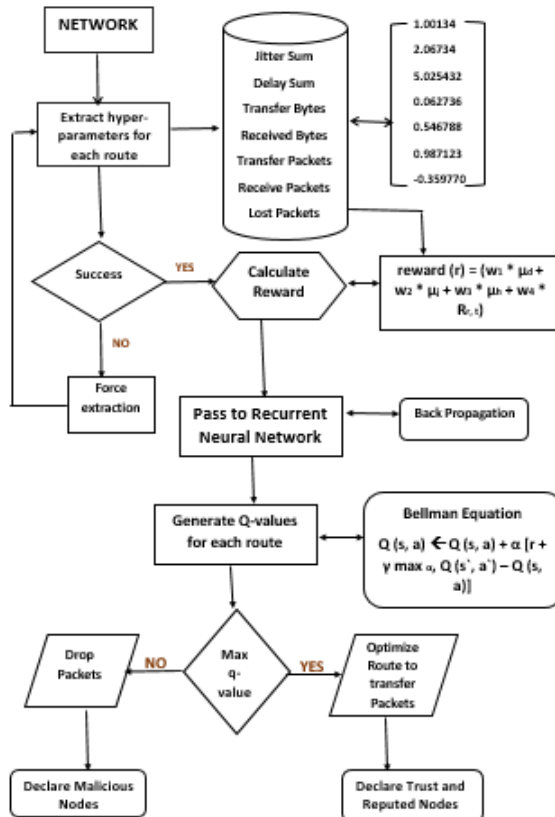
Figure 1: Process flow of generating output through RNN

As shown in Figure 1, to generate the relevant Reinforcement learning algorithm, we need to extract the relevant network and node features accordingly. For the feature extraction and testing purpose, a network where a number of nodes vary from 16 to 49 is developed within Network Simulator (NS3). From the simulation of the

designed network with the use of AODV routing protocol related hyper-parameters were extracted, and relevant cost functions were generated to detect trusted, reputed, and malicious nodes in the network and a Q-learning algorithm is developed.

Results

The evaluated results examine the performance of the network in different perspectives including accuracy of the model, transmission rate and loss in the model. Figure 2 represents the evaluated Q values after applying the proposed approach, RLTM. The transmission rate has increased after applying RLTM and therefore, can conclude that the performance of the network has improved.
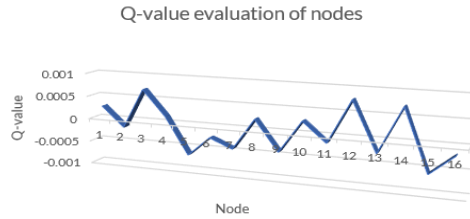
Figure 2: Q-value evaluation of nodes

Figure 3 and Figure 4 shows the accuracy and the loss summarization of the model respectively, evaluated related to the change of the number of epochs and number of nodes. As shown by the following figures, when no of epochs and nodes increases, the accuracy of the model increases, and loss decreased. Generally, it is considered that a high and constant value for the accuracy of the model and low loss rate indicates that the trained model is highly accurate and gives optimal results.

(a) Accuracy and loss of model for 500 epochs

(b) Accuracy and loss of model for 1000 epochs
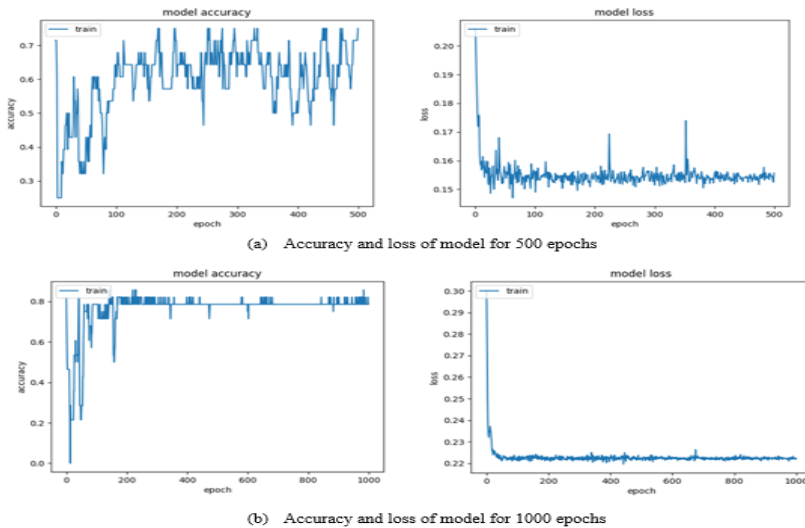
Figure 3: Accuracy and loss of the model for different number of epochs
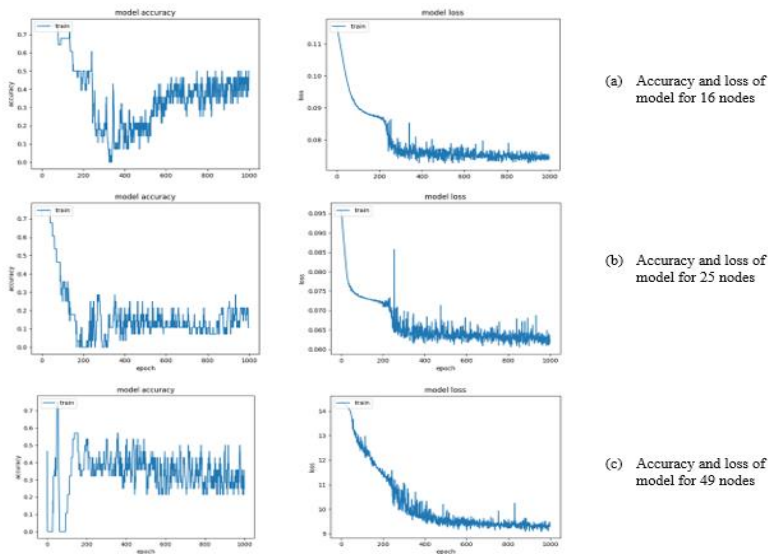
Figure 4: Accuracy and loss of the model in different node densities

Conclusion

A generic Reinforcement Model is presented to enhance the trust level in MANETs. It was developed classifying users by trust, reputation and malicious behaviour using a Q-value evaluation, to update the AODV routing protocol to find the best routes and to create a trusted network infrastructure. Empirical results show that the proposed Q- Learning approach provides accurate results on calculating the trust level. The algorithms and frameworks used in this study can be modified to work with more intelligence. As an example, all the algorithms can be interpreted as multi-agent environments using game theory coupled up with reinforcement learning. This will provide cooperative game theory solutions that provide an overall improvement in detecting malicious behaviours within the network. Further improvement can be made in overheads created by additional packets generated within the network by using the above-mentioned methodology. Next, implementations can be more tightly integrated when there are more social friendly API's available to lower layer protocols. As an example, the social trust development can be further modified and better accurate results obtained with modern day social network API's. However, there are limitations for the use such API's.

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Abstract No: SC-07   **Smart Computing**

Automatic smart parking system using Internet of Things (IoT)

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Abstract

Internet of Things (IoT) plays a vital role in connecting the surrounding environmental things to the network. The IoT is a system of interrelated computing devices that are provided with identifier and the ability to transfer data over a network without requiring human and computer interaction. These type of technologies are used to connect un-internet devices to the network from any remote location. With the number of vehicles on the roads climbing steeply over the last few years, motorists face problems in parking vehicles in designated slots in the city. In this paper a Smart Parking System is designed which enables the user to find the nearest parking area and provide the information about the availability of parking slot to the motorist. The system mainly focuses on reducing the time of finding the parking area and avoids unnecessary travelling through filled parking lots in a parking area. Thus it reduces fuel consumption and minimizes carbon emissions as well.

Keywords: Automatic smart parking, IoT, Web page, Wi-Fi

Introduction

Internet of things was first introduced in 1999 at auto-ID center and initially used by Kevin Ashton. As an evolving technology, it promises to connect all our surrounding things to a network which communicates with each other with minimal human involvement. Still Internet of Things (IoT) is at an initial stage and still there is no common architecture for it (Atsori et al., 2010). There is lot of research and implementations currently ongoing in many areas, though, there is no guidelines or boundaries to exactly define IoT. Hence, depending on the context, application of the internet of things has different definitions. It is defined as the things present in the physical world or in an environment that are attached with sensors or with any embedded systems and made connected to a network via wired or wireless connections (Karimi and Atkinson, 2013; Albano et al., 2007). These connected devices are called smart devices or smart objects. It consists of smart machines which communicate by interacting with other machines, environment and objects. It also covers connection between machine and a person as well.

The Smart Parking System (SPS) using IoT is a technology that uses any computer or mobile devices to control basic functionality. Its features automatically link through the Internet and thus are easily operable from anywhere around the world. It is meant to save time, electricity and eventually minimize human effort to a great extent. The SPS system differs from other existing system by allowing the user to easily operate and monitor their system's functioning from anywhere in the world through an Internet connection. This paper presents a SPS using Arduino Mega micro-controllers that ues elements like: lights, sensors, and appliances falling within their working range of the designated environment. It also possesses the ability to store all the records and activities for future reference purposes. This system is designed to help its users, by assisting them with their parking of vehicles in the car park lot. The system will automatically provide all the details in the parking areas on

the basis of processing all the sensor data. It is designed to be running on a low-budget platform and in the meantime, allow its developers to eventually work-on and expand their controls over a variety of other inter-connected electronic devices.

Methodology

An embedded system is a combination of software and hardware to perform a dedicated task. Some of the main devices used in embedded products are Microprocessors and Microcontrollers. Microprocessors are commonly referred to as general purpose processors as they simply accept the inputs, process it and give the output. In contrast, a microcontroller not only accepts the data as inputs but also manipulates it, interfaces the data with various devices, controls the data and thus finally gives the result. The project "IoT based Smart Parking system" was designed such that the status of parking slots can be known from anywhere in the users webpage.

    a)   Implementation

The parking system is designed in such a way that it is applicable for covered parks, open parks and street side parking. Figure1 shows the cloud based IoT architecture for smart parking system which contains cloud service provider who will provide services to store information about status of parking slots in a parking area. The centralized server stores entire smart parking systems information such as number of slots and availability of vehicles. This information will be accessed via a secured gateway through the network.

This smart parking system which consists of several components. Their functionality includes:

- Centralized server: maintains databases which contain information about parking spaces present in the city.

- Raspberry pi: the microcontroller which is used to implement our parking system and is attached with raspberry pi camera.

- Image capture: Pi-camera is used to capture the picture of parking area continuously to validate the slots which are either filled or empty.

- Navigation system: signals the availability of parking slots to the users and navigates to the exact location of nearest parking area from current location.

- Display device: a monitor or tab is used to display the adminitration interface and is capable of modifying the parking lots by observing the device.

- User device: user can connect with the smart parking system with their smart phones or with some browsers.
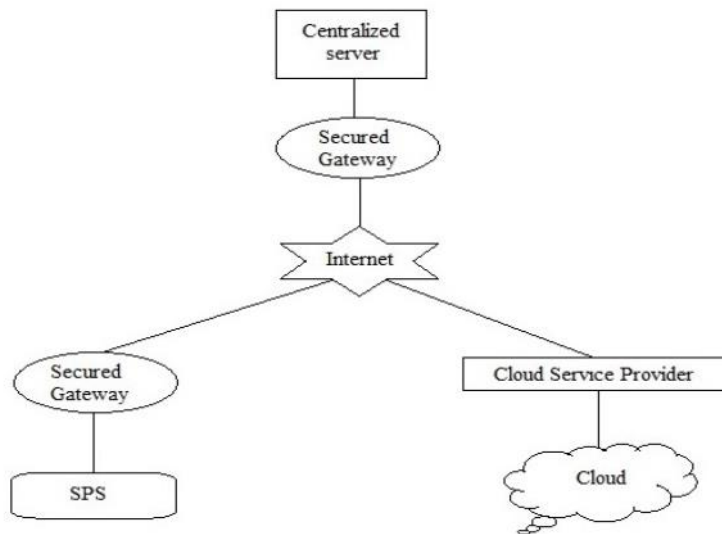
Figure 1: Architecture of proposed ystem

The SPS incorporates the features of raspberry pi 2 and is attached with pi camera. Where pi camera is mounted on the top of street light lamp posts or at the ceiling of indoor parks. Thus camera is capable of making survey on each parking slots in parking lots continuously to check whether the particular slot is filled or empty. Figure 2 presents the structure of smart parking system and it contains some control points on each parking slot which will be used as reference points for the camera. The central server presents information about multiple slots in a single parking area and multiple parking areas in a single city and it is accessed through some protocols such as HTTP from any browsers. The website is built with basic JSON interface.
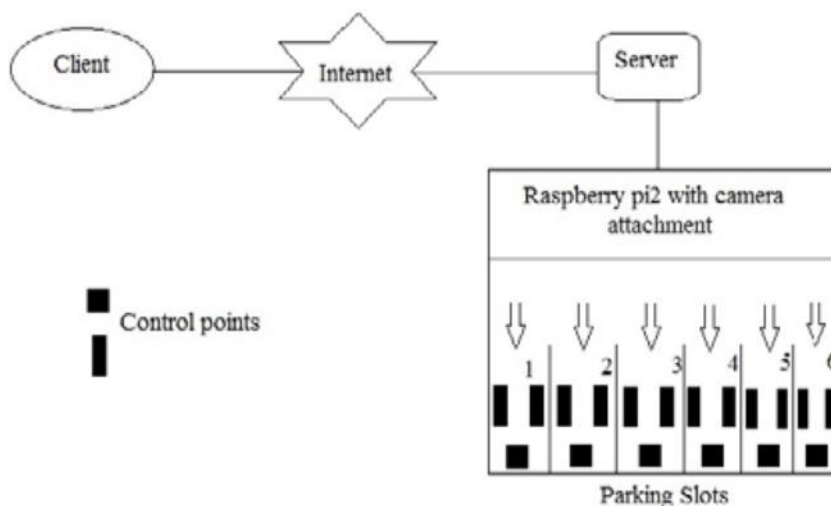
Figure 2: Structure of Smart Parking System

When the availability of parking slots changes, immediately the information is updated to the central server. Then user can access this stored information using internet from any location. Besides, this information is used by parking operators to determine free parking areas and statistics can be measured at different times in a day on each parking space.

An adequate user interface is provided so that client can access the necessary information about the system. The administrator is capable of creating new parking areas by providing the description or information about the parking area and also can manage the parking slots including the addition of new and deletion of existing parking slots in a parking area. The updated timing of each parking slot is shown along with unique number. Further above all, this user interface provides the information required for the motorist to navigate from their current location to their destination.

Conclusion

This designed automatic smart parking system is simple, economical and provides effective solution to limited parking lots in the city while reducing the emission of fumes to the atmosphere. It is deigned to access and map the status of parking slots from any remote location through a web browser. It reduces the risk of not finding designated parking slots in the city and eliminates unnecessary travelling of vehicles across the filled parking slots in a city.

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Abstract No: SC-08   **Smart Computing**

Analysis and detection of potentially harmful Android applications using machine learning

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Abstract

With the rapid advancement of technology today, smartphones have become more and more powerful and attract a huge number of users with new features provided by mobile device operating systems such as Android and iOS. Android extended its lead by capturing 86% of the total market in 2017 (Gartner, 2017) and became the most popular mobile operating system. However, this huge demand and freedom has made the hackers and cybercriminals more curious to generate malicious apps towards the Android operating system. Thus, research on effective and efficient mobile threat analysis becomes an emerging and important topic in cybersecurity research area. This paper proposes a static-dynamic hybrid malware detecting scheme for Android applications. While the static analysis could be fast, and less resource consuming technique and dynamic analysis can be used for high complexity and deep analysis. The suggested methods can automatically deliver an unknown application for both static and dynamic analysis and determine whether Android application is a malware or not. The experimental results show that the suggested scheme is effective as its detection accuracy can achieve to 93% ~ 100%. The findings have been more accurate in identifying Android malwares rather than separating those two static and dynamic behaviors. Furthermore, this research compares the machine learning algorithms for static and dynamic analysis of the Android malwares and compare the accuracy by the data used to train the machine learning models. It reveals Deep Neural Networks and SVM can be used for and higher accuracy. In addition, era of the training and testing dataset highly effect the accuracy of the results regarding Android applications.

Keywords: Android, Machine learning, Malware detection, Security

Introduction

Android operating system, which can be found on a wide range of devices, is developed by Google and powered using the Linux kernel. It is an open source operating system, which allows mobile application developers to access unlocked hardware and develop new apps as they wish.

Android application development and Android mobile market has been expanding tremendously in last few years. One of the major reason behind the success of Android OS is easy application development and distribution. Google Play Store and many other Android application markets across the globe allow developers to upload and distribute their applications almost in real time.

People tend to store / collect their life moments, photos, videos, contacts and many more private and confidential information in their mobile phones. Even nowadays, they pay for the goods and store payment information on their phones. Due to the development of IoT technologies they use smart phones to control their environment. Simply smartphones have become essential items in day-to-day life in modern

society. Therefore, necessary actions must be taken to secure the data and other relevant areas in smart phones from malwares. Malware is an abbreviated term meaning "Malicious Software." This is software that is specifically designed to gain access or damage a computer without the knowledge of the owner (Kaspersky, 2017). Google regularly enhances its security services for Android. In 2016, they used machine learning and statistical analysis to further automate and speed up detection of Potentially Harmful Applications (PHAs) and other threats (Google, 2016). In recent years, some malware detecting methods have been proposed, and these methods can be classified into two classes: static analysis and dynamic analysis (Vajdi et al., 2016).

Static analysis is analyzing a software without executing the software. Static analysis usually involves disassembling a software and analyzing the top code sequences, the control flow graphs. Most static analysis methods simply use permission as feature for analysis, which has low complexity. Besides, API is another static analysis feature which can achieve higher accuracy with increase of complexity. Though static analyzing may complete malware detection with low cost.

Dynamic analysis focuses on the runtime behavior of the application. The analysis involves the execution and monitoring and data collection is carried out at the system, network and memory levels. The system-level data includes system calls and system functions invoked by the applications. The network-level data includes DNS requests, payloads, domains and IP addresses contacted by applications.

Hybrid analysis of malware combines the advantages of both static and dynamic analysis. This research proposed a hybrid approach for detecting malwares regarding Android platform.

Methodology
This hybrid analysis approach utilizes the combination of static and dynamic analysis. This approach might be resource intensive and time consuming sometimes, but at the same time it can provides most significant, accurate results due to the completeness of data. The static analysis is usually time-efficient, but the dynamic analysis is more depth oriented. The hybrid analysis allows for the creation of robust signatures and the extraction of dynamic detection features as well as the gathering of the maximum number of features. As a result, this analysis performs more accurate detection as well as the in-depth analysis and signature creation.

In this case, that is needed to develop a methodology to identify malwares and potentially harmfully applications using currently available data-set. Therefore, the best way to overcome this is train a model using currently identified malware samples and their behaviors. It would be better if we can use Machine Learning algorithms for that. Machine learning is a branch of science that deals with programming the systems in such a way that they automatically learn and improve with experience. Learning means recognizing and understanding the input data and making wise decisions based on the supplied data.

This research used Decision Trees, Random Forest (RF), SVM and Deep Neural Networks as the classification algorithms. And those are selected due to literature review and based on experience in machine learning. In RF we have used 100 decision trees to overcome the overfitting issue. In the DNN we have used 10 hidden layers with 0.005 learning rate, 0.1 initial learning weight and 250 iterations. Data collected by several cybersecurity research centers for training and validation purposes was used for this study. The dataset, called the "SherLock Dataset" contains billions of data records over a few years (Mirsky et al., 2016). Android Malware

Dataset (AMD) contains 24,650 samples, categorized in 135 varieties among 71 malware families ranging from 2010 to 2016 (Wei et al., 2017). Both datasets and self-generated dataset by Android applications used for this research.

For static analysis, this research used features that contains the permission declared in the android application such as ACCESS_ALL_DOWNLOADS, READ_INPUT_STATE etc. Furthermore, for dynamic analysis this research selected features such as hash, millisecond, state, usage_counter, priority, static priority which obtain from Android runtime behavior.

To implement this approach, initially we create a model for static analysis using the data for static behavior. Then the same approach was applied to analyze the dynamic behavior. Then we can train the designed models using possible machine learning algorithms. At the end of this process, we can get two models with feature weights for both static behavior and dynamic behavior. After designing the model, the next process is to train it with 80% of the collected data. This process is an iterative process to identify the best model to classify. Validation process was done with the remaining 20% of data. Chosen model can be used with other applications to analyze and detect the malwares in Android context.

First in static analysis process, the application APK file will decompile using open-source tools (Androguard) to get the code as mentioned above. Our proposed method will extract permission information and API call information from the re-engineered application and generate a feature vector from it.

Before going in to the dynamic analysis part, it will check whether it's a possible malware or not using saved model because by that we can reduce time and resources. If it's not a malware it will be sent to the dynamic analysis for further validation.In the dynamic analysis process, our scheme logs the dynamic behavior of the app using virtual environment and generate a feature vector from it for the analyzation part. To do the dynamic analyzation part, feature vector from dynamic behavior will compare with relevant model. To implement this solution this research has used Python, TensorFlow, Keras, Sci-Kit and Jupyter Notebook.

Results

At the end, testing accuracy for static and dynamic analysis as separate procedures, with used algorithms can be summarized as follows.

Table 1: Analysis results

Algorithm	Static Analyze Accuracy	Dynamic Analyze Accuracy
Decision Trees	92 % - 93 %	94 %
Random Forests	93 %	95 %
SVM	90 %	100 %
Neural Networks	94 %	-

Deep learning techniques learn by creating a more abstract representation of data as the network grows deeper; as a result, the model automatically extracts features and yields higher accuracy results. To test and validate the developed hybrid model, we have selected Android malware and benign application samples from totally different data source and process with the model. In this case, we have selected 10 malware applications and 10 benign applications to test. Out of 10 malware applications, 8 applications identified as a malware in the static analyze stage and 2 applications were not identify as malwares. In the dynamic analysis, stage those 2 malwares which is not identified in the static stage were captured as malwares. Therefore, we can

argue that there is a better chance of identifying malwares in combined hybrid model. In the other hand, since 8 of malwares identify as in the initial stage (static stage), resource and time wastage were reduced. In addition, possible harm from those applications were reduced before installing, showing that the combination of these two mechanisms can provide high accuracy and efficiency in detecting malware.

Conclusion

This research revealed, what are the better approaches in each static and dynamic analysis of malware detection and what are the important features in static malware analyze. For the analyzation of static behavior of the Android malwares and benign applications, our result shows the implementation of Neural network can give better accuracy than other mechanisms for selected feature vector. In dynamic behavior analysis, we perform three machine learning classification algorithms and Support Vector Machine gives the best overall accuracy. Furthermore, we observe that different machine learning approaches utilize different number of features.

This research proposed a hybrid model to analysis and detection regarding Android malwares. Moreover, the result shows that it's better to use this kind of hybrid approach rather than separating static and dynamic malware analysis.

We note several possible confounding factors that can affect experiments using the selected outdated apps alongside more modern benign apps. Changes in Android specifications cause in above kind of scenario. Android has quickly evolved in the past 5 years bringing major changes to its APIs, permissions, and intents that have long been used as distinguishing features. Features either evolved or devolved over time will look discriminative between malware and benign apps. For example, if we use outdated malware and benign application data to train the classification model, accuracy would be questionable in analyzing modern applications. Furthermore, as a future enhancement, currently we are observing and developing an architecture to implement this methodology as a service to consume from anywhere.

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A wireless sensor network based autonomous logistic trolley system for factory automation

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Abstract

This paper presents the low cost autonomous logistic trolley for factory automation. Automation can be defined as the technology by which a process or procedure is performed without human assistance. Factory automation has automated the factory manufacturing process without human interaction. It will increase the efficiency of the manufacturing process, make the process highly accurate and because of less man power it will increase the revenue margin of the factory. The system primarily consists of a *Arduino Uno* board, *ultrasound sensors*, *infrared proximity sensors*, *Bluetooth modules*, *DC motors*, and *Servo motors.* This system mainly includes obstacle detection, line tracking, Bluetooth request transferring technologies and motion control technologies. This trolley is called up by a production desk of the factory if materials are needed, by sending a request. Trolley automatically deliveres the material to that exact production desk using its infrared sensors that are placed at both left and right sides of the vehicle. This can be used to identify each production line. This proposed autonomous trolley was experimented in different methods. It showed very accurate and successful results. This kind of autonomous trolley provides a wide range of benefits to a manufacturing process in a factory. This autonomous logistic trolley is low cost, less complicated and will increase efficiency of the manufacturing process of a factory.

Keywords: Arduino, Automation, Robotics, Wireless sensor network

Introduction

This low cost autonomous logistic trolley is specifically useful for factory automation. This trolley can be used to deliver production material inside the factory. This system is based on *Arduino Uno board*. In addition to that, *Ultrasound sensors, IR proximity sensors, Bluetooth modules, DC motors*, and *Servo motors* are also used for this system. This system mainly includes *Obstacle detection*, *Line tracking*, *Bluetooth request transferring* technologies and *motion control* technologies. Most factories use automation robots or tools for their factories. Production systems in the future will have to be able to adapt speedily to changing market needs (Telschig & Knapp, 2017). Wireless factory automation has been receiving much interest in recent years due to its advantages of low cost and high flexibility over the traditional wired networks (Ashraf et al., 2016). Factories can derive the maximum benefit of having autonomous robots or tools. Increasing accuracy, efficiency of production, and minimum man power wastage are some of the advantages of having this kind of system. The presence of wireless technologies in industrial communication systems has steadily increased over the past decade. Machine builders see the main advantages of wireless with increased flexibility. e.g. by establishing communication to hardly accessible or moving devices. In addition, wireless technologies offer the potential to decrease installation and maintenance costs. e.g. by replacing highly stressed, costly, and error prone connectors like slip rings or sliding contacts (Bauer

et al., 2014). An important part of the transportation process is the docking maneuver: the action of picking up material containers from the storage areas known as supermarkets (Kalelkar at el., 2013). There are thousands of factories, manufacturing variety of products. However, some factories are using minimum automation techniquesbecause of high initial cost, man power being cheap, lack of technicians or knowledgeable persons. In this paper, a low cost factory automation trolley that can be used for any transportation purpose inside the factory premises is proposed. Using this kind of automated trolley factory can improve efficiency rates by delivering raw materials inside the premises between production lines.

Methodology

The system is designed using different hardware components. The software is used to write the program for the autonomous logistic trolley to perform different actions under different conditions.

This proposed system uses an Arduino Uno project board. Furthermore, it uses Ultrasonic sensors as an obstacle detector of the trolley. Bluetooth modules are chiefly used for signal transferring purposes. Bluetooth beacons are placed in factory premises at every production line. This demonstrated autonomous trolley has two DC motors, connected to its back. The wheels are responsible for the back and forth movement of the vehicle. A 12V rechargeable battery is used to power the DC motors.
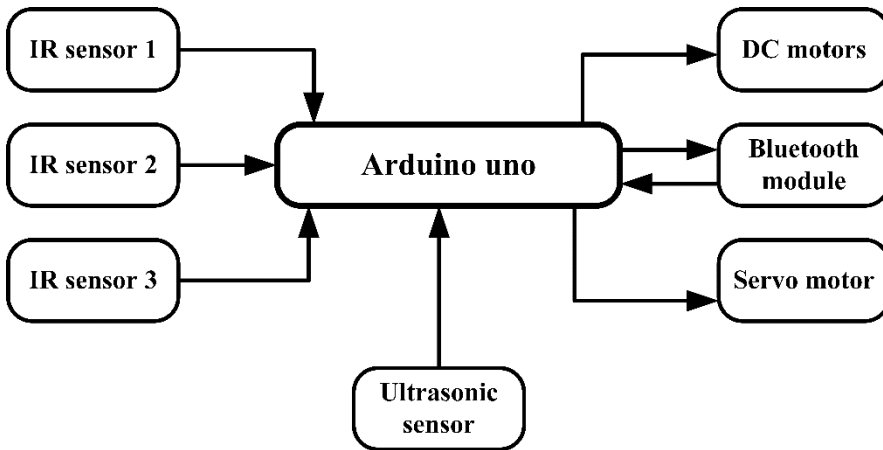
Figure 1: Structure of the project

Two infrared sensors are placed at the bottom of the trolley. It detects the black line on the floor and trolley follows the line to carry materials to the production line. In addition to that this trolley has 2 extra infrared sensors. These identify the crosses at the tracking line to identify the production lines. If the command is go ahead, check sensors. If left sensor detects the line then turn right, else if right sensor detects the line, then turn left and else middle sensor detects the track line, then go forward. Figure 1 shows the schematic diagram of the autonomous trolley. The different hardware components are connected together for its operation.

Proposed System

a) Requesting signal

Bluetooth beacons are placed in every production and employee of that production line can request materials from the main station. Then through the trolley gets the signal to go there with supply materials.
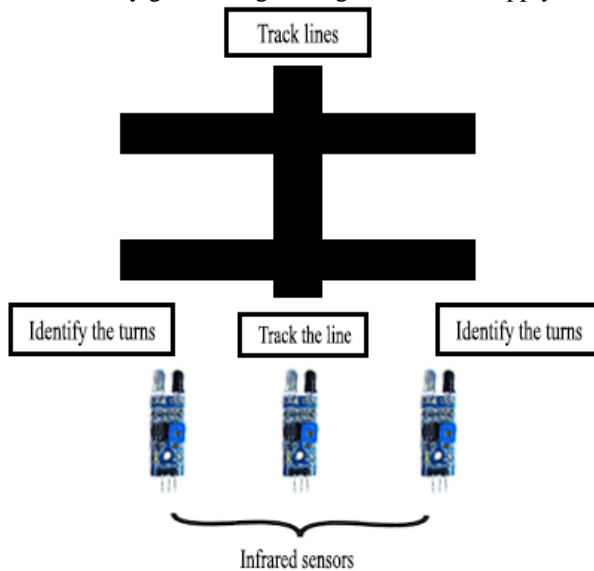
b) Following lines

Every trolley is implemented with 3 infrared proximity sensors, as seen in Figure 2. Floor of the factory premises is covered with black lines from the main station to the production line. (Pakdaman & Sanaatiyan, 2009) Proximity sensors can identify that clear black line marked on the floor. Therefore, a trolley can go to the requested production line, following the marked line on the floor. This system identifies

Figure 2: Sensors and track movement

the production desk by counting the black crosses, using its extra infrared sensors placed on both sides.

c) Obstacle detection

This trolley is also implemented with an ultrasonic sensor and a servo motor. It can assist the trolley to avoid obstacles (Wang & Chen, 2016). This sensor is placed on the servo motor using a small plastic piece. If no obstacle is detected, turn the servo to initial position, turn the chassis to right, move forward. If obstacle detected in right side, look left (130'), if there is no obstacle turn the servo to initial position turn the chassis left, move forward in that direction. If obstacle detected in all 3 directions, rotate the trolley 180 degrees and go forward. Once the package is delivered to the production line, trolley returns back to the main station.

Results

The autonomous trolley was tested in an environment having a proper black line on the floor and several obstacles in different positions on the line. It showed accurate and successful results. The movements of the trolley, speed variations, navigation and control of the trolley were also observed. Likewise, experimented with this trolley by placing a few of the crosses on the tracking line as Figure 2 showed. Using "Android Arduino Bluetooth remote control application" a signal issent to the trolley. The trolley was successful at every situation and all of them showed expected result as showed in Table 1 below.

Table 1: Result chart

Test	Percentage of accuracy
Number of Barriers faced successfully	85%
Times that tracks were not missed	75%
Times of responses to the Bluetooth request successfully	75%

Conclusion

This paper proposes a low cost autonomous logistic trolley. As mentioned earlier, this project is based on the Arduino board, couple of DC motors and servo motor, Bluetooth module, Ultrasonic sensor and IR sensors. This system was shown to obtain can obtain very accurate results. Large scale factories can get maximum benefit from implementing this kind of trolley. This autonomous logistic trolley is low cost, less complicated, energy saving, accurate and saves labour hours.

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A self-configuring communication protocol stack for fog-based mobile ad-hoc networks

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Abstract

This paper introduces a self-configuring communication protocol stack for fog-based mobile ad-hoc networks. The rapid development of Internet of Things (IoT) technologies have made mobile ad-hoc networks (MANETs) to become pervasive in our everyday lives. In MANETs, the nodes dynamically get connected and disconnected with other nodes of the network while maintaining the quality of service (QoS). However, when the devices have to contact frequently to cloud-based servers for various services and, as well as when the number of devices connected increases, the QoS could drop drastically due to high bandwidth consumption and the consequent latency. Fog computing (as well as edge computing) aims at shifting data processing and other services offered by cloud-based servers in a computer network towards the edge of the network to minimize the issues raised due to latency. Given these circumstances, combining 'fog computing' with MANETs seems a promising solution that enhances the QoS. However, the definition of fog computing is still debatable and, as well as the technologies are still being developed. Even though a reasonable foundation has been laid by the various concepts, there is a necessity for further research on different algorithms to meet the harsh requirements of node discovery, connectivity, communication and latency when combining fog computing with MANETs. The protocol stack presented in this paper addresses the issue of node discovery and peer-to-peer communication in MANETs in a fog network. The methodology involves a build and test approach in which the conceptual protocol stack has been implemented for messaging between mobile peers in a Wi-Fi network without connecting to the Internet.

Keywords: Fog computing, Internet of Things, MANETs, Node discovery

Introduction

The rapid development of Internet of Things (IoT) technologies have made mobile ad-hoc networks (MANETs) to become pervasive in our everyday lives. Even though the military tactical communication could be considered as the fundamental or primary application of MANETs (Giordano, 2002), there is a growing range of commercial and other applications such as vehicular ad-hoc networks (VANETs) (Kai et al., 2016), sensor networks, rescue missions in natural disasters, low enforcement operations, etc. (Giordano, 2002). There will be 50 billion connected mobile devices by 2020 according to Cisco and these impressive numbers will soon be overpassed by the myriad of sensing/acting devices placed virtually everywhere (Vaquero and Rodero-Merino, 2014). According to (Das, 2013), MANETs have the key characteristics of dynamic topology, shared medium, absence of infrastructure, multi-hop scenario and resource constraints. Thus, maintaining the quality of service (QoS) in MANETs is always challenging.

When the number of nodes connecting with a MANET grows, for example in IoT environments like VANETs, there would be a huge demand for resources such as

computing, storage and networking. However, the latency resulting from the communication bottlenecks created by millions of devices connecting to the Internet for cloud-based services would disqualify cloud computing as a solution that satisfies the demands of MANETs. Alternatively, fog computing, which means an extension of cloud computing paradigm from the core of the network its edge (Yi et al., 2015), minimize the issues raised due to latency as fog computing eliminates the need for the end-point devices to reach the core of the network every time they require a computing service. Given these circumstances, combining 'fog computing' with MANETs seems a promising solution that enhances the QoS.

However, the definition of fog computing is still debatable as well as the technologies are still being developed. Even though a reasonable foundation has been laid by the concepts of software defined networks (SDN) and network function virtualization (NFV), there is a necessity for further research on different algorithms to meet the harsh requirements of node discovery, connectivity, communication and latency when combining fog computing with MANETs (Yi et al., 2015). According to (Vaquero and Rodero-Merino, 2014), the open challenges to make fog a reality are 1. Discovery/Sync, 2. Compute/storage limitations, 3. Device/configuration management, 4. Security, 5. Standardization, 6. Accountability/Monetization and 7. Programmability.

The protocol stack presented in this paper addresses the issues of configuration management, node discovery and peer-to-peer communication in MANETs in a fog network. In other words, it enables nodes to connect a MANET with less number of configuration messages, discover nodes with required services and communicate data such as text, image, voice, video, etc. with the discovered nodes with minimum latency.
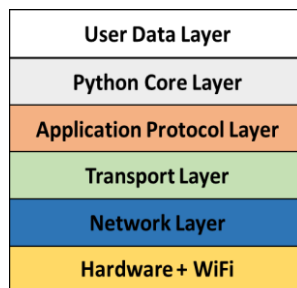
Figure 1: Layers of the proposed protocol stack

Methodology

The methodology involves a build and test approach, in which the conceptual protocol stack has been implemented for messaging between mobile peers completely unknown to each other, in a Wi-Fi network without connecting to the Internet. The proposed protocol stack, depicted by Figure 1, includes discovering peers, establishing communication with them and handling communication with peers as core functionalities. The protocol stack has six layers as follows.

- **User data layer**: directly works with the front-end of the application involving text, voice or other mediums.
- **Python core layer**: works with front-end and back-end of the application that implements various algorithms and server procedures.
- **Application protocol layer**: works with application layer protocols such as FTP, RDP, Chat, etc. that maps user input with the end device layer.

- **Transport layer**: Responsible for the UDP streams of data to be transferred to the destination.
- **Network layer**: responsible for IP addressing
- **Hardware with Wi-Fi**: works as data link layer and physical layer

The protocol stack was implemented and tested for text messaging in a private Wi-Fi environment where the nodes (i.e. mobile devices) ideally could communicate with other nodes, not only by means of text but also by other means such as voice, image, video, etc. There, the key algorithms that implements the intended functionality of the protocol stack includes *Node arrival, Node departure, Data transfer, File sharing, Master role assignment,* and *Chat master*. A console application that runs on Microsoft Windows platform was developed with the proposed protocol suite. The application was tested for a messaging environment.

Results
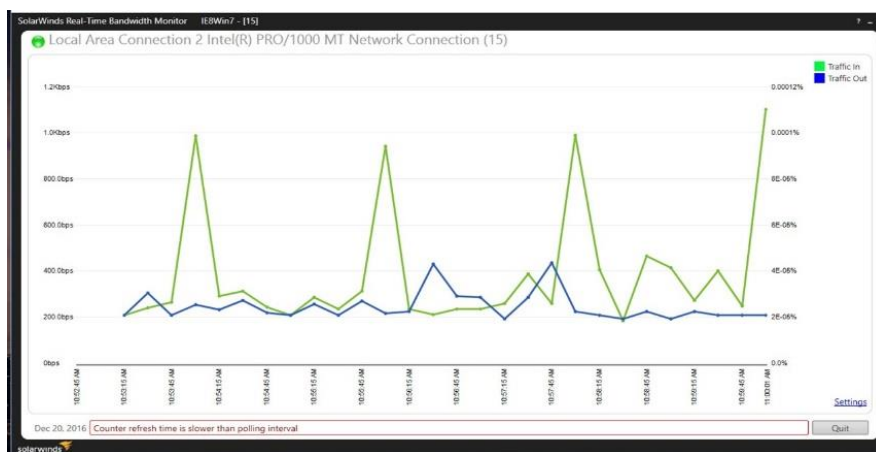
Figure 2: Bandwidth usage for three-member chat
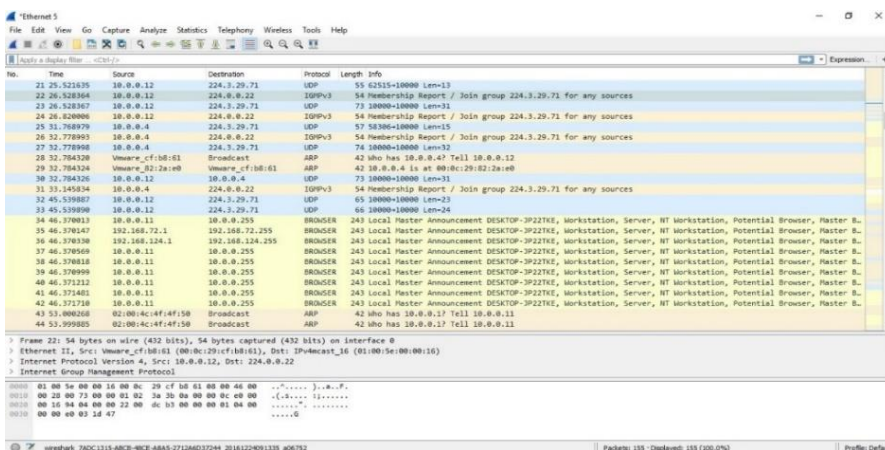
Figure 3: Overall packet capture of the application process

Figure 2 depicts the bandwidth consumption for 3 peer communication and Figure 3 depicts Wireshark packet capture analysis to explain the behavior of the protocol messages. The results of the communication between nodes on this application were

analyzed by using Wireshark and Solar-wind bandwidth monitor. The experimental results prove that the proposed protocol stack to be positive and fault tolerant in terms of the algorithms used, interoperability, simplicity, security, configurations and bandwidth consumption. The protocol suit is portable and could be plugged with any device running on any platform (interoperable) and due to the very small size, it puts less weight on the operating system as overheads (simple). Security implementation is by two means; encryption and logical grouping. Configuration is almost zero as except providing application host name and access privileges, all the other configurations are done by the protocol itself.

Conclusion

The proposed protocol stack, when tested for a text messaging context in a private Wi-Fi network, proved to be working fine with significant performance. Even though it is not particularly tested for a fog-based MANET environment, the test environment described in this paper is similar to a MANET. The Wi-Fi router in a private network, with enhanced functionality, could act as a fog device in a MANET that provide the necessary resources for the end-point devices to function. Therefore, it is possible to reasonably argue that the proposed protocol stack could be applied to a fog-based MANET for node discovery and peer-to-peer communication.

However, the proposed protocol stack has one major limitation associated with it. Basically, during the node registration phase, the protocol assigns every registering node into a predefined multicast group. After that, all the communication happens within the predefined multicast group. However, in some environments, because of the information security policy, multicast traffic is blocked by the routers and switches. This may lead the protocol suit to a not working state. On the other hand, the results explained in this paper are based on the implementation of the conceptual protocol stack for a simple chat service. The future work along this line, other than testing for a real fog-based MANET, includes implementing the other types of services such as voice, image and video communication, and as well as file sharing. Furthermore, the protocol is not implemented for IP V6. However, if the protocol is to be effectively used in IoT environments, implementing it for IP V6 addressing would be highly necessary.

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Intelligent traffic controller using image processing

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Abstract

Traffic congestion has become significant problem in recent years with the ever increasing number of vehicles and poor management of traffic. Traffic patterns are not constant throughout the day. They are changing from time to time. Since present traffic controllers have fixed time intervals for signal lights, they could not provide a better solution. Computer vision can be used to create an intelligent traffic controller which can adapt its time intervals according to the real traffic. Several studies have been carried out based on the concept of real time image processing to manage the traffic. In current traffic controllers, wastage of effective green time is occurred, as many times fixed green time period which is assigned for a phase is larger than it actually needs. Hence the other roads at the intersection have to wait in vain, with more traffic, until that fixed green time period is over. In the proposed method real time traffic image sequences are analysed using image processing, in order to obtain actual traffic area. Then, time for green light is allocated according to that traffic area. Hence, wastage of effective green time is eliminated by the proposed method since it allocates time to green signal that is sufficient to pass the actual traffic presented on the road. Results reveals, effective green time that need to pass the traffic, is proportional to the road area covered by traffic at that time.

Keywords: Effective green time, Image processing, Intelligent controlling of traffic, Traffic area

Introduction

Today, traffic congestion has become an important issue to be solved throughout the whole world. This creates a heavily bad impact on national development as well as human routine, as this leads to many problems such as air pollution, sound pollution, weariness, stress, time and energy waste. Since traffic patterns are dynamic and constantly changing, fixed time sequenced signal lights cannot adapt to the changing traffic patterns. Hence, a better solution regarding this problem is, implementing an Intelligent Traffic Control System which operates in real time, by adjusting signal timing to accommodate changing traffic patterns.

A variety of approaches to these tasks were suggested by many scientists and researchers, using different techniques of Image Processing which are based on vehicle counting methods (Fathy and Siyal, 1999), (Aher and Shaikh, 2015), image comparison methods (Choudekar et al., 2011), (Abbas et al., 2013), and traffic area methods (Gaikwad et al., 2014; Mokashi, 2015).

There are many situations such as, heavy incoming traffic only from several sides of the intersection while the rest are relatively empty. In this case, people on the heavily occupied side have to wait for a long time while, the road, containing low traffic display green signal without having vehicles to move as the green light time duration is fixed for all sides. This leads to a wastage of effective green time as well as creating more traffic in other roads. Therefore, there is a dire need for a smart system that can

adjust the timings of these lights based on the real time traffic present on the road. Thus, the aim of this research is to present technologically advanced, intelligent traffic controlling method, that would be an alternative for the prevailing systems and control the traffic in an intelligent way by recognizing the actual area of the traffic presented on a road thereby providing an adequate amount of time for the traffic to pass, by dynamically changing traffic light timer durations.

Methodology

The overall block diagram of the proposed system is illustrated in above Figure 1.
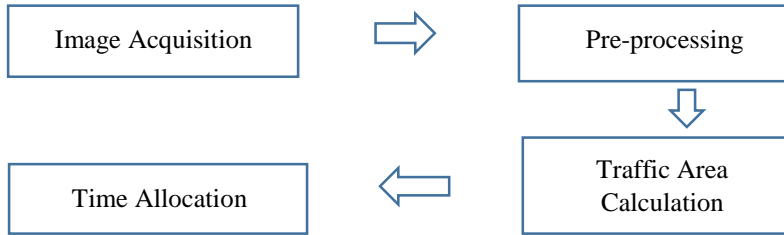
Figure 1: Work Flow of the proposed System

The workflow can be divided into four parts. First part is the acquiring of image sequences of the traffic on the road phase by using a fixed camera. The second part is applying pre-processing techniques on image sequence which are used to enhance the features of the image to prepare it for further analysis. This is achieved by using OpenCV vision library, (OpenCV, 2017). The third part is to detect the target area that the vehicles are actually presented on the road. Finally, the last part is, allocating 'effective green time' to the phase which can be performed according to the current area of the traffic which covers the road at that particular moment. During analysis stage, the value of pixels is scanned across straight lines originating from the beginning of the starting point of traffic light and going right till the end of the road, as seen in the image. A similar process is carried out across various lines on the road and then returns the length of the line which has the highest distance. This process is applied to the image sequence and takes the highest distance of line. This distance is then multiplied with the width of the road which gives the area being covered by the traffic, and through this, an appropriate time for the green light can be allocated as follows.

Let each road along the directions N, E, S and W, are having equal maximum green time T_{max}, and during that time period maximum traffic area Amax can pass the intersection point. Let TN, TE, TS and TW be the durations for which the signal turns green for the directions N, E, S and W respectively. Let AN, AE, AS and AW be the areas of traffic which are actually present at that particular moment, measured in the directions N, E, S and W respectively.

Then, we can derive TN, TE, TS and TW as follows,

$$TN = T_{max} * (AN / A_{max})$$
$$TE = T_{max} * (AE / A_{max})$$
$$TS = T_{max} * (AS / A_{max})$$
$$TW = T_{max} * (AW / A_{max})$$

Results

Figures 2 illustrates traffic area identification and time allocation results at several traffic situations, by using the proposed method of this study.
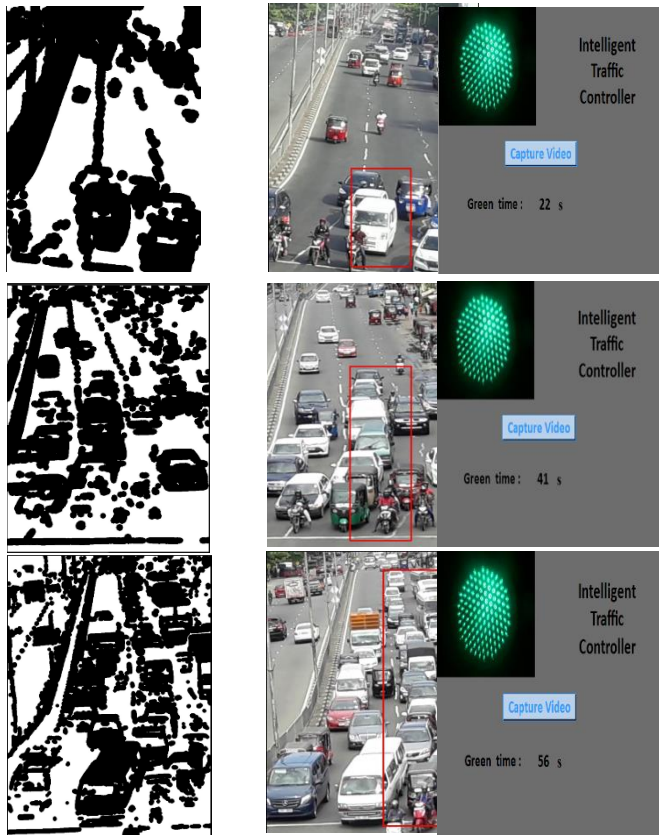
Figure 2: Traffic area capturing and time allocation results
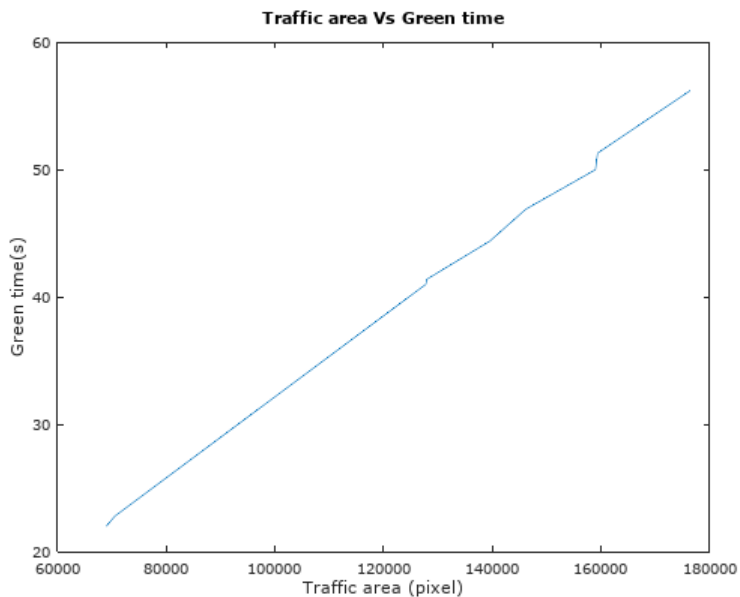
Figure 3: Relationship between traffic area and effective green time

Figure 3 depicts the relationship between traffic area and green light time duration which is generated by using the results of this method. It is obvoius, that green time duration is propotional to the traffic area.

Conclusion

The study showed that image processing is a better technique to control traffic congestion problem. It is also more consistent in detecting vehicle presence, because it uses actual traffic frames. It visualizes the reality, so it functions much better than those systems that rely on the detection of vehicles metal content. Results showed, this method acquired its objectives successfully by eliminating the wastage of effective green time and controlling traffic in an intelligent way. Hence, this method would basically reduce the vehicle waiting time on road.

This work can be further enhanced by proposing a system which identifies the presence of emergency vehicles, such as ambulance or fire brigade and give preference to those lanes with emergency vehicles to pass the traffic.In addition develop this mechanism to control traffic not only in the day time but also in the night time.

As an overall, the proposed method is in a very good state and with some improvements, we can create a fully completed intelligent traffic controller system.

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Abstract No: SC-12   **Systems Engineering**

Study of machine learning algorithms for Sinhala speech recognition

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Abstract

Speech is the primary mode of communication among humans and the most natural and efficient form of exchanging information. Therefore, it is logical that the next technological development in natural language speech recognition for Human Computer Interaction is, Artificial Intelligence. Speech recognition can be defined as the process of converting speech signal to a sequence of words by an algorithm implemented using a computer program. Speech processing is one of the challenging areas of signal processing. The main objective of the study was to conduct a study on speech recognition approaches to improve the accuracy level of Sinhala speech recognition. This study was conducted in order to find the optimal algorithm for accurate Sinhala speech recognition. According to the implementation architecture of speech recognition, feature extraction and the pattern recognition phases can be varied with different algorithms. The study identified that Linear Predictive Coding (LPC) and Hidden Markov Model (HMM) gives most accurate results than other combine algorithms.

Keywords: Feature extraction, Pattern recognition, Speech recognition

Introduction

The Sinhala language is a member of the Indo-Aryan subfamily, which is a member of a still larger family of languages known as Indo- European. Sinhala is the official language of Sri Lanka and the mother tongue of the majority of the people constituting about 74% of its population. Sinhala language is presented in two major modes: The Spoken and the Literary (Wasala & Gamage, 2005). They differ not only in their form and structure, but also in their typical uses and functions. Literary Sinhala is generally considered the 'higher' variety in that its' structure is closer to the classical literary idiom. It is used in all forms of nonfictional writing, including news bulletins, and in electronic media. News is read, rather than spoken. Different genres of fiction use a mixture of both: literary Sinhala for narration and spoken Sinhala for dialog. Spoken Sinhala is used in all face-to-face communication.

Speech technologies are emerging to be the next generation user interface for computers. Speech recognition is the recognition of natural speech through a computer. Spoken words and phrases are identified and converted into a machine understandable format. Specially, people prefer to use their voice to interact with the computer, because it is very convenient and inexpensive (Priyadarshani et al., 2012). However, the consideration taken for the low resource languages is less than the languages that are used commonly.

Linear Predictive Coding (LPC) and Mel-Frequency Cepstrum Coefficient (MFCC) algorithms have been identified as most effective feature extraction methods while Hidden Markov Model (HMM), Dynamic Time Wrapping (DTW), Vector Quantization (VQ), Artificial Neural Network (ANN) and Support Vector Machine (SVM) have identified as most effective algorithms for pattern recognition.

Altogether ten approaches were considered for Sinhala speech recognition by combining feature extraction and pattern recognition algorithms.

Feature extraction

In speech recognition, the main goal of the feature extraction step is to compute a parsimonious sequence of feature vectors providing a compact representation of the given input signal.

The feature extraction is usually performed in three stages. The first stage is called, the speech analysis or the acoustic front end. It performs some kind of Spectro temporal analysis of the signal and generates raw features describing the envelope of the power spectrum of short speech intervals. The second stage compiles an extended feature vector composed of static and dynamic features. Finally, the last stage (which is not always present) transforms these extended feature vectors into more compact and robust vectors that are then supplied to the recognizer.

Pattern recognition

Pattern recognition involves two essential steps namely, pattern training and pattern comparison. The essential feature of this approach is that it uses a well formulated mathematical framework and establishes consistent speech pattern representations for reliable pattern comparison from a set of labeled training samples via a formal training algorithm. The pattern-recognition paradigm has four major steps as shown in Figure 1, namely feature measurement, pattern training, pattern classification and decision logic.
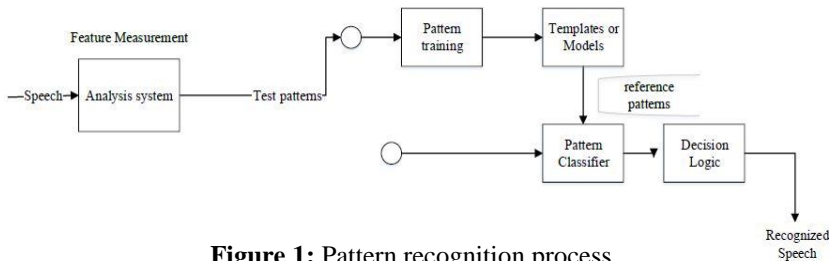
Figure 1: Pattern recognition process

Methodology

Research approach is experimental, as the accuracy of Sinhala speech recognition is measured quantitatively for every approach of speech recognition.

Corpus collection

Sinhala spoken language contains 41 letters and any word of Sinhala spoken language can be written (represented) using those letters. This corpus built up using 100 Sinhala words, represent all the letters of spoken Sinhala language. Voices are recorded via microphone and smoothing is done by the Audacity software.

Design of architecture

Initially, based on the appearance of their presence of the voice recognition process, feature extraction method is selected. For each feature extraction method, the pattern

recognition process is attached thereafter. Total number of applications that the study developed is ten according to the below design architecture.
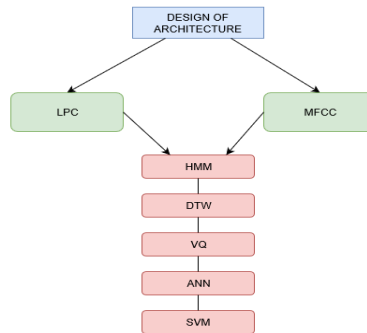
Figure 2: Design of architecture

Performance measurement

Word error rate is a common metric for measuring the performance of a speech recognition or machine translation system. Word error rate can be computed by using Equation 1, given below. In here, 'S' – number of substitution, 'D' – Number of deletion, 'I' – Number of insertion and 'N' – Number of words in the reference.

$$WER = \frac{S + D + I}{N} \qquad - \qquad \text{Equation 1}$$

Results

Word samples (twenty words) are taken out of hundred of words and subjected to the processes feature extraction and pattern recognition process. Table 1 and Table 3 shows the number of words correctly identified for each sample (out of twenty words). Table 2 and Table 4 show the error recognition rate for Table 1 and Table 3.

Table 2: LPC word recognition out of twenty words

Samples	LPC as feature	Extraction		- from	20 words
	HMM	DTW	VQ	ANN	SVM
#1	17	12	10	12	14
#2	16	11	9	13	12
#3	18	10	8	11	11
#4	17	13	10	10	12
#5	16	12	10	12	11

Table 1: LPC word error rate

Samples	LPC	word	error	Rate %	
	HMM	DTW	VQ	ANN	SVM
#1	15.00	40.00	50.00	40.00	30.00
#2	20.00	45.00	55.00	35.00	40.00
#3	10.00	50.00	60.00	45.00	45.00
#4	15.00	35.00	50.00	50.00	40.00
#5	20.00	40.00	50.00	40.00	45.00

Table 3: Mfcc word recognition out of twenty words

Samples	MFCC feature as	Extraction		- from	20 words
	HMM	DTW	VQ	ANN	SVM
#1	15	12	12	12	10
#2	14	11	11	10	9
#3	16	11	9	11	11
#4	15	13	10	9	10
#5	14	12	10	11	13

Table 4: Mfcc word error

Samples	MFFC	word	error	Rate- %	
	HMM	DTW	VQ	ANN	SVM
#1	25.00	40.00	40.00	40.00	50.00
#2	30.00	45.00	45.00	50.00	55.00
#3	20.00	45.00	55.00	45.00	45.00
#4	25.00	35.00	50.00	55.00	50.00
#5	30.00	40.00	50.00	45.00	35.00
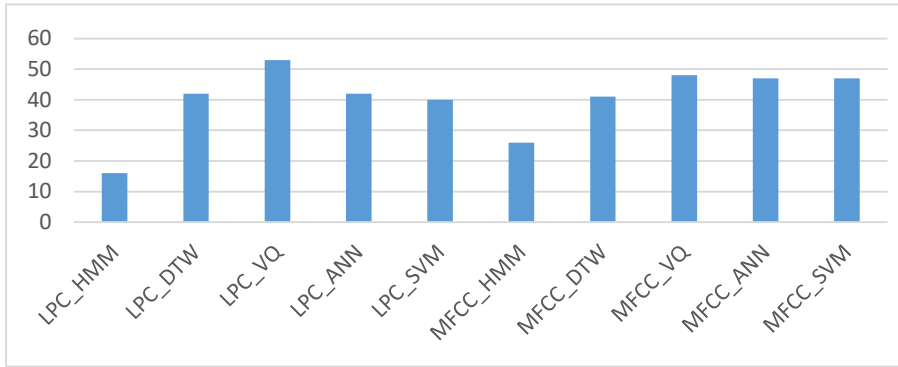
Figure 3: Overall mean error rate for LPC and MFCC

Conclusion

According to the DOE, 10 approaches were considered to conduct the study. Applications were tested using 100 Sinhala words. Then the 100-word sample was classified into 5 groups using random sampling method. In the phase of testing the applications, objective was to find the Word Error Rate (WER) with the ultimate goal of finding the minimum WER application. This gives the most accurate combined algorithm for Sinhala speech recognition. Experimental results were analyzed by using descriptive analysis.

According to Figure 3, LPC_HMM gives the least mean error rate compared to other approaches. Whatever the feature extraction method is, HMM gives more accurate results as a pattern recognition method. Considering the feature extraction methods, LPC always gave the higher accurate results comparing to the MFCC. With the minimum vocabulary (100 words) the researcher used, the lowest mean error rate is 15%. This means that the accuracy rate for LPC and HMM combine method is 85% percent which is the highest among other 10 approaches used in the study.

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Identification of alcoholic persons using EEG signals and unsupervised classification methods

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Abstract

This paper aims to distinguish alcoholic persons from non-alcoholic persons using Electroencephalography (EEG) signals. The effect of alcohol on a person is different from one to another. Nowadays, there are number of sophisticated equipment used to identify how much amount of alcohol a person consumes. However, they are vulnerable to sensor errors and need regular calibration after each test. Electroencephalography (EEG) are commonly used for identifying the effect of alcohol taken by the person through brain signals. Therefore, we aimed to distinguish ten alcoholic persons from ten non-alcoholic persons using the EEG sensor kit worn on the skull surface. Our analysis is based on frequency collected from 5 electrodes on the brain of ten alcoholic and non-alcoholic persons. We have applied time varied entropy techniques (Sample entropy and Approximate entropy) and fast Fourier transform over the electrodes measurements. Mean values of sample entropy and approximate entropy relevant to electrodes are calculated. The fourth dominant frequency was calculated for each record conducting fast Fourier transform over sensor measurements. The calculated Sample Entropy, Approximate Entropy and amplitude of fourth dominant frequency ranged from (-2.7 to -3.4), (1 to 0) and (0.25 to 2.7) respectively. The three features (Sample Entropy, Approximate Entropy and amplitude of frequency bands were plotted in a three-dimensional sphere. The alcoholic and non-alcoholic persons could be grouped, handily in to two clusters with 100% accuracy.

Keywords: Alcoholic, Approximate entropy, Electroencephalography signal, Fast Fourier transform, Sample entropy

Introduction

Alcoholism is a qualitative psychiatric phenotype with EEG based analysis conducted by a number of studies to obtain the correlated quantitative biological markers (Fattah & Fatima, 2015). Increased usage and addiction to acholol among the the general populace including the younger generation has been noted. Consuming alcohol is identified as an abuse disorder (Yazdani & Setarehdan, 2007). Studies of World Health Organization have revealed that approximately 2 billion people across the world consume alcoholic beverages and out of them, 76.3 million are seriously addicted to alcohol (Acharya & Sree, 2012).

Electroencephalogram (EEG) is the general reflection of human brain's electro-physiological activity that appears in the cerebral cortex or the skull surface. Nowadays, the study on human brain based on EEG signal is being subjected to growing concern, because it is a non-invasive and higher temporal resolution (Wu Di, 2010). The study of brain electrical activity, through the electroencephalographic records, is one of the most important tools for the diagnosis of neurological disease (Wu Di, 2010).

Since the EEG signals are by nature nonlinear and dynamic, many nonlinear analysis techniques have been developed for several EEG based applications such as detection of epileptic seizures, sleep stages, diagnosis of Alzheimer's diseases and diagnosis of autistic spectrum disorder (Acharya & Sree, 2012). Electroencephalography is used to obtain the graphical representation of the difference in voltage between two different cerebral location registered over time. The EEG signals are generated by cerebral neurons. Cerebral neurons are developed by electrical conductive properties of the tissue between the electrical sources. Normally, these records are measured by 64 electrodes, which are positioned all over the skull. However, in this study only 5 electrodes were used with the readings obtained from the EEG signal used to differentiate alcoholic and non-alcoholic subjects.

The proposed technique used in this study is feature extraction of raw data. Feature extraction include nonlinear features such as Sample entropy (SampEN), Approximate entropy (ApEn) and dominant frequency levels using fast Fourier transform (FFT).

Methodology

The controlled experiments in laboratories to investigate the artifacts of alcoholism are widely conducted producing various bio-medical signals and measurements. Yet, the consistent and accurate information which are needed to extract from those digital signals and measurements, is still under-investigation. The feature extraction along with machine learning techniques as well as entropy based mechanisms are proven to provide better results in other similar bio-medical studies. However, there are very few studies conducted to identify alcoholism using non-linear features and show the maximum accuracy of 91%. In this study, our main focus is to employ nonlinear features in signal processing and machine learning in order to achieve higher accuracy. Five electrodes (specifically F7, F8, AF1, FP1 and FP2) were attached to 10 alcoholics and 10 non-alcoholic subjects for our study. The EEG signals from these sensors were collected and used for analysing alcoholism.
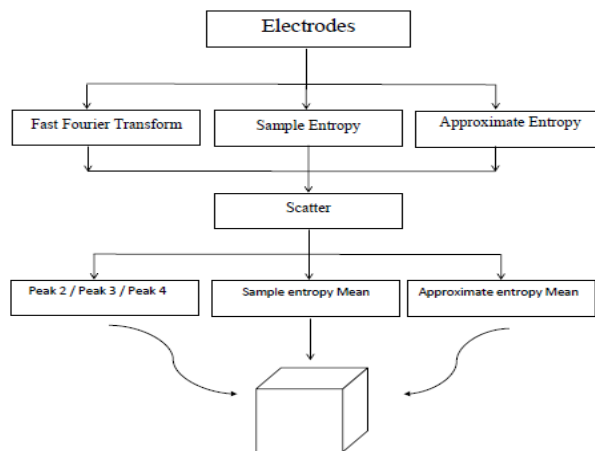
Figure 1: The Methodology

This data set contains all 120 trials for 122 subject (Begleiter, 1999). These EEG signals were used to determine features for unsupervised clustering. Here, we got three features specifically Fourier frequencies (FA), Approximate entropy (ApEn) and Sample entropy (SamEn) using each electrode of each person. SamEn (Kannathal, et al., 2005) and ApEn (Kannathal, et al., 2005) are two widely used techniques for determining the regularity of data in complex systems. Both of these techniques are successfully applied in the system with relatively short and noisy data.

In this study, sample entropy and approximate entropy were calculated using variables: bin size of 100 where embedding dimension (assigned Value is 1), tolerance (assigned value is 0.6 times of standard deviation of dataset). Every time series can be represented as a frequency spectrum based on its various frequency bands which is valuable insight to differentiate one series from another. The frequency spectrum and the power spectrum can be generated by transforming data time series in to Fourier series. Hence, we have transformed EEG signal time series in to Fourier series and calculated most amplitude frequencies (peaks) up to four peaks. Then, the corresponding peaks were considered as the third feature.

Results

Initially, we have investigated clustering alcoholic and non-alcoholic subjects into two distinct clusters using only embedded entropy techniques, specifically SamEn and ApEn. We calculated average sample entropy for each subject for electrode F7. Then, mean and variance of average sample entropy were calculated separately for alcoholic and non-alcoholic controls. Similarly, the mean and variance of average approximate entropy of electrode F8 were calculated.

The average approximate entropy and average sample entropy of alcoholic subjects are 0.6410 and -3.0315, respectively. The average approximate entropy and average sample entropy of non-alcoholic subjects are 0.6454 and -2.9681, respectively. Accordingly, the average approximate entropy and average sample entropy for non-alcoholic subjects were higher than alcoholic subjects. A time series containing number of similar patterns has a relatively small approximate entropy. This means that the alcoholic person has more slow and rhythmic brain waves than a non-alcoholic person. The alcoholic subjects who has relatively lower ApEn and SamEn, have regular pattern of EEG signals than non-alcoholic persons. However, variance of alcoholic subjects and non-alcoholic controls are overlapped significantly. Hence, it is not given a very clear clustering of these two groups and it is hard to distinguish alcoholic subjects from non-alcoholic subjects only using entropy technique.
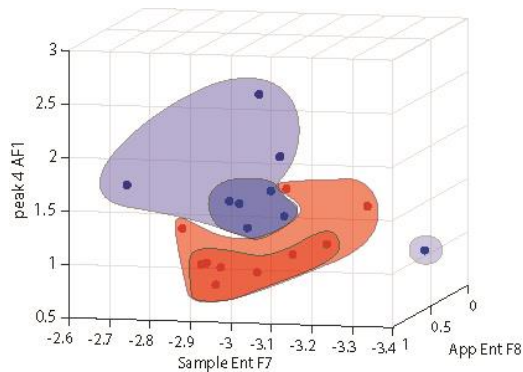
Figure 2: Analysis with 3 feature: Approximate entropy, sample entropy and amplitude of 4th peak in frequency spectrum

Then, we have introduced a new feature which is the fourth peak of frequency spectrum of EEG signals of electrode AF1. These features were plotted in a 3-dimensional sphere as Figure 2. In the sphere, the limits of SamEn, ApEn and amplitude of the fourth dominant frequency were ranged from (-2.7 to -3.4), (1 to 0) and (0.25 to 2.7), respectively. The points in red (dark) colour represent alcoholic subjects while, blue colour (light) points represent the non-alcoholic subjects. The all non-alcoholic subjects except one subject were clustered in the range of (-2.75 to -3.15), (1 to 0) and (1.75-2.75) respectively for sample entropy, approximate entropy

and the amplitude of fourth peak in frequency spectrum (refer Figure 5). All alcoholic subjects were clustered particularly in the range of (-2.85 to -3.35), (1 to 0) and (1.75 to 0.75) respectively for sample entropy, approximate entropy and the amplitude of fourth peak in frequency spectrum. These clusters are shown as circles with distinct colour variations (alcoholic - red/dark and non-alcoholic – blue/light) to highlight the clustering clearly.

Future work

The study has outwardly clustered the alcoholic and non-alcoholic subjects. However, the proposed method has a significant deficiency. When the number of features were increased, this method is incapable to accommodate this and it was difficult to visualize them effectively. Even, our analysis has more than fifteen features from five electrodes, which provides valuable insights to derive predictions. Hence, the need for a novel method independent of the number of features arises from this study. It is envisaged in the future to explore analyzing supervised and unsupervised clustering methods.

Conclusion

In this paper, a novel approach is presented to distinguish alcoholic persons from non-alcoholic persons. Three features-based clustering were calculated using sample entropy, approximate entropy and fast Fourier transform. Using these three features, it was possible to cluster alcoholic and non-alcoholic subjects with 100% accuracy.

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Abstract No: SC-14   **Smart Computing**

Preparing a magnetic map of the room

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Abstract

A magnetic field monitoring robot was designed to capture the Earth magnetic field by using the magnetometer that is already embedded with the Wi-Fi controlled robot cart. Experiments were designed using the magnetometer, where the robot constructed maps of the magnetic fields environment. There are lots of methods that can be used for detecting the position of the robot cart when it is placed to take reading in the room. The paper outlines an easy but effective method to determine the position of the robot cart and recording the magnetometer values through a Wi-Fi connection.

Keywords: Earth magnetic field, Indoor mapping, Magnetometer

Introduction

Technology has advanced to a level that an Unmanned Aerial Vehicle (UAV) can be controlled from a distance ranging from 2km to 20,000km. There are many robot systems that are controlled either by radio frequency transmission or by creating intelligence. Such robots are called Non-Autonomous robots. These robots shave the programming logic to do the desired task but, the decision power lies in the hand of controller (human) handling the robot. Here, the interface can be made using two methods: wired or wireless. The underlying technology is transmission of signals wirelessly through air by a transmitter, that is captured by the receiver and sent to the microcontroller mounted on the robot to carry out the task. Looking at the present demand for robots in the developing world, the development of cost effective robots to carry out work effectively and accurately, is necessary.

An Earth Magnetic field monitoring robot is a mechanism designed to capture the magnetic field in several places using a magnetometer which is attached with the Wi-Fi controlled robot cart. The magnetic field was measured using a magnetometer and sent it to the computer through Wi-Fi in constant time period (every 3seconds).

Methodology

In this study, the main objective was to control the robot cart through Wi-Fi and generated the Earth magnetic map at required places. Arduino Nano board was used as the main controller as it is a small, complete, and breadboard-friendly board based on the ATmega328, which offers the same connectivity and specifications of the Arduino UNO board in a smaller form factor. It has 22 digital pins, which can be used as an inputs or outputs. There are 8 analog inputs or output pins as well. Functioning frequency is 16MHz, operating voltage is 5V and USBasp programmer is used to program the microcontroller using *C* programming language (Farnel Elements, 2017a).

This Earth Magnetic field monitoring robot can be operated remotely through Wi-Fi and NodeMCU Wi-Fi communication module - ESP 8266 was used for that. Some of its features are; 32- bit RISC CPU running at 80 MHz, 64 KB of instruction RAM, 96 KB of data RAM and 4 MB flash memory. NodeMCU is an open-source firmware

and development kit based on the ESP8266 Wi-Fi chip. The NodeMCU is programmed using Lua programming language. NodeMCU module it normally does not come with the NodeMCU firmware (Adafruit Industries, 2017).

To measure the earth magnetic field Honeywell HMC5883L Magneto resistive sensor was used (Farnel Elements, 2017b). Its circuit is a trio of sensors and application specific support circuits to measure magnetic fields. With power supply applied, the sensor converts any incident magnetic field in the sensitive axis directions to a differential voltage output. Control of this device is carried out via the I2C bus. This sensor was connected to this bus as a slave device under the control of a master device, which is the Arduino Nano processor.

For programming AVR an integrated development environment (IDE) called Code-blocks, is used. It is an open source, cross platform IDE that can be used with C programming language. TCL programming language and the TK graphical user interface toolkit to create the GUI of the earth magnetic field monitoring robot, is used.

In this project four 3.7 V & 1300 mA batteries were used in parallel mode.

In the TCL/TK interface there are few buttons: Go Forward, Go Back, Go Left, Go Right, Stop, Turn Left, Turn Right and Quit. When pressing those buttons, TCL/TK send a command signal to NodeMCU, then NodeMCU's output pins D0, D1 and D2 will get high or low according to the received signal.
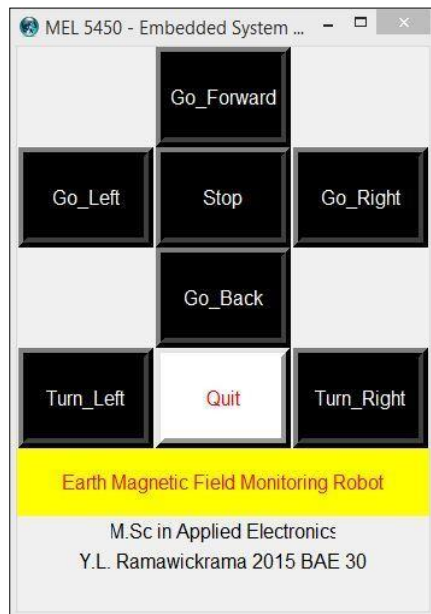
Figure 1: TCL/TK Interface

Output pins D0, D1 and D2 of the NodeMCU are connected to the Arduino Nano board's D2, D3 and D4 pins respectively. After receiving a command from the TCL/TK interface the Arduino Nano will check that command and Arduino Nano board's output pins A0, A1, A2 and A3 will get high or low accordingly. Those output pins are connected to the L298 DC motor controller and get enabled and perform which coded functionalities.

When robot cart was moving the magnetometer readings were continuously received every 3 seconds through Wi-Fi from the Magnetometer sensor, in the 5m x 8m area chosen. First robot cart was placed 0.5 m close to the wall in the selected area and the readings were recorded while robot cart was moving. Then the cart was placed 1m away from the wall and readings obtained. Likewise, the readings were recorded in 0.5m intervals until it covered entire selected area. The procedure of the receiving data and feeding data to the Excel sheet is shown in the below flow chart (Figure 2). Either NodeMCU transmission or serial data communication method can be used for sending data. Both methods for sending magnetometer readings to the Excel sheet were used for this study.
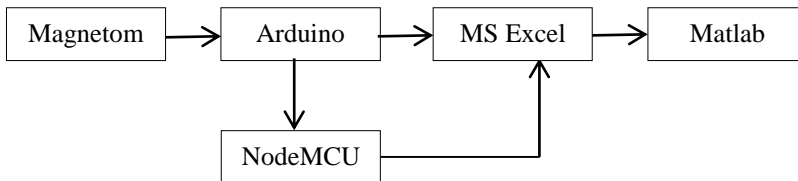
Figure 2: Flow chart of the procedure of reading and sending data

Results

Selected the 5m x 8m room which had three windows, two doors as well as two column bars inside the room to construct the Magnetic Map using the robot cart. Figure 3 below provides the output received from Matlab.
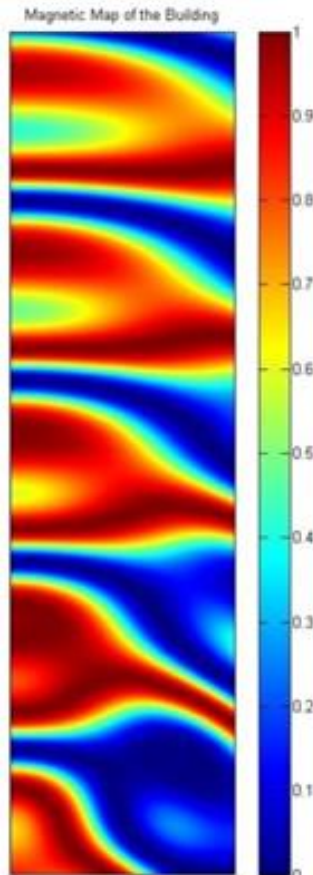
Figure 3: Magnetic map of the selected area

For understanding the generated map of the magnetic field in the room, the legend of Normalized Intensity of the magnetic field between 0 to 1 was introduced. Areas with High Intensity are marked in red (dark), level 1 and Low Intensity (light) areas are marked in blue, the 0 level. Comparing the generated map and legends of Normalized Intensity of the magnetic field, it reveals the places where windows, doors and columns are located in the room. Normally, intensity of the magnetic field is quite high near the obstacles such as windows, doors or columns. The most reddish (dark) areas are normally located above the obstacles.

Conclusion

At any location, the Earth magnetic field can be represented by a three dimensional vector. Another common representation is in X (North), Y (East), and Z (Down) coordinates. A compass was used to measure the directions of the magnetic North. Its angle relative to true North is the declination (D) or variation.
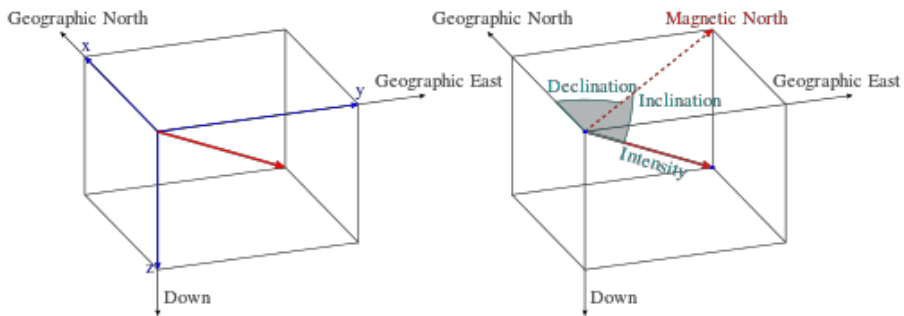
Figure 4: Common coordinate systems used for representing the earth magnetic field (Wikipedia, 2018)

Facing magnetic North, the angle the field makes with the horizontal is the inclination (I) or magnetic dip. The intensity (F) of the field is proportional to the force it exerts on magnet.

A magnitude at the Earth's surface, range from 25 to 65 microteslas. It depends on different locations (latitude and longitude) as well as the objects around the measuring device. The Earth's magnetic field varies widely inside the buildings because of the large metal structures and indoor wiring system which are used for constructing the buildings. Therefore, by comparing the actual map of Earth magnetic field inside the building, the variations of the magnetic field due to metal structures and indoor wiring systems can be visualized.

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Abstract No: SC-15   **Smart Computing**

Knowledge based system for software testing

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Abstract

Software development is conceptually a complex, knowledge intensive and a collaborative activity, which mainly depends on knowledge and experience of the software developers. Software testing is a sub area of software engineering which is also a knowledge intensive and collaborative activity. Effective software testing activities relies on the knowledge collaboration where every software tester shares his/her knowledge or acquires knowledge from others. Finding relevant knowledge within the software testing team or within the experts inside the company is not an easy task. There is a need to represent and process knowledge in an affordable and manageable manner. In this context, principles of knowledge management are pointed out as an important means to manage software testing knowledge. The research contributes in knowledge management in software testing, especially managing the software testing knowledge. An ontology based expert system is designed to share software testing knowledge and can be used to support sharing of knowledge and learning practices in other software companies.

Keywords: Ontology based knowledge sharing, Software testing knowledge, Software testing ontology

Introduction

Software development is conceptually a complex, knowledge intensive and a collaborative activity, which mainly depends on knowledge and experience of the software developers (Vasanthapriyan et al., 2015). Software testing is a sub area of software engineering which is also a knowledge intensive and collaborative activity. Meantime, the quality of a software is very much depending on its validity (Vasanthapriyan et al., 2017). Therefore, validation and verification should be carried throughout the development. In such cases, software testers have to work with all the other software engineers who are working in the development activities. There is a need to represent and process knowledge in an affordable and manageable manner. In this context, principles of knowledge management are pointed out as an important means to manage software testing knowledge (Vasanthapriyan et al., 2017). In this way, this research makes a number of contributions in managing the software testing knowledge. An ontology based expert system is designed to share Software testing knowledge. We believe our software testing ontology can support other software organizations to improve the sharing of knowledge and learning practices.

There were many researches have been conducted for developing knowledge based systems in different domains (Vasanthapriyan et al., 2017). They have not included much on the following (a) conceptual design (b) domain coverage (c) reusing of ontologies (d) implementation of international standard (e) implementation of relationships, axioms (f) vocabulary standards (g) evaluation methodologies of ontologies and (h) implemented as expert systems (Vasanthapriyan et al., 2017). Having discovered this research gap, the study has focused its attention to develop a software testing ontology to represent information needs according to software

testers context, which could be extended to design a knowledge base system to manage software testing knowledge in a software company.

Methodology
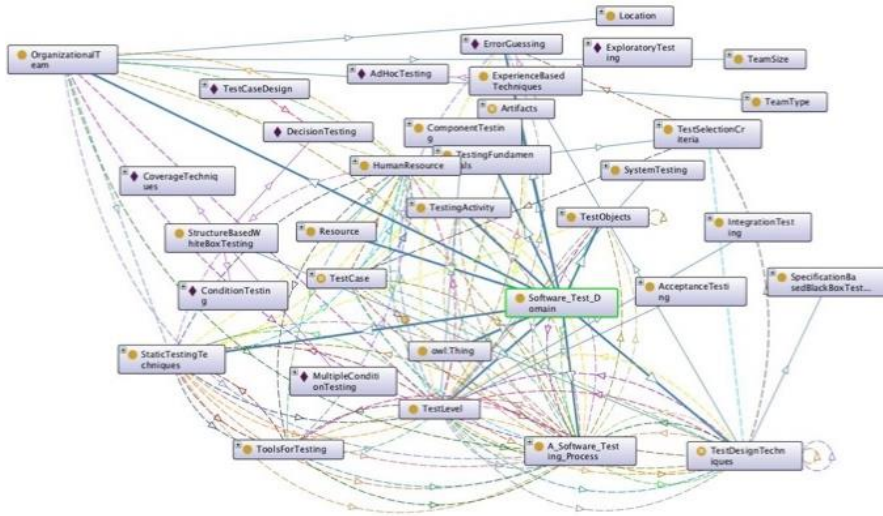
Figure 3: Part of the software testing ontology

Software testing activity contains Test Planning for planning tests, Test Case Design for test case construction, Test Implementation and Test Execution for execution of test cases and producing Actual Result, and Test Result Analysis for analysis and evaluate the test results. The Grüninger and Fox's approach to ontology development starts with the definition of the motivating scenarios that arise in the industrial applications encountered in their enterprises (Grüninger and Fox, 1995). It also provides a framework for evaluating the adequacy of the developed ontology (Figure 1). Competency Questions (CQ) are used to identify the contents of the software testing ontology. We able to interview with domain experts (eg: software testers, QA managers) from a software company to construct and formulate the CQs in a systematic way and the structure of the ontology as well (Grüninger and Fox, 1995). The software testing variable cloud basically contains the vocabularies mentioned in IEEE 829-2008(IEEE 829-2008, 2018) and ISTQB (Graham et al., 2008). Even though the standard specifies the procedures of software testing, we have also included what companies are stipulating in their practice.

Figure 2 depicts several Artifacts have been used to derive test cases during software testing activity which describes the functionalities, architecture, and design of software. Such Artifacts are used as Test Case Design Input during the software Test Case Design Activity and the output are test cases. Test cases can be documented as described in the IEEE 829-2008 Standard for Test Documentation. The document that describes the steps to be taken in running a set of tests (and specifies the executable order of the tests) is called a test procedure in IEEE 829. Besides, Test case contains a set of input values (*TestCaseInput*), execution preconditions, expected results (*ExpectedResult*) and execution post conditions, developed for a particular objective or test condition, such as to exercise a particular program path or to verify compliance with a specific requirement. That is, a test case targets to test a *CodeTobeTested*. *CodeTobeTested* can be any programs, modules, and the whole system code. Furthermore, *TestCode* is a portion of code that is to be run for executing a given set of test cases, contain three subtypes such as Test Script, Driver and Stub.
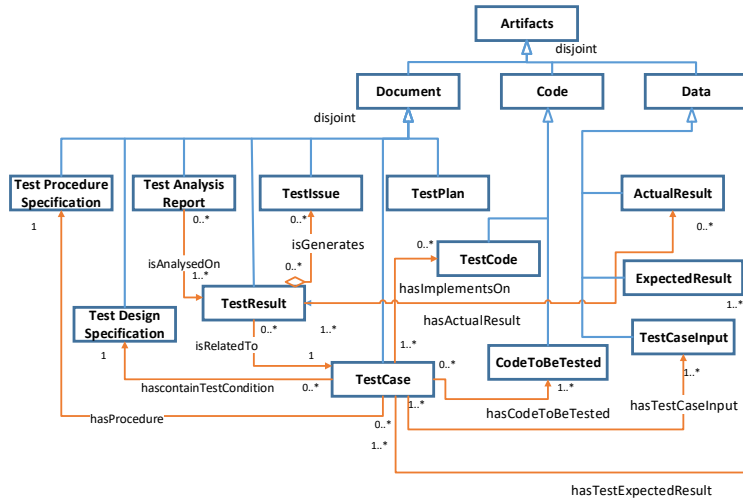
Figure 4: Artifacts used in software testing

Once the ontology is designed in Protégé 5.1, we examine the deficiencies of the ontology in use. Through the internal evaluation we test the usefulness as well as consistency of the ontology during the design process. We used FaCT++ 1.6.5 and HermiT 1.3.8.413 to check the internal consistency and inferences (Grüninger and Fox, 1995).

Knowledge base
Our Architecture consists of five layers: Experience Sharing, Ontology, Storage, Reasoning and Knowledge Retrieval Layer and is shown in Figure 3.
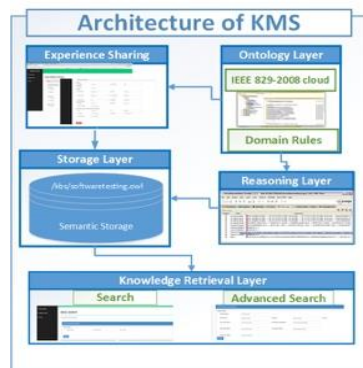
Figure 5: Ontology based knowledge base

The process is summarized as follows. Through the Experience Sharing layer, software testers can annotate their testing knowledge with an aid of software testing variable cloud. The semantic data generator transforms the software testing knowledge shared into the semantic data in a machine-understandable format.

The semantic data is expressed in triple structures according to the concepts and relationships of software testing ontology. After the semantic data is stored in the semantic storage, the reasoning engine creates reasoning data by means of a reasoning process based on defined ontology, domain rules, and semantic data.

Table 3: Pitfall description and solution proposed.

Pitfall	Description	Solution
Creating unconnected ontology elements (2 cases | Minor)	Ontology elements are created, with no relation to the rest of the ontology	Relationships are created
Missing domain or range in properties (11 cases | Important)	Object and (or) datatype properties without domain or range	Added the missing domain and range
Defining multiple domains or ranges in properties (8 cases | Critical)	More than one domain or range is defined for a property.	Modified the multiple domains and ranges

Finally, the Knowledge Retrieval Layer retrieves relevant information related to the testing knowledge from the storage layer. The main functions of the Knowledge Retrieval Layer are basic search and Advanced search.

Evaluation

The quality of an ontology should be validated before it is used in practice to avoid defects. Further, such validation process will prevent ontologies with anoma-lies or pitfalls, inconsistent, incorrect and redundant information. The developed ontology is evaluated in three methods such as internal, ontology expert method and non-expert method. Table 1 shows the OOPS! evaluation results and proposed solutions (Poveda-Villalón et al., 2012). To carry out our first industrial ap-plication based evaluation from software testing experts, the developed Knowledge base was hosted locally inside one software company in Sri Lanka. In summarizing the results, both positive and negative characteristics were revealed about the implemented knowledge base. Based on the constructive responses, there were a high need of knowledge base for continuous learning and creativity of the software testers.

Conclusion

An ontological approach to represent the necessary software testing knowledge within the software testers' context was developed. Using this approach, software testing ontology to include information needs identified for the software testing activities was designed. The ontology-based KM Portal is introduced into the semantic representation of software testing knowledge. Such ontology-based KM Portal would support and provide powerful knowledge sharing and retrieval of software testing knowledge and would encourage knowledge sharing.

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Data mining model for identifying high-quality journals

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Abstract

The focus in local universities over the last decade, have shifted from teaching at undergraduate and postgraduate levels to conducting research and publishing in reputed local and international journals. Such publications will enhance the reputation on the individual and the university. The last two decades has seen a rapid rise in open access journals. This has led to quality issues and hence chossing journals for publication has become an issue. Most of these journals focus on the monetary aspect and will publish articles that previously may not have been accepted. Some of the issues include design of the study, methodology and the rigor of the analysis. This has great consequences as some of these papers are cited and used as a basis for further studies. Another cause for concern is that, the honest researchers are sometimes duped, into believing that journals are legitimate and may end up by publishing good material in them. In addition, at present, it is very difficult to identify the fake journals from the legitimate ones. Therefore, the objective of the research was to introduce a data mining model which helps the publishers to identify the highest quality and most suitable journals to publish their research findings. The study focused on the journals in the field of Computer Science. Journal Impact Factor, H-index, Scientific Journal Rankings, Eigen factor Score, Article Influence Score and Source Normalized Impact per Paper journal metrics were used for building this data mining model. Journals were clustered into five clusters using K-Means clustering algorithm and the clusters were interpreted as excellent, good, fair, poor and very poor based on the results.

Keywords: Data mining, K-Means clustering, Journal ranking

Introduction

Research is a self-motivated creative work undertaken by researchers on a systematic basis in order to seek answers to questions that arise in their minds. The results of such studies are published in journals primarily to share the new findings with a larger peer group. By 2015, more than half a million papers had been published in predatory journals, and at the end of 2016, the number of predatory journals on Beall's list (about 10,000) approached the number indexed by the Directory of Open Access Journals (DOAJ) and Journal Citation Reports (JCR). Most of these are hosted by publishing companies (including some industry giants). Therefore, predatory publishing is becoming an organized industry (Sorokowski et al., 2017). Beall (2015) coined the term 'predatory publishers' to describe publishers in the scholarly publishing business who collect article processing charges and provide rapid publishing without a proper peer-review process. He has listed a list of predatory publishers. This list is rather long with 48 criteria, which directly or indirectly indicate whether the publisher and individual journal is predatory.

Accordingly, measuring the quality of the journals and identifying the journals with high-quality has become a vital need in the current society. There are many factors to measure the quality of electronic journals, such as quality of content standardization, purpose and coverage, periodicity and continuity, timeliness and

maintenance and navigation and graphic design. In addition, peer review has been the primary form in the past for journal ranking lists such as that of the Association of Business Schools (ABS) (Maricela et al., 2005). Further, some of the methodologies used to assess journal quality include citation analysis, peer analysis, circulation and coverage in indexing or abstracting services (Tome & Lipu, 2004). A new campaign called think, check and submit, was introduced with the specific intent of providing researchers with the information they need to become better informed about where to publish their work. It has encouraged the researchers to be aware about some important facts such as, is the publisher easily identifiable and contactable, are the articles indexed in well-known databases, are the article processing charges clearly described and does the editorial board consist of recognizable names (Roberts, 2016). Many databases such as Web of Science, Scopus, Scimago Journal and Country Rank and eigenfactor.org were developed to rank and categorize the journals. However, those databases used different factors to classify them. As examples, Scopus used SCImago Journal Rank (SJR) and Source Normalized Impact per Paper (SNIP) for classification. Eigenfactor.org used the Eigenfactor and Article Influenze (AI) for the classification. This research aimed to develop new classification criteria and data mining model by considering and combining different factors such as, The Journal Impact Factor (JIF), Scientific Journal Rank (SJR), Eigenfactor Score, The h-index, Source Normalized Impact per Paper (SNIP), Article Influence Score (AI). In this research, we propose a clustering approach to cluster the journals based on the above factors.

Methodology
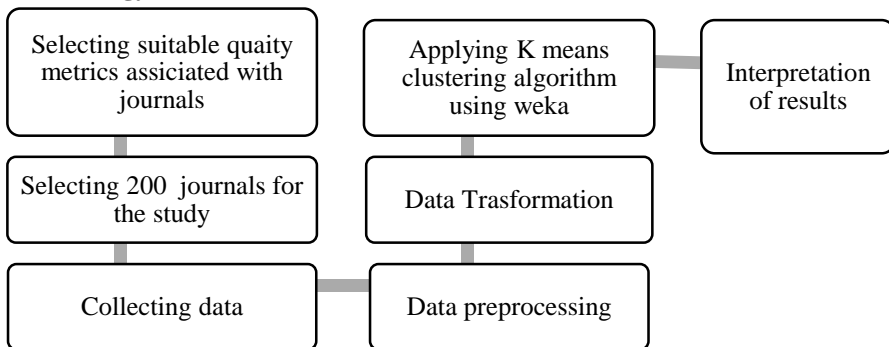
Figure 1: Design of the methodology

Figure 1 shows the methodology which was used for the study. First suitable quality metrics were selected and they are JIF, H-index, SJR, SNIP, Eigenfactor Score and Article Influence Score. Consequently, a sample of 200 journals was selected. After that, data was collected, SJR and H-index values were collected using the SCimago Journal and Country Rank website, SNIP values were collected using the Scopus database, Eigenfactor Scores and Article Influence Scores were collected using the EIGENFACTOR.org website and the Journal Impact Factor values were collected from the SCIJOURNAL.ORG website. During data preprocessing the outliers were identified and they were removed from the sample. Then, the values were normalized. After that, K-Means clustering algorithm was applied for the transformed data set.

Results

The 200 Journals were clustered into 5 clusters based on K-Means algorithm using Weka machine learning software. To detect the number of clusters, the clustering algorithm was applied for different number of clusters and "Average within Clusters Sum of Squared Errors" were tabulated against the cluster number and found that the

"Knee point" value as 5. It indicates the best number of clusters in the dataset. Besides, the journals were clustered into 5 clusters as shown in Figure 2. Further the cluster assignments are shown in Figure 3.


```
Time taken to build model (full training data) : 0.01 seconds

=== Model and evaluation on training set ===

Clustered Instances

0        19 ( 10%)
1        55 ( 28%)
2        32 ( 16%)
3        44 ( 22%)
4        50 ( 25%)
```

Figure 2: Output of simple *K*-Means, 5 clusters

No.	1: Computer Science Nominal	2: Normalized SJR Numeric	3: Normalized H Index Numeric	4: Normalized SNIP Numeric	5: EF% Numeric	6: AI% Numeric	7: Normalized JIF Numeric	8: cluster Nominal
1	IEEE Transaction...	0.602	0.457	0.401	0.94	0.94	0.808	cluster1
2	Ocean Modelling	0.503	0.312	0.243	0.82	0.89	0.365	cluster1
3	ACM Computing S...	0.498	0.598	1.0	0.8	0.96	0.821	cluster4
4	SIAM Journal on C...	0.303	0.427	0.331	0.81	0.9	0.174	cluster3
5	Foundations and ...	0.254	0.101	0.763	0.1	0.9	0.426	cluster3
6	Communications ...	0.25	0.854	0.535	0.91	0.95	0.49	cluster4
7	International Jour...	0.209	0.146	0.313	0.3	0.35	0.311	cluster5
8	Computers in Ind...	0.189	0.402	0.298	0.6	0.46	0.327	cluster3
9	Computer Support...	0.158	0.271	0.323	0.2	0.43	0.193	cluster2
10	ACM Transactions...	0.146	0.085	0.235	0.14	0.68	0.053	cluster2
11	Memetic Computing	0.136	0.101	0.208	0.13	0.43	0.473	cluster2
12	Applied Categoric...	0.122	0.111	0.121	0.36	0.44	0.064	cluster2
13	Logical Methods i...	0.104	0.106	0.178	0.6	0.53	0.08	cluster2
14	Journal of Ambien...	0.092	0.08	0.17	0.25	0.25	0.193	cluster2
15	ACM Transactions...	0.083	0.151	0.211	0.25	0.45	0.259	cluster2
16	Computational an...	0.077	0.106	0.099	0.12	0.26	0.094	cluster5
17	Control Engineeri...	0.066	0.05	0.087	0.7	0.5	0.085	cluster2
18	Computer Journal	0.06	0.256	0.103	0.66	0.43	0.086	cluster2
19	Turkish Journal of ...	0.058	0.101	0.114	0.31	0.11	0.07	cluster2
20	ICGA Journal	0.043	0.06	0.047	0.1	0.22	0.018	cluster5
21	Advances in Electr...	0.042	0.085	0.079	0.13	0.5	0.072	cluster2
22	Journal of Robotics	0.042	0.025	0.067	0.13	0.11	0.041	cluster5
23	Computer Scienc...	0.065	0.085	0.161	0.26	0.14	0.102	cluster5
24	Biological Cybern...	0.152	0.407	0.153	0.58	0.67	0.209	cluster3
25	ACM Transactions...	0.144	0.176	0.325	0.41	0.75	0.122	cluster3
26	Journal of Comput...	0.101	0.106	0.213	0.52	0.54	0.213	cluster2
27	Computer Applicat...	0.09	0.101	0.148	0.26	0.12	0.084	cluster5
28	Applied Ontology	0.08	0.06	0.243	0.8	0.27	0.158	cluster2
29	Studies in Informa...	0.058	0.065	0.083	0.8	0.6	0.094	cluster3
30	Swarm and Evolut...	0.298	0.151	0.428	0.63	0.93	0.473	cluster3
31	International Jour...	0.277	0.266	0.198	0.67	0.78	0.399	cluster3
32	Computational Ma...	0.195	0.427	0.196	0.94	0.62	0.279	cluster3
33	ACM Transactions...	0.176	0.271	0.355	0.34	0.68	0.256	cluster3
34	IEEE Access	0.169	0.126	0.299	0.49	0.67	0.152	cluster3
35	Wiley Interdiscipli...	0.168	0.111	0.347	0.42	0.69	0.257	cluster3
36	Algorithmica	0.145	0.302	0.208	0.74	0.63	0.089	cluster3

Figure 3: The cluster assignments

In order to verify the validity and correctness of the clusters they were clustered manually based on their quality standards and checked against the output of the algorithm. The clusters were interpreted as excellent, good, fair, poor and very poor.

Conclusion

When contributing to the global knowledge as researchers, it is very important to publish our new ideas and findings in an internationally recognized high quality journal. Besides that, by publishing the researchers can easily move up to the nest rung on their career ladder. One of the problems faced by researchers is finding the most suitable and high quality journal in order to publish their findings. As a solution for that, this research proposed a data mining model which can be used specially by the researchers in the field of Computer Science. The data mining model was developed based on 200 journals in Computer Science filed. As quality metrics, The Journal Impact Factor (JIF), Scientific Journal Rank (SJR), Eigenfactor Score, The h-index, Source Normalized Impact per Paper (SNIP), Article Influence Score (AI)

were used for developing the model. The journals were clustered into 5 clusters based on the above metrics and using the K-Means clustering algorithm.

The study described in this paper can be used by the researchers in the field of Computer Science to find out the most suitable and high quality journal in order to publish their findings. Further, this study paves the way for future studies for developing a data mining model to identify the high quality journals in different fields of study rather than Computer Science and that could be a great help for the researchers in the other fields of studies too.

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An assessment of machine learning-based training tools to assist Dyslexic patients

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Abstract

Dyslexia is a language based disability, where the patients often have difficulties with reading, spelling, writing and pronouncing words. The reading speed of Dyslexics tend to be lower than their equivalents, because of slow letter and word processing. Inspite of this disorder, a dyslexic person can be trained to read in normal speed. There are manual methods and some technical improvements can be reported such as the live-scribe smart pen, Dragon Naturally Speaking, Word processors, and Video Games. This study provides an assessment about the Machine Learning (ML) based techniques used for Dyslexic patients via a systematic review of literature, and a proposed ML based algorithm that will lay foundation for future research in the areas of machine learning, augmented and healthcare training devices.

Keywords: Dyslexia, Machine learning, Training tools

Introduction

In Diagnostic and Statistical Manual of Mental Disorders (DSM-V), dyslexia is listed as a specific learning disorder having a neurological origin. Dyslexia is characterized by difficulties with accurate and/or fluent word recognition and by poor spelling. These difficulties typically present as a deficit in the phonological component of language that is unexpected in relation to other cognitive abilities (Rello et al., 2016).

The impact of Dyslexia can alter during different stages of the life, but its effects last throughout an individual's life. Dyslexia is referred to as a learning disability, since its effects make it very difficult to succeed academically due to the typical environment in schools. It is a known fact that they feel humiliated and stressed, because of their reading speed. The causes for Dyslexia are still not completely clear. Most people affected with Dyslexia have been found to have problems identifying the separate speech sounds within a word or learning how letters represent those sounds, which is a key factor in their reading difficulties. The fact is that Dyslexia is not due to either lack of intelligence or desire to learn. With appropriate teaching methods, Dyslexic patients can learn successfully (Dickinson et al., 2002).

Students with dyslexia have poor fluency in reading, writing, spelling detection, short-term memory and also other related disorders. Additionally, they often suffer from emotions like frustration and low self-esteem due to lack of achievement, which in the end develop behavioral difficulties (Hamid et al., 2015). There are several training methods to improve the reading speed of a Dyslexic person. Mainly the Dyslexic people are trained in special education environments with the support of trained teachers. Video games designed for dyslexic people also play a major role in training those people. In addition, there are some tools to help them with their

studies, such as 'Live-scribe smart pen' (to record the lectures and listen again), some text-to-speech tools and word processors (Caryl and Joshua, 2017).

The reading speed of different Dyslexic people are not always similar. The reading speed differ from each other. They get stressed and humiliated because, their reading speeds do not match with typical people and thus they require the help of some assistant who works in their speed. Therefore, the most suitable way to improve reading speed would be a method to work based on the person's specific speed and improve the speed according to their ability (Patino, 2016).

Methodology

Design features for a novel adaptive Machine Learning Algorithm was introduced. A ML based algorithmic application, which allows customization on the reading speed based on the capabilities of patients, using experiment-based approach with real patients, is proposed. The study was conducted via three phases. In the first phase of the study, reading rate improvement and detection methodologies are systematically reviewed, in order to identify important characteristics of Dyslexic improvements. Second phase is focused on developing an ML-based algorithm to identify the improvement rate of the Dyslexic patients and training using Python. In the third phase, the outcome of the ML based algorithm is tested with samples from different clusters (using iterative experiments with real Dyslexic patients (Sathsara et al, 2017). This approach improves the reading speed.
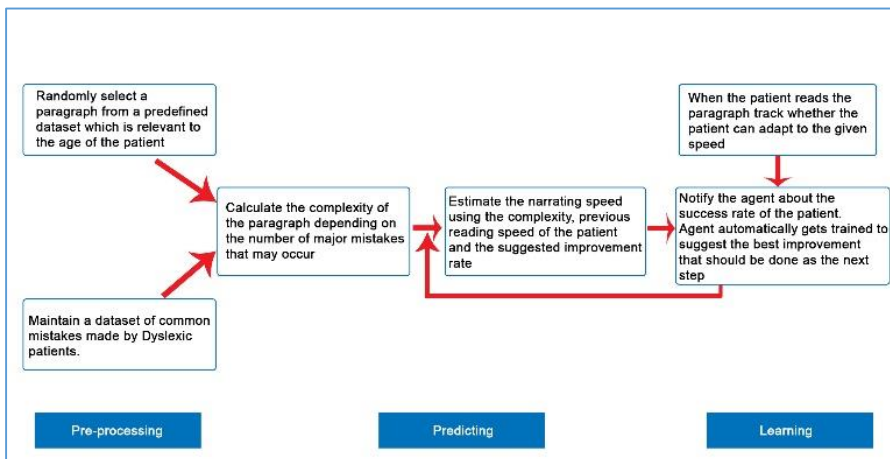
Figure 1: Design of the adaptive ML based algorithm

Results

The study provides new knowledge and a novel algorithm to literature contributing in plentiful ways, where a systematic review was done based on the applicability of Machine Learning techniques for improving reading and processing capabilities of Dyslexic patients. The study focused on reading and comprehension capabilities since reading speed helps to improve other language skills, where the reading speed implies fluency and comprehension implies the accuracy. An algorithmic approach is used since it is not limited to one tool and improvements can be added easily. An adaptive machine learning algorithm is used incorporating the Orton–Gillingham approach, since it is easy to make predictions, can automate the decision making process, is efficient and can easily work with multi-dimensional environments (Ritchey and Goeke, 2006). From literature, it is evident that minimal efforts have been put into the aforementioned focus and there is no way other than the manual method and to identify the actual reading speeds and to improve the speed according

to the ability of a particular person. Thus, this study produces a Machine Learning-based algorithmic application, which allows customization on the reading speed based on the capabilities of patients. This algorithm uses a generic and a customized model, in order to adapt to the reading speed of the patient. The algorithm is embedded to a mobile application where it is tested using an experimental analysis.

```
initialize MAX_PERCENTAGE;
initialize OBJECTIVE;
initialize ALPHA;
initialize GAMMA;
initialize REWARD;

get TIME_LEFT or EXCEEDED_TIME
get RATE_GIVEN
if TIME_LEFT then
increase RATE_SUPPOSED
assign REWARD = 1;
if EXCEEDED_TIME then
decrease RATE_SUPPOSED
assign REWARD = -1;

MAX_PERCENTAGE = (RATE_GIVEN - RATE_SUPPOSED)/ (OBJECTIVE - RATE_GIVEN)

if MAX_PERCENTAGE is closer to 0
assign REWARD = 0;
else
if MAX_PERCENTAGE > 0
Q = MAX_PERCENTAGE - MISTAKES
else
Q = MAX_PERCENTAGE + MISTAKES

IMPROVEMENT_RATE = Q + ALPHA * (REWARD + GAMMA * MAX_PERCENTAGE- Q)
SUGGESTED_RATE = RATE_GIVEN + IMPROVEMENT_RATE
SUGGESTED_TIME = SUGGESTED_RATE * NUM_OF_CHARACTERS
```

Figure 6: High level pseudocode of the algorithm

Conclusion

The study proves that there is significant improvement in the reading speed of patients in some age groups (patients of 7-10 years, 11-16 years of age and adults above 17 years of age with an improvement percentage of 5.98%, 2.25% and 0.55% respectively), and there is no significant improvement in comprehension. It can be concluded that this novel algorithm has a significant impact in improving the reading and processing capabilities of the Dyslexic patients, using an adaptive machine learning algorithm.

The limitations of the solution are that the current available APIs do not have the ability to conduct speech recognition by identifying the mistakes per sound, but it only receives the mistaken word. If the recognition is done by each sound, the results will be more accurate since the mistakes detection is done more accurately. The current methodology's recognition does not work as well for extremely slow readers with accuracy very low.

As future work, the algorithm could be improved by implementing a mechanism to identify the mistakes per each sound, instead of each word, where the accuracy will be higher than the existing algorithm. The study also could be expanded for a large set of patients, to further prove the improvement rate. This could be implemented addressing other related disorder issues too.

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Smart veggie identification and alerting system for supermarkets using image processing techniques and neural networks

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Abstract

The recent advancements in the field of image processing have become a great source of benefit to the development in fields of science and engineering. Image recognition is one of the foremost areas in computer vision as it yields favorable results in many applications. One of the main applications in image recognition is the object recognition; this is a process of identifying a specific object in an image or a video. In this paper, we present the current state of the image processing techniques to identify vegetables and fruits, and is capable of being installed with existing hardware resources. The implemented system can identify vegetables and fruits in a basket that are to be retailed and alert authorities when a basket is near to being empty. The system is based on color and size comparison of the vegetables and fruits in a live video with a reference image and thereby extract similar features by using neural network for identification. Height of the baskets is marked with colored lines, contrasting to the color of the content. The level of the basket is identified through the visible levels of the color lines and then the notifications are sent to the responsible parties. The system is tested with two vegetables egg plants and tomatoes as well as two fruits apple and oranges. Accuracy in identifying egg plants and apples have shown to be high, with the accuracy of the results for tomatoes and oranges being average.

Keywords: Color identification, Image processing, Object recognition, Neural network

Introduction

Information Technology (IT) for business alignment is a dynamic state in which a business organization can use IT effectively to achieve business objectives and improve financial performance or marketplace competitiveness. With the development of technology many revolutions have been occurred in business-to-business or business to consumer transactions. The traditional grocery store idea has been evolving in to a "mega shops" which carry all the goods shoppers need. If we observe the drivers for the evolution of current supply chains, or "contemporary trade" they had been chronic in boom demand for cost added client products, comfort food, beverage, and frozen confectioneries (Bolle et al., 1996; Sojitra and Patel, 2016). Usually customers have an idea what they want to buy. This is mostly because of modern customers browse internet daily and follow the other TV commercials to make them aware about the best products to pick. For an example, new analysis has revealed that the "experiential factor" is driving today's foodstuff shoppers who are seeking positive preparation experiences, creating deliberate selections from the shop to the stove, as well as needing to feel smart regarding the food they eat. They have pride within the brands they buy and share their change of state journeys on-line (Applebaum, 1951; Sukanya et al., 2016).

However, after implementing the system it was convinced that the sellers should be much more aware about the customer preferences to increase their sales. System

recognized the images of the vegetables and fruits, then displayed them in screen. Also the system triggers an alarm when the basket going to be nearly finish, and inform the responsible parties that an item need to be filled. So that they can avoid customer disappointment, also it is easy to locate the empty baskets around the market and as well as they can get an idea about the daily demand of that item. (Lu et al., 1994). Besides, system can identify the customer preferences, so that they know the demand and can improve sales from that item. It is a common thing that a customer can misplace an item to another basket with the busy life they lead. System can activate its alarm when a foreign object is in the basket. So, the workers can replace the item with the appropriate basket. This system can be used with existing Closed Circuit TV (CCTV) camera system without having pressure sensors embedded trays. This system is a cost effective alternative solution.

Methodology

Architectural design represents the overall structure of the Smart veggie identification system for supermarkets, which is developed to manage and maintain the information as several functions. Main activity of the users is to fill the baskets as soon as possible when they are notified. The solution is developed as it meets the minimum requirements to develop a web application. As in the Figure 1, it consists of three layers, i.e. presentation, logic and data Layer where the logic layer has an intelligent business layer which is considered the core of the platform. This system can be embedded with the existing CCTV camera system available in the supermarkets.
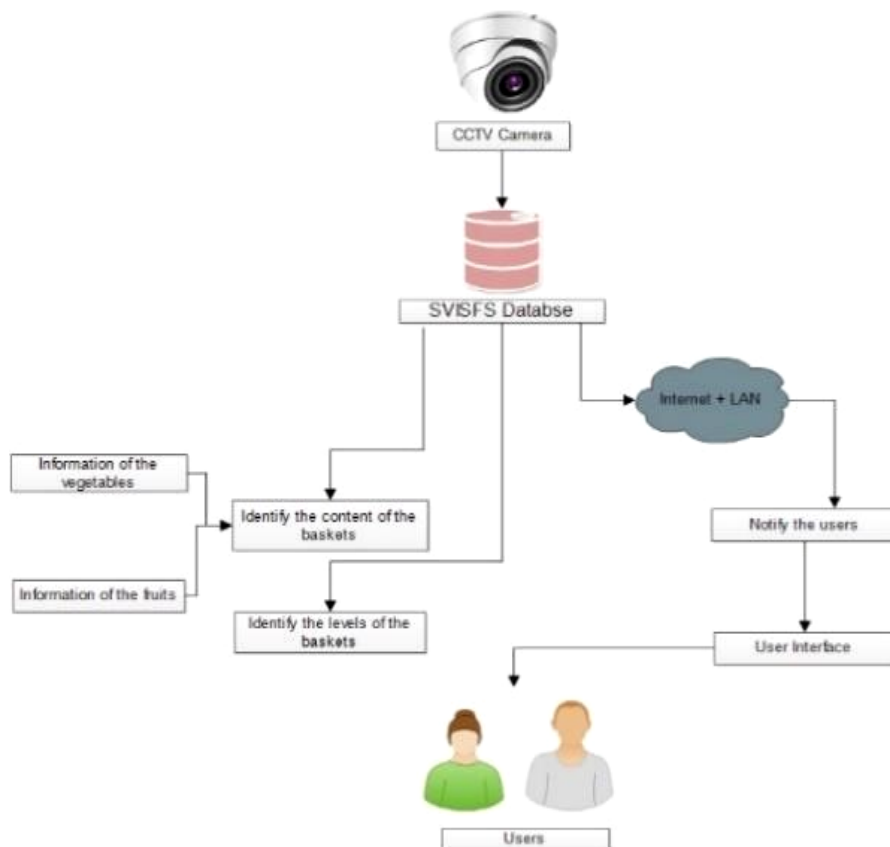
Figure 1: Software architecture

Design of the system core

The system is designed to identify the contents of the baskets which contains vegetables and fruits. The first task is to extract a single item from the image taken of the basket and identify that. After extracting the item using image slicing methods, the system is developed to identify the relevant vegetables and fruits. As the initial step, Scale-Invariant Feature Transform (SIFT) method in image processing to detect items was used. However, it did not yield the expected results as it was directing to some other items as well.

Template matching was the next step to extract features of vegetables and fruits. It is not an efficient way to identify vegetables though it was able to extract some of the features. Afterwards Speeded-Up Robust Features (SURF) method was used to identify the vegetables and fruits. Though it is much faster than SIFT method results were not accurate as expected. Then thresholding method was used. It gave accurate results, but it could not identify the vegetable separately.

After trying above methods, neural networks gave many accurate and efficient results and used the image slicing method to develop the system further. Neural network with seven layers was used to train two vegetables egg plant and tomato and two fruits, apple and orange. The neural network gave 80% accuracy. Below are some of the test results obtained and system has been tested for two vegetables and two fruits.
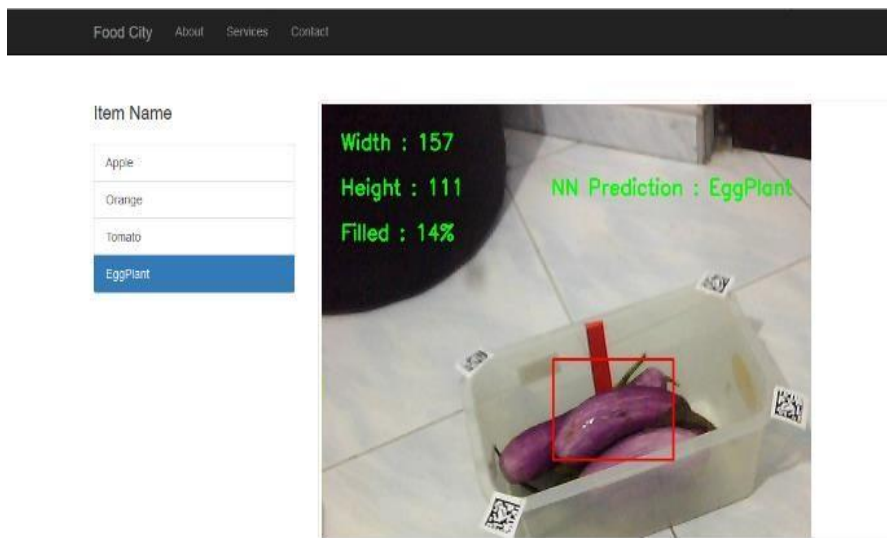
Figure 2: Final test results for aubergines

How the system works

The proposed system can identify the content of the basket by analyzing an image taken by the CCTV camera system. The system is developed to identify fruits and vegetables only. The system has been developed using image processing techniques and neural networks. To detect the different levels in the baskets, a color strip had been used. From this color strip, the filled amount is calculated. For each basket there is a specific color strip with a known height as you can see in the Figure 2. This indicates the level of the content filled in the basket. A Neural network was trained to identify the content of the basket. From four virtual markers on the top of the basket, an image is captured and cropped. This image is fed into the neural network as the input for the identification of content of the basket. One can claim that we can use pressure sensors for the baskets without using image processing. However, it

should be highlighted that the method that presented is much cost effective than wiring all the baskets and spending money on sensors. And also the system has implemented from the existing CCTV cameras that are already fixed at supermarkets and the owners do not want to spend extra money on pressure sensors. The system also provided with the specific location of the basket which is nearly to be emptied.

Conclusion

The implemented system consists with mainly three modules. One is the module to identify the level of the basket content. For this concept, color classification method has been used and small calculation was done with the height of the stripe. Second module is to identify the level of the basket. Neural network has been used to identify the fruits and vegetables stored in the baskets. Third is to notify the responsible parties and system was integrated with Raspberry pi chip set.

Implemented project is a system to identify user preferences when buying commodities and provide efficient service to the customers with the use of image processing and neural networks, and give the users the best displaying option depending on their appetite and need, and also optimize the available resources. The neural network yields an accuracy of 80.33% when identifying content of the basket. The system is tested with two vegetables, egg plants and tomatoes as well as two fruits, apples and oranges. Egg plants and apple had shown good accuracy in result, while the accuracy of the results for tomatoes and oranges are average. In future the system can be developed and tested for more accurate results when identifying vegetables and fruits. Furthermore, nature inspired algorithms such as ant colony optimization can be implemented to detect edges in the extract images of the vegetables and fruits when identifying those items. This concept can be extended to identify other items in supermarkets as well.

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Abstract No: SC-19   **Smart Computing**

Pedestrian detection using image processing for an effective traffic light controlling system

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Abstract

Traffic congestion and road pedestrian accident are the two major issues that the Sri Lankan society faced toady. These two issues can be reduced by use of traffic light controlling system in an effective way. This research paper proposed a system to make effective PEdestrian LIght CONtrolled (PELICON) crossing system using image processing. The proposed system consists of three major parts. That is CCTV camera, the system, and pair of poles with standard traffic light system. First the system captures an image of pedestrians who are waiting to cross the road, using CCTV camera. Then the system processes the image to identify and detect the number of pedestrians. Finally, if the number of pedestrians exceeds a given threshold value or pedestrian waiting time is exceeded, then the logical part of the system works and produces a result to control the traffic light system. This system that uses PELICON crossing system could be more effective than a button clicking PELICON Crossing system.

Keywords: Color detection, Image processing, PELICON crossing system, Traffic congestion

Introduction

Traffic congestion of Sri Lanka is a noticeable problem in the society. Today it has become a major problem in some major cities in Sri Lanka, like Colombo. Both of the vehicles and pedestrians represent most dominant users of road space with roads heavily congested with traffic. According to the survey, 15,000 buses, 10,000 trucks and 225,000 private vehicles, enter Colombo city daily (Edirisinghe, 2014). However, there is no proper method to handle both vehicles and pedestrians. There are 10 major entry corridors to Colombo city, with an estimated number of 750,000 people arriving daily to the city by road using 200,000 vehicles (Weerawardana, 2011). With increased imports of vehicles, the traffic congestion problem will only steadily increase. The Government and other policy makers proposed various solutions for this problem. But, still there is no reliable and efficient solution.

In addition, road accidents have become an appreciable problem. Most of the road-accidents occur while the pedestrian is crossing the road. Pedestrian have rights to cross the road safely. Nevertheless, there is a huge deficit in the provision of pedestrian controlling units in Sri Lanka. Pedestrian fatalities in Sri Lanka account for 40% of all road deaths. In Colombo district, this is as high as 70% of all accident statistics, with pedestrian constituting around 39% of them (Fernando, 2011).

These two major problems fiectly affect the Sri Lankan economy. The economic cost of accidents has been valued at over Rs 10,000 million annually in Sri Lanka (Kumarage et al., 2003). While considering these two problems, it is important to use efficient traffic controlling system for urban areas in Sri Lanka.

The use of traffic light controlling system is an effective way and reliable solution to minimize road traffic and road accidents. In this paper we propose a system using image processing techniques that can be used at PELICON crossing systems. Pedestrian detection using image processing and controlling the traffic light system is a more reliable way to handle both the vehicles and pedestrians while they are crossing the road.

Existing traffic light systems in Colombo, are administered and managed by Colombo Municipal Council's (CMC) Traffic Division. The Traffic and Road Safety Division of CMC is responsible for efficient management of road network, road furniture, facilitating the road safety and minimize traffic flow in the city. Traffic light controlling system automated based on the time period. The time period depends on the location. Some of them are automated from 6.00 a.m. to 9.00 p.m. and some of them automated thoughout the day. Recent PELICON crossing system in Colombo uses image processing technique. It detects human objects and the button click event to automate the system. However, there is still no PELICON system to calculate the number of pedestrians. Our proposed system calculates the number of pedestrians and then automates the system according to the proposed logics.

Methodology

Figure 1 shows the architecture of the proposed approach. Several methods have been using to implement this proposed system. When CCTV camera is activated the system input initiates. CCTV camera video contains with 24 frames per second, so, system needs to take one image from that 24 frames with time interval. First, it takes an image from CCTV camera that is on the top of the traffic light pole. As a second step, the captured image is converted into gray scale image. Then, the background is subtracted using several algorithms. Next, the system identifies contours from captured image. Finally, the contours of the captured image match with already stored human object contours in the system. If the image contours matches with the contours that is stored in the system or pedestrian waiting time exceeds, then the system shows green signal to pedestrian and red signal to vehicles as usual.

We used C# programming language and Visual Studio 2013 with EmguCV wrapper to implement the image processing module and logical part of the proposed system. As we mentioned, we used several image processing algorithms for color detection, background subtraction and contour analysis.
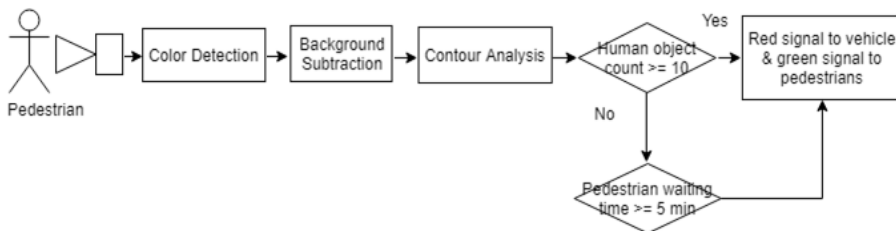
Figure 1: Architecture of the proposed approach

Color detection

HSV color model is used in color detection. The color is manually selected in color selector. HSV color models the effect of glare of the object that occurs due to light. In this color detection module, first the input image stored in RGB color mode image type variable. Due to minimize the effects of the glare image have been converted into HSV color mode image variable. The "ImageProcessing()" method is used to extract the image foreground by identifying the color range that the system needs to detect. The variable that is affiliated with the color mode HSV is then being used for

processing the image. The image is used to find out areas with a particular color range, where it helps to create color recognition. According to the amount of hue saturation and value, the system detects the maximum and the minimum color range in the system. Noted that this color detection method detect the dark color objects rather than light colors.

Background subtraction

After successful detection of the color, the system sets the input to the feature detection method in the foreground image. The system background subtraction is done to remove the background and highlight the foreground. The system starts checking pixel by pixel of the input pixels of the image. Flood fill method is used to fill the areas that which are not belonging to the particular region. The other areas that belong to the specifically needed regions are flooded, and the non-belonging areas are left away. Then, smoothing filters are applied and the noises of the image are removed. The segmented for the ground is been subtracted by the original image, where it results in an image with foreground only. This result then displayed as an image in the system. The input image is stored in an image variable. A gray image is been used to draw the rectangle on the image where the specified color is been present.

Contour analysis

Contour analysis is used to solve main problems of pattern recognition. The pedestrian shape detection contains two user defined library classes called "ContourAnalysis" and "ContourAnalysisProcessing". The "ContourAnalysis" class is designed to create and store contours. It contains basic operations for contours and the creation of base templates. The class stores contours on its value description ACF, the liner parameters of an initial contour (area) norm of contour and template id which is used as the recognize value. This class implements fast searching of the template for the given contour. It contains similarity rate and scale contour. The "ContourAnalysisProcessing" class contains the method of initial handling of the image selection of contours. The project contains the class called "ImageProcessor" and it used to handle images. EmguCV.net wrapper used for the image operations.

Finally, if the contours in captured image is matched with existing human contours already stored in system and if the minimum pedestrian count exceeds or pedestrian waiting time is exceeded the traffic light shows red signal to vehicle and green to pedestrians.

Results

Following Figues 2 and 3 show the sample outputs of background subtraction step and pedestrians' detection step respectively.

Figure 2: Background subtraction of an image
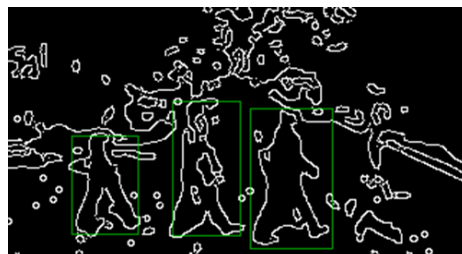
Figure 3: Detected pedestrians using contours

After doing several analysis and implementations the result of this research has been established as an executable system. The proposed system is mainly a computer

based system. As we mentioned, the input for the system can captures through CCTV camera that sets on top of the traffic light pole. The system uses color detection method to detect the pixels of foreground of the system. After several analyses, the system detects human contours and takes the count of human objects. If the object count exceeds or pedestrian waiting time exceeds the system automatically shows green signal to pedestrians and red signal to vehicles.

Conclusion

We proposed pedestrian detection approach using image processing for an effective traffic light controlling system. The system uses a CCTV camera to capture an image. To identify the human contours, the system first uses color detection algorithm. It identifies dark colors more accurately than light colors. When doing background subtraction, the system translates the captured image into black and white image. If the pedestrian wears light color dress, then the system fails to identify that pedestrian as a human object. The image should be captured with clear human shapes to analyze contours from an image match it with existing contours. However, in generally the pedestrians who are waiting for cross the road anchored as a bunch. Therefore, in CCTV captured image of this system has no clear human objects. Therefore, the system fails to identify clear human contours and calculate real human object count from that image. This system is suitable for less number of pedestrian crossing locations.

As future work, we hope to do a survey about this system to check the suitability of such a system for the genral public in Sri Lanka. Vehicle identification algorithm and vehicle count calculation algorithms, are important for future improvements of this system.

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Abstract No: SC-20   **Smart Computing**

Identification of water stressed leaves using Artificial Intelligence: The case of eggplant

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Abstract

Identification of water stress of leaves from the photos taken has a long history. Researchers have defined a parameter called Leaf Water Content (LWC) to quantify the dryness of leaves. However, in the case of automatic watering of plants, such high accuracy of LWC is not needed as a decision to water or not alone is sufficient. Furthermore, the agricultural industry cannot use methods of remote sensing that are required to find LWC as they are complex and costly. In the current practice, farmers use their knowledge and experience together with the appearance of plants to estimate the water stress and watering time point of plants. The approach presented in this paper is easily implemented and requires only a series of photos taken by a smartphone or a camera and a software app. In this paper, a method s introduced using Artificial Intelligence (AI) where the images of leaves are directly used to determine whether the leaves are water stressed. We could identify the water stressed leaves accurately using this method. Once an app based on our method is developed, it could easily be used by farmers to automatically identify whether the eggplants are water stressed and need watering.

Keywords: Image classification, Image filtering, Leaf water content, Leaf water stress recognition

Introduction

Plants lose water that they absorb through the roots during photosynthesis and respiration as well as through transpiration. About 90 percent of the water that enters the plant is lost through transpiration. When the plants do not receive enough water, leaves of the plants droop, showing water stress. Both overwatering and underwatering can damage plant growth. As such, for better yields, the farmers need to determine the exact time point to water the plants and the quantity of water supplied. In some advanced irrigation systems, the soil moisture content is used to determine these two. But most farmers water the plants at regular time points or when they notice the drooping of leaves.

The amount of water found in a leaf is called LWC. Some methods of measuring LWC require a leaf to be removed from the plant, but the majority that use advanced spectrophotometers do not. A related variable to LWC is the Equivalent Water Thickness (EWT), which is defined as the volume of water per unit surface area of the leaf. Continuous wavelet analysis (CWA) (Cheng et al., 2014) and a genetic algorithm (GA) (Li et al., 2008) have been used to determine spectral features of LWC. Zheng et al., (2015) describe a method based on electrical property of plants to estimate LWC. However, this is not a remote sensing method and hence, is not suitable for automated leaf water stress detection. Ge et al., (2016) report a method to predict LWCs using hyperspectral imaging but it has the drawback of needing a hyperspectral camera. Zhu et al. (2016) investigate full-waveform terrestrial laser scanning data (TLS) to estimate the LWC vertical distribution within the canopy of

individual plants. González-Fernández et al., (2015) evaluate the effectiveness of using a field spectroradiometer to estimate the water content at the leaf and canopy levels of vine. They conclude that spectroradiometry is a rapid and non-destructive method for leaf level estimation of LWC in commercial vineyards.

However, these methods are unsuitable for automatic LWC determination using Unmanned Aerial Vehicles (UAVs) because of the cost and weight of the cameras. As such, a simple method that uses a camera such as a smartphone mounted on a UAV would be very useful for automatic water stress identification of plants.

To the best of our knowledge, there is no publication that reports the use of Artificial Intelligence (AI) to identify water-stressed plants, although AI has been used to recognise the plant varieties from the images of the leaves (Pornpanomchai et al., 2011).

Methodology

Our approach consists of capturing colour images of eggplant (*solanum melongena*) leaves that are under water stress and not under water stress using a 12 megapixel smartphone camera. We do not control the camera angle, capture distance and illumination in order to have a good randomness in the results. This is necessary as, in practical situations, we need to use a handheld smartphone or a UAV camera and we cannot control these parameters. Any method that we design should be robust to these variations. Then, we filter the images using a built-in image filter in Waikato Environment for Knowledge Analysis (WEKA) 3.8.0 to create attributes. We select WEKA 3.8.0 data mining software because it has several image filters that are able to automatically construct the attributes from the images. WEKA also has a number of built-in classifiers so that we can classify the data quickly using various classifiers and decide which one is mostly appropriate. Finally, we use 66% of the images to train a classifier in WEKA 3.8.0 and the rest of the images to test the classifier.

To this end, we took photos of eggplant leaves using a Samsung smartphone. We extracted 62 images of leaves from plants that were not under water stress. Then, we did not water the plants for 2 days. On the 3rd day, the pants showed water stress and the soil appeared to be dry as well. Then, we took photos of the plants again before watering them. We extracted 69 images of leaves from these water stressed plants.

Results

Images using various image filters in WEKA 3.8.0 and found that Colour Layout Filter was the best filter for this application. This created 33 colour attributes. Then, we experimented with various classifiers in WEKA and found that Random Forest Classifier produced the best results. We used 66% split for training and the rest were used for testing.

Table 1: Confusion matrix with random forest classifier

Actual Leaf Condition	Classified as Not Water Stressed	Classified as Water Stressed
Not Water Stressed	75%	25%
Water Stressed	13.6%	86.4%

The accuracy of testing was 82.22%. The confusion matrix in Table 1 shows that 75% of 'not water stressed' leaves and 86.4% of 'water stressed' leaves were identified correctly. This outcome is not particularly useful as it is. However, in practice, it is not a single leaf image that we want to test and determine whether it is water stressed or not. We would take a sample of a number of images of leaves from

a plantation and if we can correctly classify this sample as water stressed or not, it would be sufficient.

Inspection of the attribute values generated by the Colour Layout Filter showed that MPEG Colour Layout 0 attribute values of water stressed leaves were significantly different to that of not water stressed leaves. MPEG Colour Layout 0 attribute values are, in fact, the mean values taken over the area of the image of a leaf. The mean value of this attribute for water stressed leaves was 33.92 whereas that of not water stressed leaves was 44.47. Therefore, these mean values are the mean values of the sampling distributions of MPEG Colour Layout 0 attribute of water stressed and not water stressed leaves. As such, we can use the mean values of this attribute to identify a water stressed plantation of eggplants accurately. Statistics of MPEG Colour Layout 0 attribute values of water stressed leaves and that of not water stressed leaves are shown in Table 2.

Table 2: Statistics of MPEG colour layout 0 attribute

Statistic	Water stressed leaves	Not water stressed leaves
Sample size	69	62
Minimum	7	15
Maximum	54	57
Mean	33.928	44.468
Standard deviation	13.327	8.623

The ratio between the standard deviations of the two categories, water stressed leaves and not water stressed leaves is less than 2, so that we can use the t-test to compare the population means. Let the sample sizes, sample means, sample standard deviations and population means of water stressed leaves and not water stressed leaves be $n_1, \bar{x}_1, s_1, \mu_1$ and $n_2, \bar{x}_2, s_2, \mu_2$ respectively. We define the null hypothesis H_0 and the alternative hypothesis H_1 as:
$H_0: \mu_1 = \mu_2$ and $H_1: \mu_1 \neq \mu_2$

The *t*-distribution has degrees of freedom $(df) = n_1 + n_2 - 2 = 129$.
We calculate the pooled value of standard deviation using
$$s = (n_1 - 1)s_1^2 + (n_2 - 1)s_2^2/df$$
Therefore, s = 11.35.
We calculate the t-statistic value using
$$t = \frac{(\bar{x}_1 - \bar{x}_2) - (\mu_1 - \mu_2)}{s\sqrt{\frac{1}{n_1} + \frac{1}{n_2}}}$$

Thus, $t = 5.2665$.
Using one-tailed distribution, this corresponds to a very small probability (p-value) that lies outside the table, and therefore, with a level of significance of 1%, we reject the null hypothesis, and accept that μ_1 is significantly different from μ_2.

On the other hand, if sample sizes of water stressed and not water stressed leaf images are 64 each, since df is 126, to obtain a t-value of 4.985, we need to have a p-value of 0.000001. Assuming that the pooled standard deviation is 11.35, $(\bar{x}_1 - \bar{x}_2)$ will be 10.

Hence, we recommend capturing 64 photos of the leaves of an eggplant plantation about 2 hours after watering and then, building the mean value of MPEG Colour Layout 0 attribute of the Colour Layout Filter. This is the mean value of the attribute for a not water stressed eggplant plantation. When the process is repeated next time,

if the mean value of the attribute is less than this value by about a margin of 10, the plants are considered to be water stressed and should be watered.

Conclusion

The aim of this research was to develop a method that can identify water stressed eggplant leaves from their images taken by a smartphone. Image filters provided in WEKA 3.8.0 were used to extract attributes from the images. Various classifiers provided in WEKA 3.8.0 were then used to classify the images to identify the water stressed leaves. Classifier used 66% of the images for training purpose and the rest for testing. The best result that we could obtain was only 82.22% accurate, and that was not sufficient for the practical application of this classifier. But we noticed that we do not need to classify each leaf as water stressed or not, but only need to classify a sample of images. Therefore, we developed a different solution to the problem by inspecting the values of the attributes.

It was noticed that MPEG Colour Layout 0 attribute generated by the Colour Layout Filter showed significantly different mean values for water stressed leaf images and not water stressed leaf images. As such, we conclude that this attribute can be used to classify a water stressed eggplant plantation. We hope to extend this research to include more images and various other fruit and vegetable plants.

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A haptic feeding GPS navigation solution for visually impaired people

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Abstract

According to the World Health Organization (WHO), it is estimated that 285 million people are visually impaired worldwide and out of which 39 million of people are blind. Further, about 90 percent of the visually impaired people in the world live in low-income settings. Among many difficulties that they encounter in their day-to-day activities, the visually impaired people are often disadvantaged particularly when travelling due their inability to see the obstacles and visual signs of directions that are essential to navigate not only through the unfamiliar terrains but also in the familiar environments. Therefore, the visually impaired people usually use a white cane to detect obstacles on their path whilst get the assistance of the trained guide dogs for navigation. However, when they roam in an unfamiliar environment, they always have to rely on a third party for finding their directions. In this paper, we presents a novel Global Positioning System (GPS) and Google Map Direction Application Programming Interface (API) based navigation solution for the visually impaired people with a simple haptic direction feeding interface as an alternative to the sonification systems available. Our objective of this research is to develop an economically viable haptic feeding GPS navigation system for the visually impaired people in order to help them with their day-to-day activities such as reaching for public services, socializing with people and exploring the world more confidently than ever before.

Keywords: Blind, GPS navigation, Haptic, Visually impaired

Introduction

With the advancement of the Global Positioning System (GPS) technology, development of GPS navigation solutions for the visually impaired people have become an active domain of research in the recent years. They include the Brunel Navigation System for the Blind (Garaj, 2001), BrailleNote GPS (Humanware, 2017), Trekker Breeze (Trekker Breeze, 2017) and BlindSquare (BlindSquare, 2017) to name a few. However, most of the present GPS navigation solutions (Helal et al., 2001; Gill, 1997) for the visually impaired people are based on the auditory perception of visual information. These navigation systems capture data from various sensors and information services, process them and convert the navigational instructions into sounds. As the visually impaired people see the world through their ears due to their lack of vision, these sonification systems not only pose a high risk of interference to a visually impaired traveler's perception of environmental sounds but also attract an unnecessary attention.

In this paper, we presents a novel GPS navigation solution for the visually impaired people, with a haptic feeding system as an alternative to the sonification systems. The proposed solution contains two interconnected main components, a wearable device and a navigational directions providing server. The wearable device consists of a haptic feeding system, a GPS locator, a Global System for Mobile communication (GSM) module, an electronic compass and an embedded processor.

The navigational directions providing server obtains real-time navigational directions from the free Google Map Direction Application Programming Interface (API) using the GPS location of the wearable device and intended destination to be reached. The obtained navigational path are then narrow downed into GPS pointed path in order to meet the requirements of the haptic feeding system. The GPS pointed path is then transferred into the wearable device via a GSM link. Based on to the obtained GPS pointed path, the visually impaired user is then guided through point to point with simple and easily understandable haptic instructions using the user's heading direction until the destination point is reached.

Methodology

Corresponding to source and the destination, directions JavaScript Object Notation (JSON) are first obtained from the Google Directions API. By decoding the polyline information of the JASON, the latitude and longitude of each point of the GPS pointed path is then extracted and full GPS pointed path is created as an array. This GPS pointed path array is then transferred to the wearable device via a GSM link.

Figure 7: Prototype wearable device developed to validate the haptic navigation algorithm

The algorithm of the firmware embedded into the wearable device executes as follows. The algorithm generates haptic navigational instructions whenever the GPS pointed path array is passed in to the system. For this purpose, it first creates a point embedded array with the given path points. Then it sets the array index variable to zero. Depending on the first four elements on the GPS pointed array, linear equations are created according to the graph theories. The first four elements of the array represent source latitude, source longitude, next point latitude, next point longitude respectively. Next depending on the angle of the line and the magnetic north of the world, the direction to where the user should face is notified. This is done with the left and right haptic feeders until the heading direction is correct. Once the direction is correct, the user is notified this with a long (300ms) frontal haptic feed. Next the user's location acquiring functions is called and the current location is repeatedly checked until the next point is reached. Meanwhile, there are two functions are executed to keep the user on the path. The first is to identify whether perpendicular distance of the user point to path is very close. The second function is used to see whether the user going off the line. Then the left and right haptic feeds are used to reallocate the user on the path. When the user reaches the next point, the array index is incremented by two and the new line equation is generated according to the new points. Using compass signals, the user is kept on the path according to the new line. These steps of the algorithm execute repeatedly until the last element of the array is accessed. Accessing the last array element indicates that the user has reached to the required destination. The flowchart representation of the haptic navigational algorithm is shown in Figure 2.
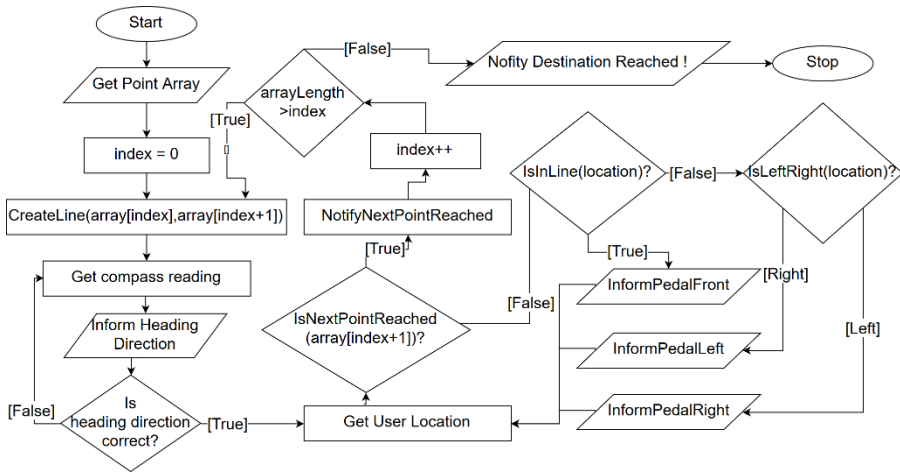
Figure 8: Flowchart of the haptic navigational algorithm

Results

A prototype wearable device was developed to demonstrate the viability of the proposed approach. The prototype wearable device is shown in Figure 1. However, at the beginning, empirical data such as user's live coordinates and navigational points were not available for validation. Even if the empirical dataset is available, geographically moving here and there to test the algorithms was considered as not a feasible solution due to safety concerns. Therefor some hypothetical GPS pointed paths were created with Microsoft Excel. Once the success of the testing with hypothetical data became apparent, the real-time empirical testing was carried out.

Real-time empirical testing was carried out using actual GPS coordinates, prototype wearable device and visually impaired human users. Feedbacks from the visually impaired users were then considered for improving the usability of the prototype. The real-time empirical testing was completed with four users and the results of one of the test case used for the validation is shown in Figure 3. In Figure 3, the light color squares represent the GPS pointed path and the dark color rhombuses stands for the actual user's navigation path by following haptic feeds from the prototype wearable device.
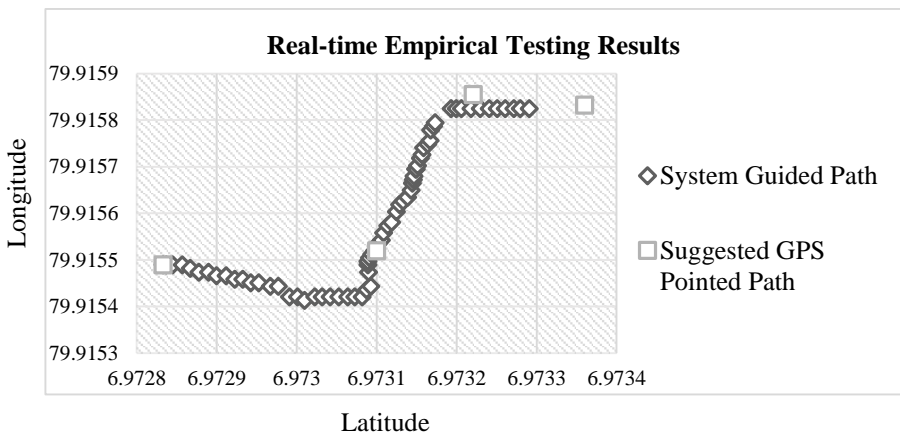
Figure 3: Flowchart of the haptic navigational algorithm

Conclusion

In this paper, we have presented a novel GPS and Google Map Direction API based navigation solution for the visually impaired people with a simple haptic direction feeding interface as an alternative to the sonification systems available.

A prototype wearable device was developed to demonstrate the viability of the proposed approach and the feedbacks from the visually impaired users were used for improving it. A real-time empirical validation of the proposed algorithm was also carried out using actual GPS coordinates, prototype wearable device developed and visually impaired human users of the Employees' Federation of Ceylon.

The user feedback confirms that the proposed haptic interface is suitable for the purpose. Further, in comparison to the available sonification solutions to the problem, the results of the empirical validation is evident that our proposed approach is fairly accurate enough to guide a visually impaired user to his/her intended destination without posing any risk of interference to his/her perception of environmental sounds and also attract any unnecessary attention. Therefore, we have achieved our objective of this research as set out in Introduction.

However, we agree that further empirical evaluation is required before making the proposed approach operationally available due to safety concerns.

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Traffic through - An effective right-turn-bay of signalized intersections for busy hours

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Abstract

Sri Lanka, as a developing country, the traffic congestions are becoming severe day by day because of the population and the economic background. To overcome the congested areas, the traffic controlling light systems were introduced and used in most of the junctions. Existing traffic light system is based on the fixed cycle times for each phase, depending on the environmental conditions, geometry design of the junction and traffic movements of the particular junction. Among the most of the features at the road intersections, the feature called "Right-Turn-Bay" is an extra segment of lane which was introduced to the vehicles which are supposed to proceed right turning movement at the intersection. Because of the limited area of that lane segment, it can be filled easily. The proposed solution is to overcome the overflowing problem in the right-turn-bay by giving an extra cycle time period for the right turnings in busy time. For this real-time process, the image processing techniques were used for a video sequences, captured by a video camera to detect the arrival of vehicles at the bay and its count was gathered using the pixel-wise detection and blob tacking of the vehicle. The traffic light was controlled as usual and the additional functionality was to control the junction considering the maximum count and the current count at the bay. The controller is to decide whether the traffic should leave the bay or not by considering its parameters.

Keywords: Image processing, Phase, Right-turn-bay, Traffic

Introduction

The safe driving with minimum road accidents and the congestion controlling within the congested areas are guaranteed using the Traffic controlling light systems worldwide. Existing traffic light system of Sri Lanka, is based on the fixed cycle times, controlling by the electro-mechanical time clocks. The time period remains unchanged either there are available vehicles to pass through the junction or not and the allocated time may be not enough for all the vehicles waited in the lane (Kamalrajh, 2011). The controlling mechanisms depend on the environmental conditions, geometry design and traffic movements of the particular junction. "Right-turn-bay" is one of the geometrical designs that were implemented in the road intersections in Sri Lanka lately with world standards. It is an extra segment of lane which was introduced for the waiting vehicles which are supposed for the right turning movements at the intersection without holding up vehicles going straight through. Since the lane segment is limited, it can be overloaded within seconds in congested times and it leads the difficulties for the vehicles, driven straight forward, in the nearest lane (Gaikwad et al., 2014). Reduction of overflowing at the bay can reduce the congestion in the junction and the proposed solution is to give an extra phase for the right-turn-bay when it is filled together with the aims of minimizing road delays and accidents which are led to the economic and environmental benefits of the country.

Traffic controlling can be done using Computer Vision (Bradski and Kaehler, 2008) techniques for video sequences (Sankhe, et al., 2014; Hasan et al., 2014). The proposed solution introduces the controlling mechanism with respect to the vehicle count at the waiting bay (Gupta et al., 2014) by detection of vehicles using pixel wise detection (Hofmann et al., 2012), blob tracking mechanism (Ekanayake et al., 2012) and passing a vehicle through Region of Interest (ROI) using two point distances (Jamal et al., 2014). Additionally, the simplest junction as T-junction was considered for making the functionality with the traffic phase possibilities at the junction (Darzentas et al., 1980).

Methodology

Since the mechanism is a real-time process, the data were needed to be collect as the video sequences captured by a camera which was fixed at a high place to avoid the disturbances from the surroundings (Hewage and Ruwanpura, 2004). Through the videos captured, the cycle times and the right-turn-bay segment were studied to find the maximum count of the vehicles that can be held in the segment. A typical three-legged junction (T-junction) with a right-turn-bay (Figure 1) was selected for the introducing process of the new controlling.

Figure 1: A typical three-legged intersection with a right-turn-bay

Then the vehicle detection process was done with the Image Processing Techniques. The first step is "Background Segmentation". Since there were so many methods to filter foreground from the background, the most used efficient method was defined on pixels of the image and processed a binary image considering a threshold of differencing foreground and background using current pixel values (Hofmann et al., 2012). Since the background may be less or highly dynamic, the background was updated through the whole segmentation process for a better foreground mask output.

From the above method of pixel-by-pixel, the smooth edges of the moving objects would be lost at most. Additionally, the moving objects needed to find its centroid to track the direction of moving. For the both factors, edge loosing and finding centroid, the vehicle boundary tracking ("Blob Tracking") was needed much more task for an accurate detection of the moving vehicle. The blobs were tracked using the "8-connected" neighborhood to find the nearest pixel values to the help of verifying the moving object boundary and its center of gravity. The centroid was helped to verify the same vehicle had been tracked throughout the process and the positions of the vehicle.

For the vehicle counting process, the centroid of the vehicle and the ROI, a virtual vertical line on the screen, were used. Considering the previous and next positions of the centroid relative to the ROI, the vehicle was counted by an incremental variable as it had passed the ROI. That count was implemented to be reset when it reaches the maximum number of vehicles that can be held by the right-turn-bay and the maximum will depend on the lengths of the vehicles and the turning bay. Then a request of signal changing would forward to the signal controller, when the current count of vehicles hits the maximum count. The signal controller is to work as usual with regarding its parameters. Additionally, the request would be accepted if the waiting period is not less than 30s (thirty seconds) at the right-turn-bay.

Results

As the results, the video sequence was captured as the input for the process by a static camera (Figure 2). Since the solution is only focused on the right-turn-bay, the camera should capture only that segment and a single queue of vehicles. The foreground image was detected by the binary video image that was produced using the input video (Figure 3) with the aid of the "Background Segmentation". The detected foreground would be displayed as a white color region.

Figure 2: Video capturing by a static camera

Figure 3: The detected foreground

Since the preprocessed video image gives the less sharp blobs for the vehicle, blobs of the vehicle were tracked using pixel connectivity and a rectangular blue color bounding box was drawn as the structured element to find the centroid (Figure 4). Then the centroid is the center pixel of the bounding box. Using the centroid coordinates relative to the ROI, the vehicles were counted (Figure 5). The ROI was a vertical line since a single queue of vehicles is needed to count as mentioned above.

Figure 4: The vehicle detection with the bounding box

Figure 5: The vehicle was counted as 1 (One)

Then the request of changing the phase was created when the count hits the maximum and the count would be reset for the camera screen at the same time (Figure 6).
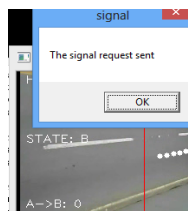
Figure 6: Sending the changing request and the count is reset

When the controller received the request, it would be checked the waiting period for the right-turn-bay. If it is 30 seconds period, the phase is to be changed and the right turnings will be allowed together with a dead period and unchanged otherwise.

Conclusion

It can be concluded that the proposed solution is focused on the right-turn-bay and its clearance of vehicles in busy hours. So the proposed mechanism is applicable only for the signalized junctions which are capable of right-turn-bays. Reduction of the overflowing problem at the turning bay will lead the less difficulties at the nearest

lane which is allocated for the straight driven vehicles, since some of turning vehicles are waited holding some area of it in congested hours. Because of above factors, the given solution ensures the convenient and safety at the junction.

Moreover, the outside factors cannot be fully avoided here since it is a real time process. So the implementations in other methods as using sensors (Mirchandani, 2005) can be tried further to check the reduction of interferences from the environment. It can expand for the complex junctions with more turning bays.

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Abstract No: SC-23   **Smart Computing**

Isolated Sinhala handwritten character recognition using part based matching technique

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Abstract

This paper presents a novel approach for Sinhala handwritten character recognition using a part based matching technique. The Sinhala character set consist of some common parts. Therefore, the characters can be split into its parts. Each part in turn, can be considered as an atomic element, which these characters are composed of. The proposed method splits the characters into their atomic parts and then conducts the recognition process. Template matching is used to compare the character parts and characters. To improve the recognition process, the global characteristics of the characters are used. Experimental results show that the proposed method gives an average accuracy of 46% where the maximum accuracy is 100% and the minimum accuracy is 11%.

Keywords: Part-based approach, Sinhala characters

Introduction

Character recognition is a procedure of converting images of handwritten, typewritten or printed text into machine encoded code or text (Schantz, 1982). Most of the hand written character recognition methods have been proposed for the recognition of scripts such as English and Chinese. Few attempts have been taken on the Asian languages such as Sinhala. Sinhala is the language used by Sinhala people, the major ethnic group in Sri Lanka. The characters in the Sinhala alphabet share some common parts. Hence, Sinhala characters can be split into a set of parts, which can be considered as the basic elements in which these characters are composed of. Each Sinhala character can be formed by a set of distinct parts.

Part-based approaches have been experimented for object recognition with promising results. Most of the work consider the problem of matching corresponding parts of objects across different images. The part-based methods can be applied for the experiments in character recognition as well. There is no research done in the area of evaluating the influence of decomposing Sinhala characters, recognizing them in a part wise manner and combining the results to character recognition.

Most of the related work for decomposing characters has been experimented on Chinese characters (Cao and Tan, 2000), (Lin and Tang, 2002). The reason is that the Chinese characters can be easily decomposed to a set of basic character parts. Because of the nature of using straight lines in Chinese characters some researches have used the method of identifying strokes of characters (Lin and Tang, 2002), (Su, and Wang, 2003). This method is not applicable for Sinhala characters as the straight lines are almost non-existent in the Sinhala character set. The work of Matsuo, et al. (2013) is more relevant to the work of the present research. They work on Chinese characters but they decompose the characters in to parts, which are short segments of an entire character. Then they represent each part as a segment comprised of

(2k+1) consecutive points, where k is the radius of the part. They have used 80 elementary Chinese character classes, and extracted 25 representative parts. Each handwriting character was then resampled to have 50 points and through that, each character was converted into a set of 50 parts. Those parts are then represented as a bag-of-features, which is a histogram showing how many parts similar to a specific representative part exist in the character. They show that without any global structure information a 50-60% accuracy can be attained for 80 Chinese character classes.

In digit recognition, it is only a matter of recognizing between 10 different classes from 0 to 9 whereas in character recognition, the number of different classes are much higher in number. (Wang et al., 2013) has presented a study of the behaviour of several part-based methods for handwritten digit recognition. According to them, even without the usage of the global structure of the digits, the part-based method can achieve promising recognition rates for digit recognition.

In Sinhala handwriting recognition part based approaches has never been experimented. However, various other methods have been experimented by several authors.

Rajapakse et al. (1995) was the very first attempt of Sinhala handwriting recognition. They have divided a handwritten character into 9 sections and generated a binary code by overlaying a grid pattern over an image section. By using the binary pattern, a neural network is trained and recognition results are obtained. Thereafter, many other methods have been explored. The latest research on Sinhala handwriting recognition (Madushanka, et al., 2017) addressed a curvature based pattern matching and histogram formation method for Sinhala handwriting recognition.

Template matching is a technique used to map one template image into another. It searches for the most similar image pattern in the image for the template image. Template matching is used for character recognition in the work of (Kumar and Sharma, 2013) for offline handwritten and typewritten character recognition. (Qatran, 2011) has also used a template matching method, to recognize Musnad alphabet, which is considered the basic alphabet of the modern Arabic language.

Methodology
The purpose of this research is to explore a novel part based mechanism for Sinhala handwritten character recognition. A set of 24 characters from the Sinhala alphabet are selected for the investigation. The selected character set excludes the modifier symbols and less frequently used characters.

A dataset for the characters was created, considering of two sets; a set for character parts and a set for characters. To create the dataset, several samples from each character were written on a blank A4 sheet and scanned using 300dpi resolution to create an image in jpeg format. Character parts and characters were segmented from the scanned images. All the images were then thresholded to create a binary image. Because of the concept of the character part assembling in to complete characters, a set of patterns can be identified which helps to increase the accuracy of an identified character. An example of a pattern is that if part no. 03 is present it is always the character අ. The set of character parts are shown in Table 1.

In order to get a rating based on the match between a particular character and a character part, template matching is used. Illumination invariant Normalized Cross Correlation algorithm was used as the template matching algorithm. Template Matching searches for the most similar image pattern in the image for the template

image. Template matching requires a template image and a source image. In this case the template would be the character part image and the source image would be the character image.

Table 1: Set of character parts

Part No.	Part	Part No.	Part	Part No.	Part	Part No.	Part
01	○	08	▬	15	○	22	○
02	⊂	09	⌣	16	⊔	23	○
03	⎮	10	ℰ	17	⌒	24	○
04	◗	11	∞	18	○	25	○
05	○	12	⊃	19	○	26	○
06	○	13	○	20	ℰ		
07	⁚	14	╱	21	○		

In recognition, all the parts are compared with a particular character and a rating based on the match was obtained. Then for each character class the matching score can be calculated using the individual part matching ratings for a particular character class.

The above matching score using the simple average does not use the character rules defined earlier. Now a better matching score can be calculated using the character rule set and the position of the character parts. There were three horizontal and two vertical regions that was considered in using matching the character parts. Therefore, considering all the combinations of horizontal and vertical regions, there were six possible character regions. Table 2 shows the identified regions of a character.

Table 2: Regions of a character

Example Image	Region	Example Image	Region	Example Image	Region
	Upper region (Horizontal)		Left region (Vertical)		Lower region (Horizontal)
	Middle region (Horizontal)		Right region (Vertical)		

Results and Discussion

200 handwritten characters were compared for each character part. Thereafter, weighted average calculations were obtained per each test character for each character class. The individual accuracies of the final results are shown in Table 3.

Table 3: Individual character class matching accuracy

Character	Percentage	Character	Percentage	Character	Percentage
අ	100%	ඉ	44%	ස	89%
ඊ	44%	උ	22%	ල	55%
එ	67%	ක	56%	ඝ	55%
ග	11%	ජ	22%	ළ	11%
ට	22%	ඩ	11%	ර	22%
ත	77%	න	67%	ව	11%
ද	89%	ප	44%	හ	11%
බ	67%	ම	66%		

Conclusion

We have experimented a simple approach for Sinhala handwritten character recognition using a part based matching technique. The matching score was computed using template matching to identify similar pattern between the test character and the character part. Experimental results show that the proposed method gives an average accuracy of 46% where the maximum accuracy is 100% and the minimum accuracy is 11%.

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Gender recognition of Luffa flowers using machine learning

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Abstract

Automatic flower gender identification could be introduced to large farmlands to help artificial pollination of imperfect flowers. Incomplete flowers contain either male or female organs but not both. In this paper, we present a computer aided system based on image processing and machine learning to identify the gender of a Luffa flower automatically. A pre-trained machine learning model is used for gender segmentation of flowers. The system is developed using Tensorflow Machine Learning Tool, which is an open-source software library for Machine Intelligence. The network was selected as the Google's Inception model and a dataset was prepared after capturing flower images from a Sri Lankan Luffa farm. The system was tested using two datasets. The first contained the captured original images and the second was prepared by cropping each image to extract male and female floral organs, stamen and pistil respectively. The prototype system classified the flowers as either male or female at 95% accuracy level. The experimental results indicate that the proposed approach can significantly support an accurate identification of the gender of a Luffa flower with some computational effort.

Keywords: Convolutional neural networks, Image classification, Image processing, Flower recognition

Introduction

The concept of automatic gender identification of imperfect flowers and artificial pollination using Unmanned Aerial Vehicles (UAVs) was developed at CQUniversity Sydney Campus in 2015 (de Silva & Venugopal, 2016). The work presented in this paper is our first attempt in this direction. The results of this research may be useful in the crop farming industry where the farmers owning hectares of farmland could artificially pollinate the flowers using UAVs. This will not only save money and time but also would increase the productivity. The objective of this research is to use artificial intelligence to identify the gender of a Luffa flower from its image. Images of male and female Luffa flowers are used to first train the algorithm and then the rest of the images are used for testing. This system is suitable for identifying the gender of Luffa flowers in large farms. Luffa is well grown in low country dry zone, intermediate zone as well as wet zone in Sri Lanka. It is an edible vegetable, used in indigenous medicine and mature fruit is used as a bath brush or sponge, and as a pesticide in some countries (Nanayakkara, 2014). The female flowers are the solitary large stemmed ones. The males are located in clusters of buds with thin stems. Both flowers are large and yellow (Blumenstock, 2015). It is naturally cross pollinated through bees. Otherwise, manual pollination is done by picking up male flowers and transferring pollens to female flowers using cotton buds (Nanayakkara, 2014). However, this process is less efficient in a large farm. Automatic artificial pollination could be adapted to increase the production, and determining the gender of each flower is critical.

Many previous studies have focused on identifying flowers using computer based techniques. Digital images are used for species recognition, automatic labelling and flexible searching. Recent researches indicate that the machine learning techniques can be used as a classifier of images. Lee & Hong (2017) propose a method for the recognition and retrieval of a flower species in the natural environment. They describe a capturing technique for a flower object that is blooming in the natural environment. They claim that the colour-texture-shape features of the flower pictures are the most effective. The study developed a flower-image automatic recognition technology using random forest algorithm. Leaf and Flower Recognition Using Preferential Image Segmentation (PIS) Algorithm suggested by (Valliammal & Geethalakshmi, 2011) uses PIS method to segment an object of interest from the original image. A probabilistic curve evolution method with particle filters is used to measure the similarity between shapes during matching process. In their Leaf and Flower Recognition System, (Pornpanomchai et al., 2011) describe a software system that can recognise a plant by using an image of a flower of the plant. The images are captured by a camera in a white background, and then processed. In the image recognition module, the system extracts eight main features from a flower image and recognises it by the Euclidean distance algorithm. They report recognising flower images with an accuracy of 74% by using this method. The image recognition technology developed by (Li et al., 2017) at Microsoft Research claims a success rate of 90% in flower recognition, which is almost at the same level as the flower identification skill of an expert botanist.

Methodology
Our approach consists of six sections, namely, image acquisition, image labelling, selecting a neural network model, training, validating and fine tuning the network. The image acquisition consists of collecting suitable flower images and labelling includes categorizing each image according to its gender. Once trained, the application allows the user to input a flower photograph and identify the gender.

Data was collected for the system, from a farm located in Bandaragama, Kalutara, Sri Lanka. We used a built in iPhone 5s rear camera having 8 mega pixels to capture images. As the flowers blossom in the evening, we could get flowers in several brightness settings, including day light, night mode and flash mode. Further, as Luffa flowers grow in every season, we were able to collect data on a rainy day. Total of 500 Images were collected for both genders of Luffa flowers. Images were captured in different angles, focusing levels and distances and while they were on the vine. Some images were discarded due to duplications and blur. All the images were included in separate folders named as male and female. Two datasets were prepared; one with unprocessed flowers (dataset I) and another with flower organs only (dataset II).The final Luffa dataset consists of 331 Luffa flower images and divided into 247 (80%) images as the training set, 42 (10%) as the testing set and 42 (10%) as the validation dataset. The system was developed for Windows 7 operating system platform. In our method, we used Version 3 of Inception (GoogleNet) model. The final layer of the model was trained and fine-tuned for our dataset. Network was trained on the Tensorflow software.

Inception 3 by (Szegedy et al., 2015) provides state of the art performance on the ImageNet dataset and to be more computationally efficient than its competitor architectures. However, what makes Inception attractive is that its architecture can be applied to a whole lot of other learning problems in computer vision.

Modern object recognition models have millions of parameters and can take weeks to fully train. Transfer learning is a technique that shortcuts a lot of this work by taking a fully-trained model for a set of categories such as ImageNet, and retrains it

from the existing weights for new classes. Though it is not as good as a full training run, this is surprisingly effective for many applications, and can be run in as little as thirty minutes on a PC, without requiring a GPU (How to Retrain Inception's Final Layer for New Categories, 2017). The retraining script loads the pre-trained Inception v3 model, removes the old top layer, and trains a new one on the dataset.

Even if none of our data were in the original ImageNet classes that the full network was trained on, transfer learning utilizes lower layers that have been trained to distinguish between some objects can be reused for many recognition tasks without any alteration. During the training, the learning rate was set to 0.01. We trained the network for 10000 epochs with default settings.

Results

Training time for the model was 40 minutes. The retraining script includes TensorBoard summaries that make it easier to understand the retraining. By visualizing, graph and statistics were obtained such as how the weights or accuracy varied during training. As shown in Figure 1, red and green colours indicate the accuracy of the final layer of Inception3 model for training, validation and test data respectively. Table 1 shows the results obtained for each model for validation images.

Table 1: Results of the study

Dataset	Training Accuracy	Validation accuracy	Test Accuracy
Dataset I	~100%	~85.5%	100%
Dataset II	100%	100%	100%
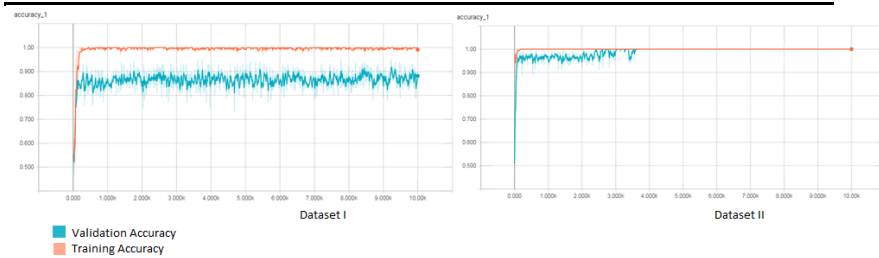
Figure 1: Accuracy graph of the model for dataset I (Left). Accuracy graph of the model for dataset II (Right)

The results show that the Inception model is better in flower image classification according to the gender when the given images have only the reproductive organs of a flower than a whole flower. Since we retrained the final layer of the network the performance is higher. Size of the dataset is crucial to determine the accuracy and robustness of system. Most practical larger systems in the literature were trained with 5-10 millions of data in GPUs with parallel processing. Large dataset can produce more accurate classification because of the large amount of training examples.

Conclusion

The goal of the study was to develop a prototype system that can identify flower gender by using machine learning. Deep convolutional neural network architecture was considered in advance. The system was trained, validated and tested. The accuracy of validation dataset for each dataset was compared. The results indicate that the deep convolutional neural network is more useful in identification of gender of an imperfect flower.

The implemented system can identify the gender of a flower in a good accuracy rate. But there are some potential enhancements. This system only trained with 331 flower images that were captured during the blooming of flowers. In testing, both the flower images as well as flower organ images have performed 100% accurately. However it should be noted that we have tested the system using 42 images randomly selected. During the process gender organs get changed. Trained with images from blooming to blossomed flowers may enhance the scope of the system. Efficiency of the training of the system can be increased by using better computer resources such as GPUs. Applications can be implemented using this system to be engaged in artificial pollination process. It can be further expanded into web based or mobile friendly applications.

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Abstract No: SC-25   **Smart Computing**

Web application securing methods

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Abstract
Web applications are one of the most prevalent platforms for information and services delivery over Internet today. As they are increasingly used for critical services, web applications become a popular and valuable target for security attacks. Although a large body of techniques have been developed to fortify web applications and mitigate the attacks toward web applications, there is little effort devoted to drawing connections among these techniques and building a big picture of web application security research. The main objective of this paper is to point out the possible vulnerabilities in a content serving web application and propose suitable security techniques to protect the site from the attack and provide significant help to the developer of a web application. This research paper organizes the existing research works on securing web applications into three categories based on their design philosophy: security by construction, security by verification and security by protection. Finally, this research paper summarizes the lessons learnt and discuss future research opportunities in this area.

Keywords: Cross-site scripting, SQL injection, Web application

Introduction
Today, almost every enterprise conducts business online. As the applications that run online businesses spread out over technologies and platforms, the security risks also increase. In 2012 alone, there were more than 800 reported hacking incidents, and 70% of those were perpetrated through web application flaws. The web is the new perimeter for enterprise IT security, and it is not nearly as easy to lock down as a network (Hoff, 2013). As web applications are increasingly used to deliver security critical services, they become a valuable target for security attacks. Many web applications interact with back-end database systems, which may store sensitive information (e.g., financial, health), the compromise of web applications would result in breaching an enormous amount of information, leading to severe economic losses, ethical and legal consequences. Current widely-used web application development and testing frameworks, on the other hand, offer limited security support. Secure web application development is an error-prone process and requires substantial efforts, which could be unrealistic under time to-market pressure and for people with insufficient security skills or awareness. As a result, a high percentage of web applications deployed on the Internet are exposed to security vulnerabilities. According to a report by the Web Application Security Consortium, about 49% of the web applications being reviewed contain vulnerabilities of elevated risk level and more than 13% of the websites can be compromised completely automatically.

According to (Gordeychik, 2010) the most widespread vulnerabilities are Cross-Site Scripting, Information Leakage, SQL Injection, Insufficient Transport Layer Protection, Fingerprinting, HTTP Response Splitting (Figure 2).

Many of the available techniques make assumptions on the web technologies used in the application development and only address one security flaw. This paper, surveys
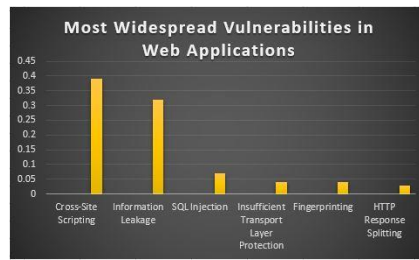
Figure 2: Most widespread vulnerabilities in web applications

the state of the art in web application security, with the aim of systematizing the existing techniques into a big picture that promotes future research. With the help of existing techniques, categorization of those techniques into three categories namely security by construction, security by verification and security by protection will happen.

Methodology

Most common types of vulnerabilities are SQL injection and Cross-site scripting (XSS).

a) SQL Injection

SQL Injection (SQLi) refers to an injection attack wherein an attacker can execute malicious SQL statements that control a web application's database server. Since an SQL Injection vulnerability could possibly affect any website or web application that makes use of a SQLbased database, the vulnerability is one of the oldest, most prevalent and most dangerous of web application vulnerabilities.

To run malicious SQL queries against a database server, an attacker must first find an input within the web application that is included inside of an SQL query. The following server-side code is used to authenticate users to the web application and it is vulnerable to SQL injection. (Figure 2).

```
# Define POST variables
uname = request.POST['username']
passwd = request.POST['password']

# SQL query vulnerable to SQLi
sql = "SELECT id FROM users WHERE username='"
+ uname + "' AND password='" + passwd + "'"

# Execute the SQL statement
database.execute(sql)
```

Figure 2: SQL query vulnerable to SQLi

b) Cross-Site Scripting (XSS)

Cross-site Scripting (XSS) refers to client-side code injection attack wherein an attacker can execute malicious scripts into a legitimate website or web application. To run malicious JavaScript code in a victim's browser, an attacker must first find a way to inject a payload into a web page that the victim visits. The following code is used to display the most recent comment on a web page and it is vulnerable to Cross-site scripting (Figure 3).

```
print "<html>"
print "<h1>Most recent comment</h1>"
print database.latestComment
print "</html>"
```

Figure 3: HTML query vulnerable to XSS

To overcome the above vulnerabilities several methods have been introduced. (Lam et.al, 2008) has introduced a high-level declarative language called Program Query Language. PQL and security scanners can be used to identify and mitigate those vulnerabilities.

c) Program Query Language (PQL)

PQL allows programmers to describe a class of information flow as a pattern that resembles an excerpt of Java code. A simple, concrete example is given below. Here is a code fragment that may be found in a Java servlet hosting a Web service:

String p = request.getParameter(_); con.execute(p);

This code reads a parameter from an HTTP request and passes it directly to a database back-end. By supplying a properly crafted query, a malicious user can gain unauthorized access to data, damage the contents in the database, and in some cases, even execute arbitrary code on the server. To catch this kind of vulnerability in applications, we wish to ask if there exist some
  • *object r of type HttpServletRequest • object c of type Connection, and*
  • *object p of type String*
in some possible run of the program such that the result of invoking getParameter on r yields string p, and that string p is eventually used as a parameter to the invocation of execute on c. Note that these two events need not happen consecutively; the string p can be passed around as a parameter or stored on the heap before it is eventually used. PQL queries are expressed as a pattern of dynamically executed statements.

Figure 4, gives a more complete PQL query for SQL injections. The main query binds the variable source to an initial input drawn from an HTTP request, then binds tainted to any value reachable with zero or more derivation steps. This is handled via the derivedString subquery, a tail recursive loop that tracks derivation through the functions involved in string concatenation. Once a tainted object has been identified, it then searches for its use by the database.

```
query main(object Object source, object Object tainted)
matches
{
source = HttpServletRequest.getParameter();
derivedString(source, tainted);
java.sql.Statement.execute(tainted);
}

query derivedString(object Object x, object Object y)
var object Object temp;
matches
   y := x
 | { temp.append(x); derivedString(temp, y); }
 | { temp = x.toString(); derivedString(temp, y); }
```

Figure 4: PQL Query for handling SQL Injection

d) Web Application Scanners

Web application vulnerability scanners automate the process of identifying vulnerable systems, locating injection points and automating the exploit process. These can be a rapid way to test for XSS/SQLi vulnerability, but due to the wide variability in techniques used by these exploits, few tools will provide the comprehensive solution on their own. In general, commercial tools such as IBM AppScan, HP WebInspect and Acunetix came out significantly ahead of Free and Open Source Software (FOSS) solutions in consistent identification of XSS and SQLi vulnerabilities. A combination of FOSS tools however (say, arachni and sqlmap) would serve as an excellent starting point, both offering excellent coverage with minimal false positives.

Results

Many countermeasures have been developed to secure web applications and defend against the attacks towards web applications.This paper organizes the existing securing methods into three categories.

- Security by construction: this class of techniques aim to construct secure web applications, ensuring that no potential vulnerabilities exist within the applications. They usually design new web programming languages or frameworks that are built with security mechanisms, which automatically enforce the desired security properties.
- Security by verification: this class of techniques aim to verify if the desired security properties hold for a web application and identify potential vulnerabilities within the application.
- Security by protection: this class of techniques aim to protect a potentially vulnerable web application against exploits by building a runtime environment that supports its secure execution.

After evaluating the mitigating techniques, it can be generalized into these three categories. Summarized results are shown in Table 1.

Table 1: Summarized results of mitigation techniques

Vulnerabilities	Security by Construction	Security by Verification	Security by Protection
SQL Injection	PQL	Security Scanner	Taint based protection
Cross-Site Scripting	PQL	Security Scanner	Taint based protection

Based on the results, PQL queries can be added to the existing code to protect web applications. Security scanners will verify the expected properties of the web applications.

Conclusion

The internet and web becoming vulnerable as the advanced in technologies and skills are implemented for wrong reasons by attacking in advance and complex technique. Therefore, the solution has to provide for the various types of web vulnerabilities. As summarized in this paper web vulnerabilities such as SQL Injection, Cross-site Scripting and XML Injection, and methods for identifying those vulnerabilities and successfully implemented security mechanism to all those vulnerabilities to provide protection. The work can be further improved by studying, identifying and providing security mechanism to various vulnerabilities like Broken Access Control, Broken Authentication and Sessions Management, Insecure Configuration Management, Cookie Modification, Buffer Overflow, Denial of Service and providing solution for the same.

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Developing a concept to convert LD/STL to VHDL

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Abstract

A Programmable Logic Controller (PLC) is a microprocessor based solid state device which is a very significant control component unit in industrial automation systems. Ladder diagram (LD) is a form of graphical language type PLC programming. LDs and Statement Lists (STL) are used to program PLCs. Both of these programming methods represent the schematics of electrical relay circuit diagram. Since LD programs are executed in a sequential and cyclic way, the operational efficiency and performance of PLC will be limited by the length of the ladder diagram and the operational speed of the microprocessor. Field Programmable Gate Array (FPGA) is a new technology used in industrial process control systems. VHDL (VHSIC-HDL-Very High Speed Integrated Circuit - Hardware Description Language) programming is used to program FPGA devices. Because of its parallel execution system and reconfigurable hardware structure, FPGA has excellent performance. Therefore, flexible and high speed systems can be implemented using FPGA. The main aspect of this research was to develop a concept to convert LD/STL to VHDL. By using Siemens - STEP 7 Micro/WIN - version 4.0.81 and Xilinx® – ISE Design Suite version 14.6 software, this concept was developed to convert Bit Logic LDs into VHDL. After identifying the Boolean logic of the STL code, inputs and outputs are declared in the entity part and PLC to FPGA conversion logic is defined in the architecture part of the VHDL code. To overcome the performance limitations of microprocessor based PLCs, FPGA based PLC implementation is suggested as a better approach.

Keywords: FPGA, LD, PLC, STL, VHDL

Introduction

Before the introduction of PLCs, mechanical relays were used to implement control systems. Ladder logic was used to document the design and construction of relay networks. With the invention of PLCs, ladder diagrams which is a form of graphical language type PLC programming, was introduced. Programming languages which are used to implement automation systems are standardized in IEC 61131-3 norm (Karl-Heinz et al., 1995).

Ladder Diagram programmes are executed in a sequential and cyclic way. Therefore, performance of PLC is limited. Operational efficiency and performance of PLC will be limited by the length of the ladder diagram and the operational speed of the microprocessor. In this research project FPGA based PLC implementation is suggested to overcome these drawbacks of PLCs. Some advantages of using FPGA to implement PLCs are parallel execution, reconfigurable hardware structure, high speed, increased flexibility, increased reliability and faster scanning time (Hauck & DeHon, 2008). IEEE 1076 is standardized for VHDL norm (IEEE Computer Society, 2008). A number of researches of this field have been conducted. In 1999 Ikeshita et al., developed a very rough manner to convert the LD into a program description of a very high speed integrated circuit VHDL (1999).

Methodology

Concept to Convert LD/STL to VHDL:

In this study, two software were used for developing the concept of LD to VHDL conversion.

LD - PLC Software: Siemens - STEP 7 Micro/WIN - version 4.0.81 (Siemens 200-series PLC programmer).

VHDL-FPGA Software: Xilinx® - ISE Design Suite version 14.6.

PLC Software is used to draw ladder diagrams and to generate STL. The extensions of ladder diagram file and STL file are as below.

- .mwp: STEP 7 - MicroWIN project - include LD program
- .awl: S7 200 simulator file- The AWL is a text file that contains STL coding.

STL is a description of ladder diagram in text format (Shuichi at el., 2006). A text file of STL code is then uploaded to the web based application which was developed according to the concept of LD to VHDL conversion. The conversion block diagram is shown in Figure 1. The web application then generates two source files with extensions .ucf and .vhd.

- .ucf: Implementation Constraints File, Also known as User Constraints File. Contains user-specified logical constraints (Xilinx®, 2009).
- .vhd: VHDL Module - Contains a collection of VHDL packages
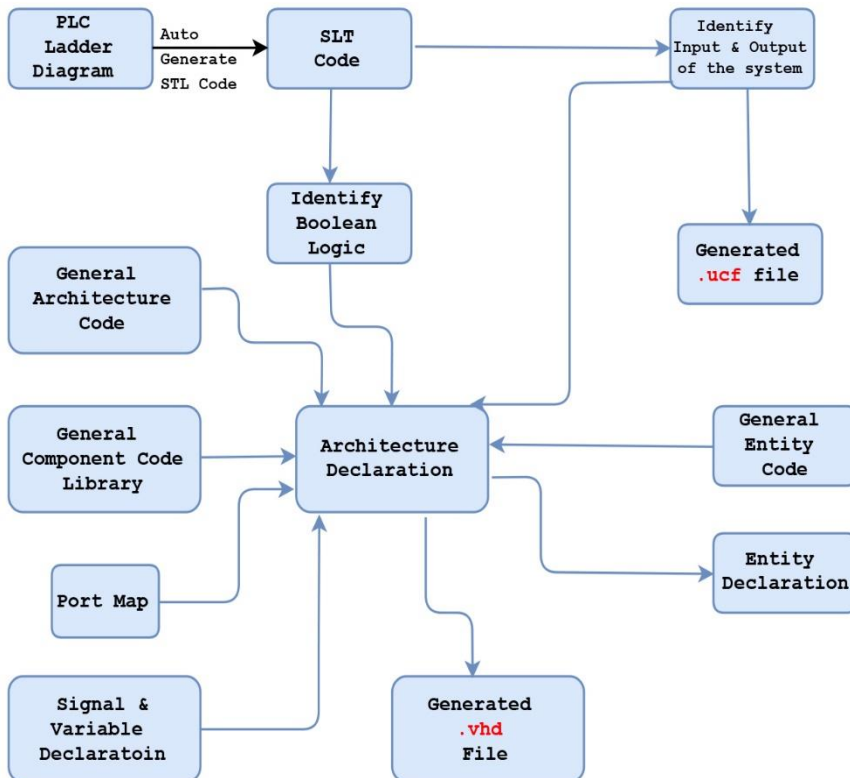
Figure 1: LD to VHDL Conversion Block Diagram
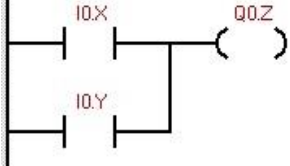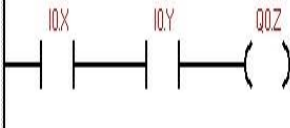
This concept was developed to convert Bit Logic LDs into VHDL.

ISE Design Suite version 14.6 is used to create a new project and two source files are added to it. At this point inputs and outputs can be renamed appropriately. Then the

bit file can be generated. By using the Adept software this bit file can be uploaded to the Xilinx® FPGA device.

Following Table 1 illustrates a basic example for above concept.

Table 1: LD to VHDL Concept Example

LD	SLT code	Boolean Logic	FPGA code
	LD I0.X O I0.Y = Q0.Z	LD with O : OR operation;	Q0_Z <= I0_x or I0_y;
	LD I0.X A I0.Y = Q0.Z	LD with A : AND operation;	Q0_Z <= I0_x and I0_y;

Web Based Application Platform to Convert STL to VHDL:
A JavaScript code is written in the web based application according to the conversion block diagram in Figure 01. This JavaScript code analyzes uploaded STL code line by line and identifies inputs and outputs and creates .ucf file. In this research project the web based application platform is limited to 8 inputs and 8 outputs. There is another java script code written to identify the Boolean logic of STL and to generate .vhd file.

Results

In order to verify the concept developed in this research project, a very simple logic gate system containing AND, OR, NOT & X-OR gates was used. Using the developed web based application LD of this logic gate system was converted into VHDL.

To make this system more user friendly, a windows based GUI can be implemented using Microsoft Visual Studio software, to generate VHDL codes directly by drawing LDs.

Conclusion

PLCs are unable to respond at highly complex systems (higher clock rates). Nevertheless, FPGAs can operate reliably at higher frequencies also. That's why converting LD into VHDL and implementing it on FPGA board is important. To overcome the performance limitations of microprocessor based PLCs, FPGA based PLC implementation is suggested as a better approach. In this paper a new method is introduced to convert STL to VHDL. This idea will be suitable for implementing a new micro-PLC based on FPGA which gives better performance and speed.

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Abstract No: SC-27   **Smart Computing**

Coordination and control in virtual teams in software industry

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Abstract

The last couple of decades has witnessed a steady, irreversible trend towards globalization. Economic forces have relentlessly turned national markets into global markets while emerging competition and corporations reach across national boundaries. More than a decade ago, seeking lower costs and access to skilled resources, many organizations began to experiment with remotely located manufacturing and service facilities. The ready availability of skilled IT personnel at very competitive prices in developing nations like India, and the rapid infrastructure development in these countries made it a ready industry to make this transition. With this trend, emerged the concept of virtual teams. Virtual teams are work arrangements where team members are geographically dispersed and work interdependently through the use of electronic communication media to achieve common goals. There is a difficulty in developing strategies for various team processes in virtual teams. The objective of this research was to identify the factors influencing working of virtual teams and strategies to facilitate better coordination and control among them in the context of software development. Literature revealed the factors that affect the coordination process of virtual teams in software development. The factors identified include level of authority of team members, leadership style, media synchronicity of the team, distribution of information within the team and experience in working together. Then a conceptual model was developed to analyze the impact of each factor in virtual team coordination. A detailed questionnaire was used to obtain views of industrial experts. The results concluded that the developed model is significant and it explains sixty-six percent of the working of virtual teams. It was shown that, level of authority and media synchronicity are the most significant of the factors. The applicability of the model was verified by conducting interviews with software industry personnel. The study also focused on finding reasons for using virtual teams, pros, cons and problems faced by virtual teams in Sri Lankan context. The findings can be used to better coordinate software projects with the use of virtual teams.

Keywords: Control, Coordination, Virtual teams

Introduction

With the technological advancement, different economic forces are turning national markets into global markets while emerging competition and corporations reach across national boundaries. This trend is having a major impact on the way products are designed, conceived, constructed, tested, and delivered to end customers. Software and high-end information and communication technology has been playing a major role in globalization. While being a vital part of almost every business, success increasingly depends on using software as a competitive weapon. The trend was fueled by the factors such as reduced cost, increased focus on core business, access to experts and latest technology, reduced risk and employee morale. This ever increasing trend leads software companies to form virtual teams for software development.

Despite of the advantages of virtual teams, studies have shown that virtual teams present a number of challenges compared to co-located teams. When a team performs complex and interdependent tasks, team members have different tasks, roles, responsibilities, competencies, resources and shared set of knowledge among them (Bezooijen, 2011). Coordinating activities and monitoring actions requires communication. Inputs that encourage effective communication and enable or encourage mutual monitoring can lead to effective coordination. (Korsgaard et. al., 2009) However, various coordination methodologies may prove to be more or less effective depending on the situation. Managing virtual teams is more difficult than managing co-located teams (Hoch and Kozlowski, 2014).

A number of studies have addressed the different factors that affect the coordination and control factors of virtual IT teams. In some cases, with reliable statistical data. Main objective of the research is to develop a model using the factors that affect the coordination process of a software based organization. The research has further analyzed the effect of each factor on the coordination process.

Methodology

A detailed literature review was conducted in order collect the data from relevant empirical studies with respect to scope has been conducted. The identified variables were grouped into five factors, and relevant metrics for coordination process was also identified. Organizational coordination and control is taken as dependent variable and the factors were taken as independent variables.
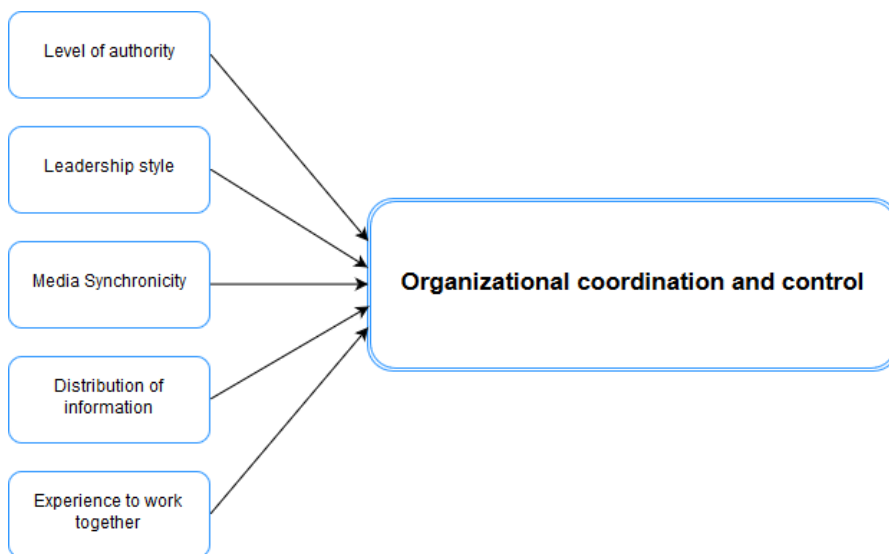
Figure 1: Conceptual model

After the development, operationalization was carried out to identify indicators and to prepare questionnaires. Questionnaire was divided in to three main sections, first part was to collect demographic details of the respondents, second part to address the independent variables and the third part to address the dependent variable. Likert scaling system was used for scaling purposes. A pilot survey was conducted to assure the validity of the questionnaire. Snowball and purposive sampling techniques were used to collect data. The questionnaire was emailed to potential respondents, those that did not use virtual teams were filtered out. Cronbach's alpha value was calculated. Then Spearman's test was used to find the correlation coefficients between variables and linear regression was done to check the validity of the hypothesis. Since the model considers six factors, multiple regression has been used

to find the correlation between all the independent variables. Stepwise regression analysis was conducted to find the significance of factors. Finally, the results were shown to eight industrial experts for their feedback.

Results

Questionnaires overall Cronbach's Alpha value of 0.819 based on standardized items has been obtained. Since it is greater than 0.7 it was concluded that the scale has a higher level of internal consistency. The values obtained from the Spearmen's correlation and significance values generated from linear regression for both extent and effectiveness of informal communication, was used for approving and rejecting of the hypothesis. The results are summarized as in the Table 1.

Table 1: Correlation summary table

Model	R^2	F value	Sig	Separate sig	Durbin Watson	VIF
Level of authority						1.131
Leadership style				0.000		-
Media synchronicity				0.019		0.023
Distribution of Information	0.660	12.080	0.000	0.000	1.455	1.407
				0.001		0.869
Experience to work together				0.001		0.788
Level of authority	0.329	40.302	0.000	0.000	1.496	1.230
Media synchronicity	0.271	27.099	0.000	0.000		1.230

From these results, we can conclude that level of authority has the highest correlation with the coordination process. Then cross relationship analysis was conducted to measure correlation between the factors as shown in the Table 2.

Table 2: Cross correlation table

	LevelofAuth	LeadershipStyle	MediaSynchronicity	DistribOfInfo	ExpToWrkTogether
LevelofAuth.	1.000	.415	.398	.355	.301
LeadershipSty	.415	1.000	.391	.394	.360
MediaSynch.	.398	.391	1.000	.518	.385
DistribOfInfo	.355	.394	.518	1.000	.463
ExpToWrkTogether	.301	.360	.385	.463	1.000

Multiple regression analysis was conducted and as some of the factors individual significant values were greater than 0.05 stepwise regression was conducted. The summary of results is given in Table 3.

From multiple regression it was identified that all the five factors have a R2 value of 0.660, and level of authority and media synchronicity factors has R2 values 0.329 and 0.271 respectively. The results show that factors including leadership style, distribution of information, experience to work together are not significant, while level of authority and media synchronicity are significant. The developed model is significant and model explains sixty-six percent of the variation. After doing a stepwise regression it was identified that model is significant only for level of

authority and media synchronicity. Model fit between these two factors and coordination process is 60.0%. It can be concluded that these two factors contain the highest weight on coordination process, which is 60.0 out of 66.0.

Table 3: Regression summary table

Model	R^2	F value	Sig	Separate sig	Durbin Watson	VIF
Level of authority	0.660	12.080	0.000	0.000	1.455	1.131
Leadership style				0.019		-0.023
Media synchronicity				0.000		1.407
Distribution of Information				0.001		0.869
Experience to work together				0.001		0.788
Level of authority	0.329	40.302	0.000	0.000	1.496	1.230
Media synchronicity	0.271	27.099	0.000	0.000		1.230

Industry expert opinion largely agreed with the questionnaire findings. Both leadership, experience and distribution of information did not have major effects on team cognitive processes or team coordination. In some cases, the results had to be attributed to methodological issues.

Conclusion

This study was intended to determine the factors that are affecting the coordination process in virtual teams and to develop a model using those identified factors. Data was collected by taking a sample of software organizations in Colombo district having using virtual teams. Though level of authority and media synchronicity were the most significant factors among the identified factors, other factors were also significant in at least one stage of the analysis out of the six stages. It is believed that the theoretical model and the empirical results presented here provide a useful starting point for future empirical studies that coordination and control of virtual teams in software development in different aspects.

Finally, it can be concluded that coordination process includes creating a clear organization structure, work specialization, formalizing work environment, giving responsibilities to subordinates, encourage for innovations, having an open mind, providing quality mediums to communicate, and lesser organizational laws to bind information sharing. These indicators impact on the company growth as well. Therefore, by improving level of authority and media synchronicity factors it can improve the coordination process in virtual teams.

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Improved hierarchical role based access control model for cloud computing

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Abstract

Cloud computing is considered as the one of the most dominant paradigms in the field of information technology which offers on demand cost effective services such as Software as a Service (SAAS), Infrastructure as a Service (IAAS) and Platform as a Service (PAAS). Promising all these services as it is, this cloud computing paradigm still associates number of challenges such as data security, abuse of cloud services, malicious insider and cyber-attacks. Among all these security requirements of cloud computing access control is the one of the fundamental requirement in order to avoid unauthorized access to a system and organizational assets. Main purpose of this research is to review the existing methods of cloud access control models and their variants pros and cons and to identify further related research directions for developing an improved access control model for public cloud data storage. The paper presents detailed access control requirement analysis for cloud computing and have identified important gaps, which are not fulfilled by conventional access control models. As the outcome of the study an improved access control model with hybrid cryptographic schema and hybrid cloud architecture and practical implementation is proposed. The study tested the model for security implications, performance, functionality and data integrity to prove the validity. It used AES and RSA cryptographic algorithms to implement the cryptographic schema and used public and private cloud to enforce our access control security and reliability. By validating and testing we have proved that the model can withstand against most of the cyber-attacks in real cloud environment. Hence, it has improved capabilities compared with other previous access control models that we have reviewed through literature.

Keywords: Hybrid cloud, Hybrid cryptographic schema, Public cloud data storage,

Introduction

Cloud is one of the major and dominate technologies, which paved the way for digital transformation across the globe. It is a model for providing convenient on demand network access for computing resources such as applications, services, servers and storages that can be rapidly provisioned and released with minimal management effort or service provider interaction (Bibin, 2013). Cloud has lot of advantages mainly in ubiquitous services where everybody can access computer services through internet. This cloud model composed of three service delivery models mainly SAAS, PAAS, and IAAS. Depending on the type of data that you are working with, cloud computing come in three forms. Public cloud, Private cloud and the Hybrid cloud. Along with the rapid steady development of the cloud applications cloud computing cyberattacks are also increased and cloud itself create a good attacking surface for hackers. (Faisal at el., 2015)Denial of Service attacks (DOS attacks), Authentication attacks, Side channel attacks, Cryptographic attacks, and Inside Job attacks are best attack vectors for those hackers and due to these generalized attacks we need a better security reinforcement for cloud computing as it can lead to a major cyber-attack. Due to this reason, there are a number of security challenges associated with utilizing

cloud computing such as data security, abuse of cloud services, malicious insider and cyber-attacks.

Among all security requirements of cloud, access control is one of the fundamental requirements in order to avoid unauthorized access to system and organizational assets. Cloud access control models can be traditionally categorized into Discretionary Access Control (DAC), Mandatory Access Control (MAC) and Role Based Access Control (RBAC). In the DAC model, the administrator of the object decides its access permissions for users based on an access control list and in the MAC model, access permissions are decided by the administrator of the system. In the RBAC model, a user has access to a resource based on his/her assigned role in the system (Younis et al., 2014). Roles are defined based on job functions and permissions are defined on authority and responsibilities of the job. Operations on the resources are invoked based on the permissions. RBAC models are more scalable than the discretionary and mandatory access control models, and more suitable for use in cloud computing environments (Natarajan, 2011).

Methodology

A thorough literature survey was conducted to assess the potential gaps and the features that are not available in the existing access control mechanisms. Based on that, the study identified Hierarchical RBAC access control model to be improved with hybrid cloud architecture *(combination of public and the private cloud)* and hybrid encryption schema (*AES -128 bit symmetric key algorithm and RAS 1024 bit public key encryption*). The proposed model uses AES for encrypting and decrypting cloud data and RSA public key encryption algorithm is used to encrypt the secret key generated by the AES cryptographic algorithm.
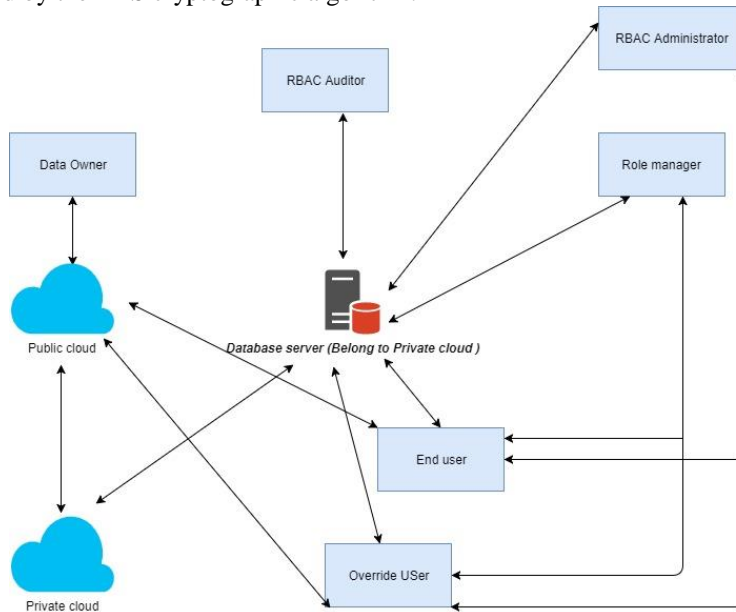
Figure 1: Architecture of our proposed access control model

As depicted in Figure 1, proposed architecture of the access control model comprised of Public Cloud, Private Cloud, System Administrator, Role Manager, Data Owner, End User, and Override User.

Public information are encrypted using symmetric AES algorithm, which will be saved in the public cloud. The organizations stores only critical and confidential

information in private cloud. Private cloud is built on an internal data center that is hosted and operated inside the organization. The amount of information stored in private cloud is relatively smaller when compared to public cloud. Administrator of role based system provides authentication to end users. End users are just to access data from cloud. They cannot do any modifications or updates to original data. They cannot communicate directly with the private cloud as they do not possess access permission. Administrators generate the system parameters. System parameters represent the position of the role and stored that role in private cloud. Similarly, administrators manages role hierarchy. Role manager will be there for manage roles for users. According to the role and authorization from the role manager, user gets access permission to cloud data. The access policies related to authorization and roles are stored in private cloud.

Results

The study implemented the proposed model in ASP.NET, C# using Visual Studio 2017 IDE and for the public cloud, we have taken an instance from Microsoft azure. Testing and validation done on Microsoft Azure instance that has single core, 1.75G Ram with 10 GB storage. For the implementation on the private cloud we have chosen a SQL server instance from the Microsoft Azure with inbuilt firewall with 50 MB storage. (SQL Server database as a service). For the public cloud we have deployed our developed model on to the Microsoft Azure as an app service.

After the successful implementation, the model was tested for performance, data integrity, security implications and functional analysis. From the performance testing it was concluded that encryption took more time than decryption time. It was seen that when the file size increases both the encryption and decryption time are gradually increasing. For data integrity testing, the study compared and verified MD5, SHA-1, SHA-256 and SHA-512 values for both original file and decrypted download file and both types of files have same values when testing for data integrity. Thus, the study concludes that the file integrity of resources was preserved during encrypting and decrypting, which enforce the reliability and the integrity of our access control model.

Three vulnerability assessment tests were conducted to compare and validate our model in real cloud environment and results from these tests have showcased that our access control model withstands against most cyber-attacks. Further, for functional testing, based upon the functionality, access control model is compared with conventional access control models for cloud, as depicted in Table 2.

Table 2: Functional analysis and testing

No	Comparison Criterion	DAC	MAC	RBAC	ABC	Model
1	Least privilege principle	N	N	Y	Y	Y
2	Separation of duties	N	N	Y	Y	Y
3	Scalability	N	N	Y	N/A	Y
4	Auditing	Y	Y	Y	Y	Y
5	Policy management	Y	N	Y	Y	Y
6	Configuration Flexibilities	N	N	Y	Y	Y
7	Delegation of capabilities	Y	N	N	N	Y
8	Hybrid cloud architecture	N	N	N	N	Y
9	Role hierarchy management	N	N	Y	Y	Y
10	Ops. & situational awareness	N	N	N	N	Y
	Y-Yes; N– No; N/A – Not applicable					

Conclusion

The main objective of this research was to come up with an improved access control model, that can be utilize in public cloud and also that can be utilize for secure cloud data storage. Before proposing our model, we have reviewed almost every access control model in cloud and, none of the researches were targeted about the security implications of access control in real cloud computing environment. We have showed the experimental result of our implemented access control model through the perspective of performance, data integrity and security in real cloud environment. We observed that time taken for encryption and decryption is efficient on public cloud and maintaining data storage in public cloud is efficient as it is highly scalable, cost effective and provides redundancy for the organization data. Further we observed that original and decrypted data after encryption was same, when data integrity checking thus, it will enhance the reliability and assurance of our model. From the security perspective we have observed that it is not vulnerable to exploit and, hence it provides the reliability and security for our access control model.

It is believed that the proposed model is useful in various commercial and non – commercial situations as it implements the hierarchical cryptographic role based access control policies based on the job functionality and user requests in an organization for providing secure data storage in the real cloud environment enforcing hybrid cryptographic techniques for providing security for underlying data along with hybrid cloud architecture.

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Abstract No: SE-01   **Systems Engineering**

Street attractiveness enables change to a city structure

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Abstract

The study proposes an agent-based model for urban dynamics, combining locating of a facility for stopping off and measures to promote street attractiveness. The model expresses simplified urban dynamics. It also enables to verify how policies affect the daily travel of urban residents and indirectly change an urban structure towards a desirable formation. As a result, the model clarified that the policy of street attractiveness affected compactification of an urban structure physically and a significant decrease of car users along with CO_2 reduction. Use of this model, reveals significant differences of improvement effects on an urban structure depending on the locations of the facility, the implementation scale of each promotional measure around the facility, and demonstrates the synergy effects of the policy on transportation.

Keywords: Agent-based model, Compact city, Urban design, Urban sprawl

Introduction

Throughout the 20th century, there was a rapid increase in the world's population along with rapid urbanization. Even in this century, there is no decline in the momentum. The urban sprawl structure has been one of the larger themes related to urbanization for decades and recognized as a serious issue in many cities (Haase et al., 2010; Kazepov, 2011). In Japan, residents in towns were assumed to commute by public transportation, but gradually motorization in their daily life progressed. For this reason, the expansion of less-populated urban areas has been progressing until now (Kaido, 2010; Koike et al., 2000). There is a concern that this situation may lead to consequences such as a decline in living convenience of residents due to a lack of public services.

Additionally, another concern is, problems caused by the excessive dependence on automobiles. This results in another chain of reactions such as air pollution and an increase in consumption of fossil fuels. There is a concern that in the near future, such problems will become more serious in many cities like Japan, and also in some emerging countries. Therefore, as a countermeasure to this situation, the transformation into compact cities has been explored (Howley, 2009). In order to analyse urban dynamics and verify how policies that affect the daily travel of urban residents change an urban structure toward a desirable formation indirectly, we conducted an agent-based model (ABM) to verify the possibility of changing an urban structure towards a desirable formation indirectly, by inducing behaviours of autonomous individual residents rather than by forcing them. For this reason, this simulation method is expected to contribute to measure the effects of the policies on a complicated environment (Jager & Mosler, 2007; Taniguchi & Takahashi, 2011).

Simulation model

Figure 1 shows the schematic of the simple urban model. This is the simplified expression of a part of a central commercial area and bedroom towns connected by railway. In the urban model, two domains are located: the residential zone and the

destination zone. The residential zone is an aggregation of residences, which are the base point of each resident agent's travel corresponding to their daily commute. The destination zone is an aggregation of workplaces or schools, which are also a halfway point of the travel.

The distance between the two centres of each zone is 4km at the same latitude. Two train stations are located at the centre of each zone, and these stations are connected by a railway. With the assumption that uniform and high-density sidewalks and roads are located in this continuous planar space, resident agents can freely move on this space by foot, by bicycle or car. As the initial location, in the residential zone, residences of the same number as the number of resident agents are randomly located based on normal distribution centering on the stations.
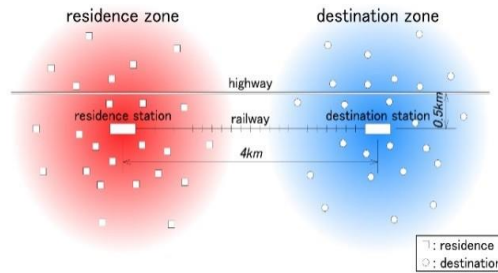
Figure 1: Simplified urban dynamics model

Travel mode selection
The series of travels of each resident agent from the base point to the final destination is referred to as a linked trip. Each travel mode that is a component of a linked trip is referred to as an unlinked trip. Additionally, the main travel mode among unlinked trips of a linked trip is referred to as a representative travel mode of the linked trip. After that, each resident agent repeats travel assumed as a commute according to the selected linked trip every day. The initial representative travel mode of all resident agent is by train. Departure time of each resident agent, from its residence and destination, is based on normal distribution. At the time when each resident agent comes back residence, total travel cost C_i is calculated according to the equation below.

$$C_i = w_t C_t + w_c C_c + w_f C_f \quad (1)$$

C_t, C_c and C_f indicate time cost, charge cost and fatigue cost. Similarly, w_t, w_c and w_f indicate each preference bias. The preference biases of all agents are assumed to be equal. According to the cost, the resident agent changes the values V_i of i-th linked trip, according to the equation below.

$$V_i \leftarrow a(-C_i) + (1-a)V_i \quad (2)$$

The following day's travel mode of the resident agent is selected by the epsilon-greedy method. Each resident agent fixes the travel mode in one way through a learning period of 30 days. After all the resident agents fix the travel mode, 1/10 of all resident agents that are chosen randomly changes their residences. Selection of a new residence is performed based on the total living cost lC_i according to the equation below.

$$lC_i = C_i + R_i \quad (3)$$

C_i and R_i indicate the total travel cost and land rent. Land rent R_i increases correspond- ing to the accumulation of residences and destinations. To the resident agents chosen to change their residences, 10 of the residence candidates are presented randomly. Those resident agents select a new residence where the total living cost lC_i is the minimum. After 20 times of the loop process of residence selection, model stops running.

Experiment 1 - Basic model

Hereinafter, the experiment used the basic model which is referred as scenario A. Figure 2 shows the quantitative initial state and result of scenario A. Fig. 3 shows the final distribution of residences of scenario A. The result shows that the percentage of car users reached over 85%, the majority of whose residences were distributed on the periphery of the destination zone.

The result of the experiment using the basic model shows that an urban structure changed significantly, from an initial zoned structure between residence zone and destination (workplace) zone to a sprawling structure of residences on the periphery of the destination zone. Additionally, the majority of resident agents who were living in such residences used a car as the main travel mode (pink-coloured dots). This almost coincides with the experimental results of Taniguchi & Takahashi (2011). Additionally, this coincides with the fact that the main commuting mode has shifted from railway-centred to private car-centred in many local cities in Japan. These were the reproduction of multiple social patterns that were not built in the model. Therefore, these show the validity of our basic model (Railsback & Grimm, 2011).
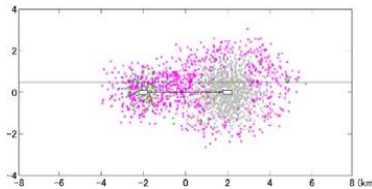
Figure 2: Final distribution of residences of scenario A

Experiment 2 - A Facility for stopping off and street attractiveness

In these experiments, one public facility, such as the libraries mentioned in section II, is located inside or outside the destination zone. And from each destination, all resident agents leave for not each residence but the facility. After arriving and staying there, finally, they leave for each residence. Staying time is based on normal distribution. Within 500m radius centering on the facility, which was set as an influential area of the facility, a measure to promote street attractiveness is considered.

Locations of a facility for stopping off - Locations of the facility are assumed to be the following three types.
- B: 2km south and 0.5km east from the destination station
- C: same place as the destination station
- D: 0.5km south and 0.5km east from the destination station
Figure 3 shows these locations.
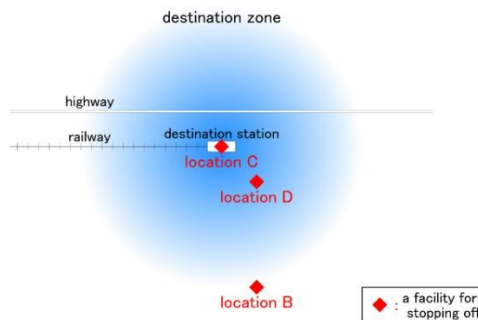
Figure 3: Types of the facility location

The results of scenario D show that a large number of car users changed their travel mode to using the train or walking. As shown in Figure 6, the cluster of residences of train users (green-coloured dots) around the residence station became more remarkable and the total CO2 emission was reduced to about 40% of scenario A.
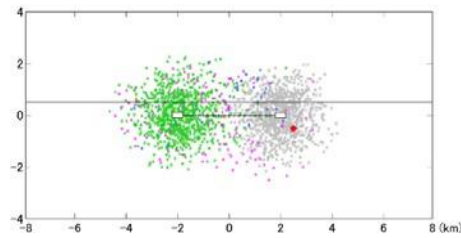
Figure 4: Final distribution of residences of scenario D

Conclusion

We proposed an agent-based model for urban dynamics combining locating of a facility for stopping off and measures to promote street attractiveness around the facility on an appropriate scale. The model clarifies that the measures could affect in compactification of an urban structure physically and, decrease the car users along with a reduction of the total CO_2 emission. It also demonstrated that the slight difference in the location of the facility brought about the significant difference in such an effect.

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An e-pest surveillance and advisory system to empower farmers in managing rice pests and diseases in Sri Lanka

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Abstract

An e-pest surveillance and advisory system called "*Govi Vedaduru*" was developed with two broad objectives in mind; to enable rice farmers in Sri Lanka to manage pest and disease problems efficiently and in a cost-effective manner and to facilitate relevant authorities with better monitoring and control of pest and disease incidents. Many farmers are not competent to identify pests and diseases related issues and decide the correct management practices themselves. They expect the assistance of the field officers of government agriculture extension services for this purpose. However, lack of officers and the knowledge gaps that exist among them hinder the achieving these expectations. Hence, farmers do not receive the correct advice in time and crop get damaged leading to higher production cost. The *Govi Vedaduru* mobile application was designed to provide an advisory service through smart phones enabling the farmers to obtain expert guidance from the Rice Research Stations of Department of Agriculture (DOA), in identifying their field problems and remedial measures to follow. A user friendly mobile interface was developed in local languages (initially Sinhala) to upload data about the pest and disease problems. The system was initially piloted in five areas (*yaya*) of rice cultivation representing two agro-ecological zones in Galle district in Sri Lanka. A follow up survey of the participant farmers indicated that they received timely, useful and trustworthy advice that helped them with correct remedial measures. The reports generated via web application with limited incident data showed the system's capability of providing valuable information to relevant authorities for monitoring and planning purposes.

Keywords: Mobile and smart computing, Pest and disease surveillance

Introduction

In rice farming, 10-20% of the production is lost due to pests and diseases annually, making rice farming unproductive and unprofitable (Nugaliyadda et al., 2000). Pest and disease problems should be identified early as possible and remedial measures should be taken immediately. However, most farmers are not competent enough to recognize the pest or disease problem correctly and are not aware of the recommendations. In this context, the field officers of agriculture extension services are responsible for providing necessary advice to farmers in solving their field problems. However, lack of officers to meet the demand and the knowledge gaps among them are considered as serious issues. This hinders the farmers to receive correct identification and remedial measures immediately by making a considerable damage to the crop yield. Incorrect identifications and recommendations lead to unnecessary and excessive agro-chemical usage by farmers leaving farmers with higher production cost and agriculture eco-systems being damaged. There is no established local or island-wide system to monitor pest and disease incidents and

hence, potential out breaks of pest or disease cannot be recognized at the initial stages by the authorities to take corrective actions to control. To overcome these challenges, a new approach is introduced to building an e-Agricultural Advisory and surveillance System for rice pest and disease management aimed at bridging the information gaps that exist between farmers and, extension officers and scientists at Rice Research Stations of DOA. Some of the applications designed to address such issues (Perera et al., 2016) lack the usability and the credibility due to not having local language support and not capturing the expert knowledge in a targeted crop. Even though the automated image recognition can be applied to scaleup pest and disease identification, lack of training data in the targeted crop has been cited as a major issue (Majid et al., 2013).This research project aimed to address such issues by capturing the domain expertise of rice crop and designing a farmer friendly interface. The broad aims of this programme are empowering the rice farmers to obtain correct identification and recommended solutions for their pest and disease problems on time; monitoring pest and disease incidents to identify potential outbreaks and carrying out early intervention and remedial actions; enabling regional authorities with better planning of preventive measures; and building a training database for a AI based automatic recommendation system.
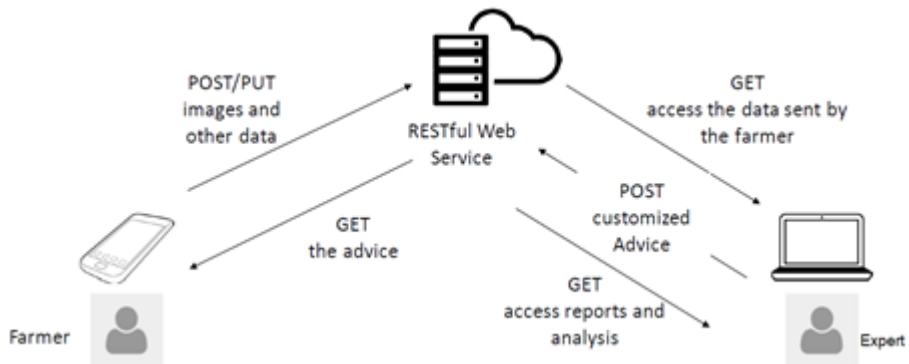
Figure 1: Architecture of e-pest surveillance and advisory system

Methodology

The system is a multidisciplinary effort of the scientists at Plant Protection Division of the Rice Research Station (RRS) at Labuduwa and a team of software engineers. Scientists formulated integrated solutions, using available information and research findings in the DOA, for common pest and disease problems covering curative actions to be taken in a pest or disease incident including preventive actions for the next season. It was decided to harness the vast adoptability of mobile devices by the public to disseminate these solutions tailored to individual circumstances scalable and cost-effective manner. The proposed solution was captured in the following workflow: a) Farmer sends the data of the field problem to the shared database using a mobile application, b) An expert analyses the data and find a tailored solution, c) The solution is sent back to the farmer in Sinhala language. To verify the initial concepts, a prototype was developed with a mobile application and a back-end web service supported by a database (Nilakshi, 2013).
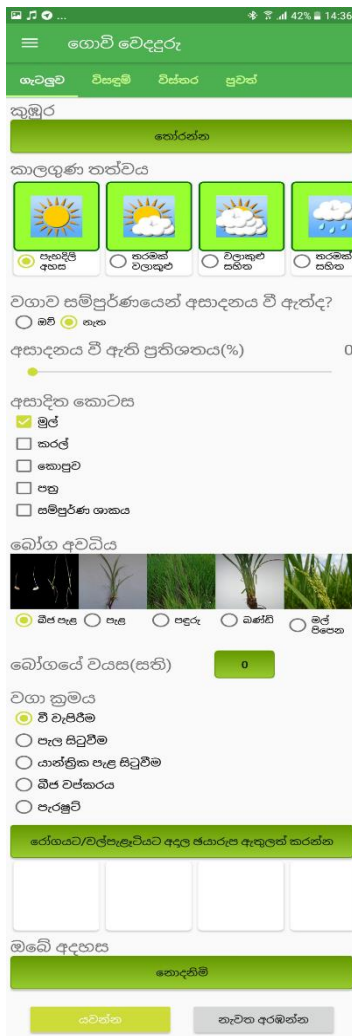
After successfully verifying the proposed workflow through the prototype, a production ready implementation was rolled out. As shown in the Figure 1, information captured via the smart phone application was sent to the Web service. A user-friendly menu system (shown in Figure 2) was designed to capture data such as affected part of the crop, age of the crop, percentage of the area affected, establishment method, prevailing weather condition, images (up to 5) captured via phone camera (guided by the menu) and capture date, time and location automatically. This data is then stored in a database allowing experts in Rice Research Stations to access individual incidents and make recommendations. Once the recommendation is made, farmer can access the full advice through the phone. The system is composed of a web application and a mobile application called "*Govi Vedaduru*", which is compatible with Android 4.0+ version and can be installed to an Android device from the Google play store. Once the mobile application is installed to a smart device, the farmer will have to obtain a username and a password from the RRS, Labuduwa to access and use the application. The experts facing web application can be accessed via multiple logins concurrently. This will ensure the scalability by allowing multiple experts with sufficient privileges to access reported incidents and make recommendations. The web application is also used for analysis and reporting by the officials for better planning and decision making. These reports include classified pest and disease

Figure 2: The GUI of the mobile application

incidents and Google mapping of incidents making identifying pest and disease outbreaks possible. Once the implementation was completed, a training session was held to give awareness on the "*Govi Vedaduru*" mobile and web applications and the overall objective of the e-pest surveillance and advisory system for selected farmers covering 5 areas and extension officers in the Galle district. During this session, farmers were registered to the system and a demonstration on using the mobile application was also held.

Results

In *Yala* season of 2017, "*Govi Vedaduru*" mobile application was introduced in selected five areas (*yaya*) of rice cultivation representing two agro-ecological zones in Galle district as a pilot project. The areas selected were *Keradevala, Kurunda, Uhanowita, Yakkalamulla, and Indurannewila*. 60 farmers were registered to the system. During the period of June to October 2017, 19 inquiries were received and

correctly identified by the scientists at the RRS, Labuduwa and solutions in Sinhala language were sent back to the farmer accounts. Typically, a solution contains instructions on curative actions to manage pest or disease and preventive methods for the next season (Figure 3). Follow up survey was conducted with 10 farmers who reported incidents using the application. We used binary type questions instead of Likert scale to make it simple for participants. Following table summarizes the results:

Useful	Informative	Understood	Reliable	Instructions Followed
10 (100%)	10 (100%)	10 (100%)	10 (100%)	7 (70%)

All participants said that the instructions received were useful, informative, understood and reliable. 9 farmers received a response within 3 days and all within 5 days. 4 farmers used their family members' phones and thought that having their own would be more useful. Seven followed provided instructions.

Conclusion

The pest and disease surveillance and advisory system developed using the mobile and web technologies piloted in selected areas in the Galle district found to provide information-poor farmers a reliable solution to manage their pest or disease problems. This application can be further improved and extend gradually to use island-wide. The same generic architecture and the workflow can be applied to other agricultural crops. With the accumulation of good quality structured data and images about pest and

Figure 3: A solution sent to the mobile application

disease incidents, machine learning techniques can be used to automate some recommendations with a high degree of confidence, further increasing the cost effectiveness and scalability. A detailed evaluation of the effectiveness of the system is planned to identify strengths and weaknesses and to make improvements.

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Abstract No: SE-03   **Systems Engineering**

Framework for embedding strategic use of simulation and optimization technologies in supply chain management

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Abstract

Simulation and optimisation technologies provide virtual environments to fine tune supply chain operations and to develop best operational configurations and strategies. However, recent review of literature and a survey of industry professionals revealed that in most instances, these technologies are typically deployed to address specific problems in isolation. Therefore, companies are failing to reap full potential of simulation and optimisation technologies. This paper presents the development of a new framework which should enable supply chain managers to embed these technologies in their decision-making processes. The proposed framework serves as a guide which helps to (a) identify missing resources (Data, Assets, Stakeholders and Processes) and make appropriate assumptions before design or re-design processes begin (b) Identify gaps against competitor business performance and develop strategies to deploy simulation and optimisation to narrow existing gaps and (c) develop necessary capabilities such as improving in-house logistics and / or out-sourcing for better ROI.

Keywords: Supply chain system design, Supply chain optimization, Supply chain simulation, Supply chain system

Introduction

Supply chains are the backbone of global economy. They are designed to achieve efficient delivery of products to customers on time. Increasingly, many supply chains fail to accomplish this primary aim. Among the many underlying causes for this failure, poor design is considered as a major factor. Any combination of (a) needlessly complex networks (b) inefficient transportation and (c) ineffective operating policies leads to poor designs.

Rapid environmental changes, technological advances and fast changing customer behaviours make even newly designed supply chains obsolete within short operation spans. It is therefore critically important that supply chains are systematically and regularly evaluated with the view to sustain/improve operational efficiencies (Muralidhar and Sarathy, 2018). Traditionally, such evaluations are confined to specific area(s) of supply chains and incremental improvements are targeted in those isolated areas. Sporadic interventions of this nature, however, may not improve overall performance supply chains.

In recent years, supply chain designers and manages have begun to deploy optimisation and simulation platforms which enable them to evaluate entire supply chains. They not only produce best configurations/policies and but also assesses impact of any anticipated changes. Built-in animation and extensive data analytics add further value (Stefanovic and Radenkovic, 2018).

This paper presents a framework which guides supply chain designers to identify appropriate design strategies and how to deploy simulation/optimisation in fine-tuning supply chain performance.

Methodology

This research work involves an extensive literature review and an empirical investigation. Both qualitative and quantitative data were collected via surveys, interviews, and social media blogs. This mixed method research (Homer et al., 2008) provides a more complete and comprehensive understanding of the problem than either quantitative or qualitative approaches alone. This on-going research programme has four distinctive but connected phases;

Phase 1 - Data Collection: Surveys, interviews and review of social media blogs were carried out to collect primary data. The main objectives of this mixed method approach were to identify (a) successful applications of simulation/optimisation tools (b) limitations of current software platforms and (c) challenges experienced in deploying simulation/optimisation software. Survey sample includes (a) end users (b) software vendors(c) industry professionals and consultancy.

Phase 2 - Design and Develop Framework: Information collated from various sources were systematically analysed to identify key issues and gaps in application domains. This analysis led to the preliminary design of the framework.

Phase 3 - Verification and Validation: The primary purpose of this phase is to test the validity and robustness of the framework, Inputs from industry professionals and relevant research communities will be sought in the validation process. It is also expected to test the framework in a live project. Feedback from these two exercises will be used to refine the framework.

Phase 4 - Software concept development: The final phase of the project will focus on the concept development for software applications to automate the process.
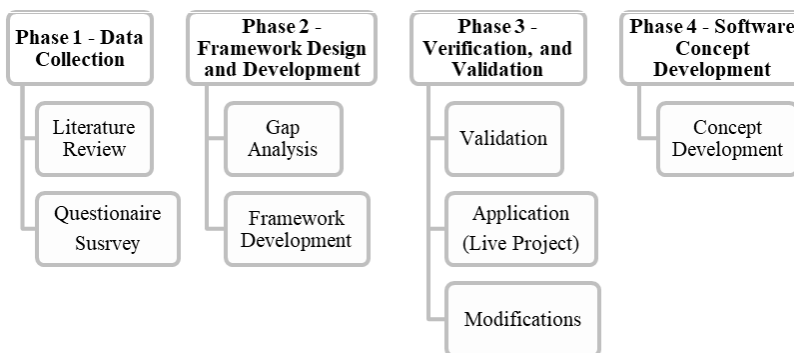
Figure 1: Research methodology

Results

The literature review and questionnaire survey analysis revealed that simulation/optimisation are not fully embedded in their design/operation enhancement projects. It was evident that companies have used these tools in isolation to address very specific problems. Essentially, companies are not reaping full benefits of these technologies. Table 1 below, shows application areas (some areas not shown due to limited space) where simulation/optimisation tools have been used. Whilst almost all sectors report the use simulation/optimisation in network design stage, in other areas the use of technologies has been sporadic.

Table 1: Survey questionnaire results - Supply chain design stage

Company	A	B	C	D	E	F	G	H
Industry	Beverage	3PL	Automotive	Hi-Tech	Electronic	Packaging	Electrical	Manufacturing
Have you used simulation-optimization technologies to determine ?								
SECTION 1 - Supply Chain Design								
Network								
Right "size" of your supply chain network (Size: No. of facilities)								
Right "sites" of your supply chain network (Sites: Locations)								
Right service levels								
Inventory								
Right inventory levels								
Right inventory placements (i.e. Inventory at different locations)								
Appropriate Inventory policies								
Product flow path								
The locations of ports and volume of flow through each location								
Lowest landed cost of the shipments to be arrived / planned								
Appropriate transport policies (i.e. LTL, FTL)								
Transportation and route								
Optimal mode of transportation for the supply chain								
Optimal level of transportation assets								
The most efficient routings								
Best hub locations								
Omni-Channel Fulfillment								
Best channel's configurations								
Strategies for each channel								
Channel's performance								
The best allocation of assets to the channel								

Figure 2, shows the usage of technologies in operations and enhancements areas. Figure 3 shows the structure of the emerging framework.
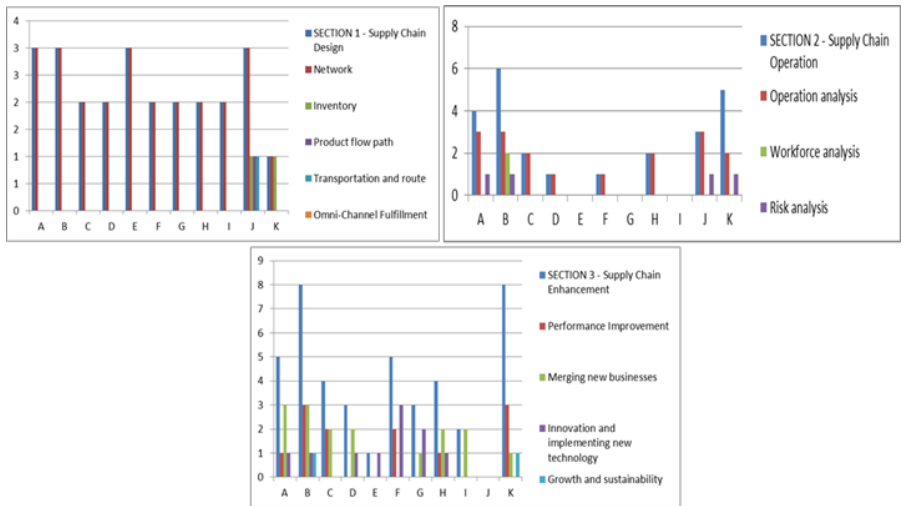
Figure 2: Survey questionnaire results

In Figure 3 above the proposed framework aims to guide users how to embed simulation-optimization in three key "Stages" of supply chain management life cycle (S1 to S3); design, operations and enhancement. "Tiers" (T1 to T7) shows key milestones that needs to achieved in order to embed simulation/optimisation. Figure 4 below, shows some of the input data sets required data and expected outcome from technologies.

Conclusion

This research work aims to develop a framework which should enable supply chain managers to use simulation/optimisation in a strategic manner. As outlined in the introduction, various internal/external factors force re-design of supply chains more

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regularly. Simulation/optimisation technologies provide a powerful platform for a systematic design/re-design of supply chains.
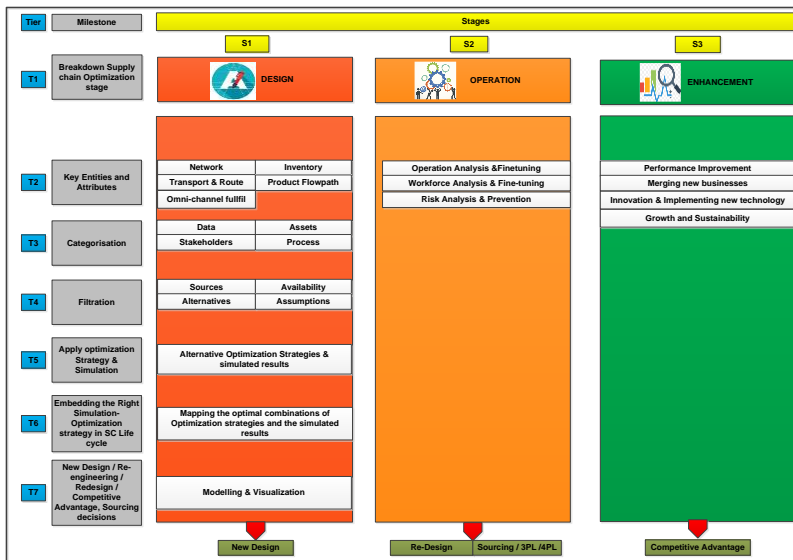
Figure 3: Preliminary framework (under development)
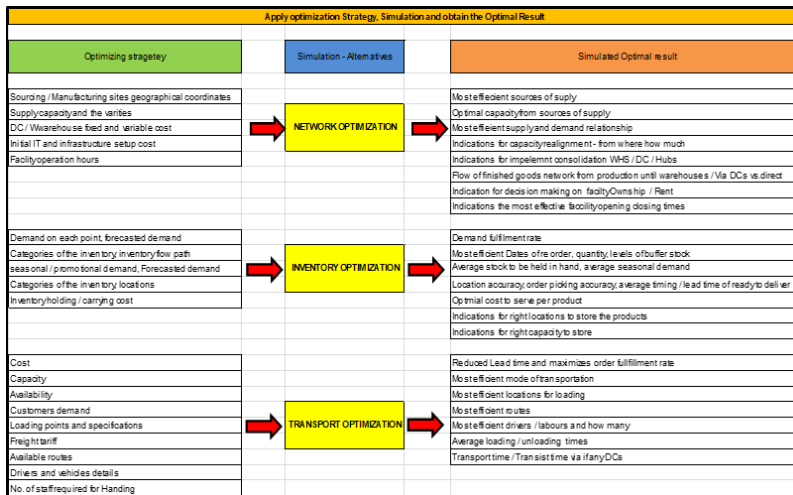
Figure 4: Tier 5 optimization strategy and simulation

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AHP integrated MILP approach to minimize transportation cost to prioritize distribution requirements

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Abstract

Customer satisfaction can be considered as the most important factor for any business as it is tightly linked to revenue and determines the company's growth and the sustainability. Further it is the leading indicator of customer repurchases and loyalty. Final outcome of the effective supply chain (SC) management is to make the customer loyal and if failed it would result to transfer the customer towards the competitor. Understanding this importance, research in supply chain management (SCM) has grown significantly in recent years. Many organizations have identified that customer satisfaction (CS) and the SC cost are linked and it is impossible to optimize both at the same time. Many studies have been done under different situations to minimize transportation cost (TC) as it ultimately reduces a tremendous amount of SC cost. The need for a reliable approach to optimize customer satisfaction while minimizing the transportation cost has been raised in many occasions as improving customer satisfaction is a goal sought by many businesses in the logistic industry. This requirement becomes critical when the distributor has to select a set of customer orders to be delivered when the supply is less than the demand. Therefore, the objective of this study was to develop a model to find a way to optimally satisfy the customer orders, while minimizing the transportation cost. As a result, a customer focused approach is presented by incorporating Analytic Hierarchy Process (AHP) and then employing a mixed integer linear programming (MILP) model to find the optimal solution. The proposed model addresses customer satisfaction while minimizing the transportation costs

Keywords: Analytic Hierarchy Process**,** Customer satisfaction, Logistics, Supply chain management, Transportation cost

Introduction

Satisfying customers' needs is the key to the success of many companies. Supply chain design has a vital role to play in the logistics decision-making process. The importance of supply chain design has increased when more and more companies have understood the possibilities of offering increased value to their customers by restructuring the supply chain. Among the general processes of a supply chain, transportation or the distribution of goods makes a significant contribution. In addition, transportation as a part of logistics operations can be seen as a value-adding process that directly supports the primary objectives of the companies, which is to be competitive in terms of high-level customer service, competitive price and quality, and flexibility in responding to market or customer demands. Satisfying customers' demands on time is very important, both from a cost reduction perspective, and for its role in increasing the service level of customers. In the distribution process, a variety of supply chain (SC) objectives can be achieved, such as, minimize SC cost, maintain a seamless SC, and provide a high level of service to the customer (Sharma et al., 2008). Logistics costs form the major part of a SC's cost (Farahani and Elahipanah, 2008). The TC alone comprise the highest percentage of this expense for

most of the companies. Furthermore, transport operations occupies almost one-third of the amount of operations in SC (Tseng et al., 2005). Therefore, transportation cost minimization makes a significant cost reduction in SC cost.

With the growth of the logistics industry, most of the companies have been encouraged to move towards third party logistics (3PL) services that are mainly focused on cost reduction, improve productivity, maximize profits and offer end user satisfaction. However, in situations where the demand is higher than the supply, important customer orders are not prioritized enough to save the customers from transferring to a new service provider. These problems mainly occur because most of the 3PL services are attentive to cost cutting approaches rather than satisfying the end user. This is vital and a common problem for logistics service providers and these nonconformities cause customer dissatisfaction as well. The focus of logistics is increasingly turning towards providing improved services for customers instead of widely used criterion of the minimization of transportation or logistics costs and maximization of profits of 3PL companies. Therefore, a customer service based approach is proposed for distribution logistics, which enables the inclusion of both qualitative and quantitative customer service elements and identifies the most important and loyal customers. Further, a MILP model is proposed that addresses needs of loyal customers while sacrificing the minimization of the transportation cost.

In AHP literature, identification of loyal suppliers, development of models to evaluate customer satisfaction using AHP are widely prevalent (Ozfirat et al., 2014; Yadav & Sharma, 2016; Medjoudi et al., 2012; Lan et al., 2016). However, few studies focused on giving priority to customer needs. Therefore, the proposed model contributes to literature as a customer oriented approach for distribution while minimizing the transportation cost. Furthermore, the study provides solutions for some critical issues that exist in the logistics industry, such as, customer dissatisfaction towards delivery, higher transportation cost, and complex decision making among customers.

Methodology

As the objectives of this study is to reduce transportation cost and prioritize needs of the important customers, both quantitative and qualitative research approaches are needed to be used to provide a solution for the above discussed problem. Customers who are the most important for the organization can be identified by evaluating them under several criteria, which are defined from distributor's perspective and then, the goods are delivered to the customers in a way that minimizes the transportation cost. The proposed model is developed by integrating AHP and MILP together, as presented below.

As the first step of AHP, criteria and sub criteria are defined using the knowledge and experience of the 3PL service providers. The identified criteria that are used to assess the customers are, Delivery Time, Order Frequency, and Capacity of the Truck, Previous Delivery, Sub Warehouses and Value of the End User. Under these criteria, the customers are evaluated through pair-wise comparison method. And for the evaluation of alternatives, a decision support tool based on AHP has been used and it facilitates to revise the judgements based on the 'Congruence' and 'Dissonance' measures. Consistent judgements are made and then the priority values of the customers are obtained based on the decision criteria. The overall consistency ratio is $0.045 < 0.1$, which means that the decisions can be accepted as logically accurate.

Then the priority values that are obtained from the AHP model which are incorporated to the MILP model in order to find the optimum solution where all the important customers are satisfied and the transportation cost is minimized.

$$Min\ Z\ =\ \sum_{i=1}^{m}\sum_{p=1}^{P} Cip\ Xip$$

Subject to

$$\sum_{p=1}^{p} Xip\ \leq Vi \qquad\qquad i=1\dots..$$

$$\sum_{i=1}^{m} Xip = S - Dp \qquad\qquad p = 1\dots. P$$

$$Xij >= 0$$

a) If $S - D_p > 0$ then
   $S - D_p > D_{p+1}$
   $p = p+1$

b) If $S - D_p > 0$
   $S - D_p <= D_{p+1}$
   $p = p+1$
   $\sum_{i=1}^{m} Xij < S - Dp$

c)   If $S - D_p <= 0$
   Then Stop the process

m	Number of Customers	Xip	Quantity transport from warehouse p to customer i
n	Number of Warehouses	ciP	Unit shipping cost from warehouse p to customer i
Dp	Demand of the prioritized customers	S	Total Supply from warehouses
Vj	Throughput volume of warehouse j	p	Priority value

$$S = \sum_{j=1}^{n} Vj$$

Results

Table 1 shows the comparson of results of the above two models. It is observed that customers who are recognized as important to the organization are partially satisfied in the ordinary transportation model, while those customers are fully satisfied in the proposed model. Our model was tested for twenty different samples with 3 to 5 different warehouses and 3 to 6 customers. In all cases, the prioritized customer's requirements are satisfied compromising the transportation cost.

Table 1: Comparison of the results of proposed model and ordinary/conventional transportation model

Customer	Priority of the Customer	AHP integrated MILP model Not Supplied (%)	Ordinary Transportation Model Not Supplied (%)
C1	4	40.5%	0%
C2	**2**	**0%**	**38.1%**
C3	5	100%	87.3%
C4	**1**	**0%**	**38.5%**
C5	6	100%	0%
C6	**3**	**0%**	**0%**

Furthermore, when comparing the opportunity lost cost of the two models, it is higher in the traditional transportation model than the proposed AHP integrated MILP model. It clearly illustrates that when the organizations are focusing on cost cutting approaches, the satisfaction level of the customers gets diminished.

Therefore, when the demand is higher than the supply, when an organization needs to prioritize their customer satisfaction, while sacrificing their logistics cost, always the proposed model works better than the conventional method.

Conclusion

This study makes a significant contribution to the literature as a AHP integrated MILP approach to minimize transportation cost while prioritizing customer requirements, which can be identified as a customer – oriented approach to optimize customer satisfaction and the transportation cost at the same time. When discussing about the objectives, one of the main objectives of the study is to provide an effective solution to manage circumstances that ensue when the demand is higher than the supply. Mainly, how to distribute the in-hand quantity to the customers in an efficacious manner where the satisfaction level of the most important customers is ensured. Moreover, the unarticulated needs of the distributor have been taken into consideration and the customer needs are prioritized based on the criteria defined by the distributor. Furthermore, as one of the main costs in the SC, the transportation cost is minimized by MILP model, which is developed as an extension of the conventional transportation model.

The result of the study concludes that the model is capable of assisting the decision makers to examine the importance of the customers by comparing them with appropriate criteria. And the model is assured that the customers who are identified as more important to the company are fully satisfied while the transportation cost is minimized. Furthermore, the opportunity lost cost of the proposed model is comparatively lower than the traditional transportation model, as the primary concern of the proposed model is maximization of the customer satisfaction. Therefore, the proposed approach will be beneficial for many organizations who are seeking new approaches to satisfy customers, as to maintain a strong customer base and increase customer retention. Moreover, it allows other companies to rethink about their distribution process when competing in the industry.

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Abstract No: SE-05 **Systems Engineering**

Swarm intelligence for urban traffic simulation: Results from an Agent-based modeling and simulation study of the Sri Lankan context

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Abstract

Traffic congestion is a crucial issue affecting the quality of life of individuals all over the world. In a country like Sri Lanka where the traffic is mostly heterogeneous and unorganized, traffic congestion could be largely influenced by the behaviors of pedestrians and drivers. Due to the significant impact of traffic congestion to economic growth, various measures have been taken to reduce the urban traffic congestion, such as widening the roads, expanding the road network and constructing overhead bridges. However, despite all these approaches, traffic congestion still remains as a serious issue. We are of the view that the traffic congestion in Sri Lanka is largely depending on the behaviors of the pedestrians and as well as the drivers, which is something that is not adequately investigated yet. Therefore, we propose the Agent-Based Modelling and Simulation (ABMS) approach, which is a popular computational research method based on swarm intelligence to study complex social and economic systems (O'Sullivan and Haklay, 2000), for researching the impact of driver and pedestrian behavior on traffic congestion and evaluating different traffic control strategies. We used the ABMS environment called NetLogo to develop our simulator and the data collected at the *Kiribathgoda* junction in Western Province, Sri Lanka was to calibrate the model with accurate parameter values. Macroscopic statistics, such as the rate of traffic flow, average speeds and queue time were used to validate the model by comparing data from real traffic situations at *Kiribathgoda* junction with model outputs. The ultimate objective of this research is to come up with a cost-effective decision support system for administrators and policy makers to understand various reasons behind congested unorganized traffic environments in Sri Lanka and, thereby to make better-informed decisions to control urban traffic congestion.

Keywords: Traffic simulation, Agent-based modelling, Heterogeneous traffic, Swarm intelligence

Introduction

When it comes to Sri Lankan urban traffic, it is mostly heterogeneous with different types of vehicles (motor cars, buses, motor bicycles and three wheelers), which differ in their static characteristic: vehicle size as well as dynamic characteristics: speed, acceleration, maneuverability, and driver behavior. In Sri Lanka, often motorcycles and three wheelers do not wait along with the other vehicles when traffic is not moving. These two types of vehicle tend to have weak lane discipline and perform dynamic virtual lane-based movements or non-lane based movements (Lee and Wong, 2016) in high-congested traffic conditions while other vehicles follow vehicle following behavior (Lansdowne, 2006). In literature, this behavior is defined as *seepage* behavior, *lane filtering*, *lane splitting*, *lane sharing* or *percolation* (Agarwal and Lämmel, 2015; Lee and Wong; 2016), which is common in all countries that have mixed traffic condition (Agarwal and Lämmel, 2015).

Agent-based modelling is a microscopic computer simulation technique focusing on simulating the actions and interactions of a set of computational agents that represent a complex socio-economical system. It helps to have a bottom-up view on a system by modelling the simple interactions of its components to investigate and to observe how the individual behaviors collectively generate the macroscopic regularities. In this study, individual vehicles and pedestrians are modeled as software agents who have a set of individual (i.e. micro level) behavioral rules. When these agents are put together, they behave as the vehicles and pedestrians in the real world interacting with each other, giving rise to emergent macro-level patterns, which we call traffic congestions.

Due to the size and ability to move through small gaps between other vehicles, motor bicycles and three wheelers seem to be less sensitive to the traffic flow but, their behaviors could affect the flow of the other vehicles. Therefore, the effect of drivers' vehicle following behavior as well as *seepage* behavior (hybrid behavior), are taken into consideration when designing the model. Apart from drivers, pedestrians are other users of the road. As the pedestrians' crossing behavior is also an important determinant of the congestion, this variable is added to the model as an extension to make the results more accurate. The aim of this study is to model a reliable, detailed microscopic traffic simulator using agent-based modelling to simulate Sri Lankan mixed urban traffic congestion. This model factors in the hybrid behavior of vehicles to add more accuracy, which is an unaddressed area according to literature findings. The simulator is calibrated and tested with real data taken from urban traffic flow of *Kiribathgoda* Junction, Western province *Sri Lanka* to ensure the models reliability.

Methodology

Figure 1 depicts the overall methodological process of agent-based modeling and simulation.
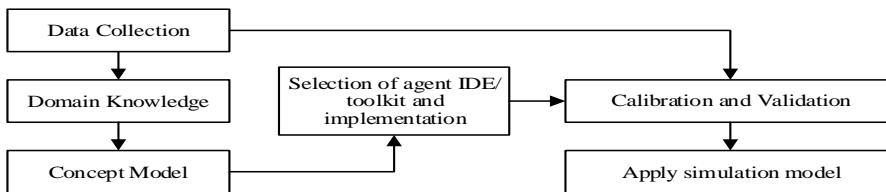
Figure 9: Overview of Agent-based modeling

Both quantitative and qualitative data are required for creating the concept model as well as its calibration and validation. Some quantitative data related to the model are vehicle category, vehicle proportions in the road network and, road network data, such as length and width, which is collected through interviews, literature, and other available sources.

Behavioral theories are gathered through desk research to cover the qualitative aspects of the model and to understand the behavior of individuals; for example, *lane changing behavior*, *vehicle following behavior*, *seepage behavior* and, the *flow-density relationship*. *Kiribathgoda* junction, Western Province, Sri Lanka is the area chosen as the test bed for the simulation study. Video capturing and observation methods were carried out during the peak hours to accurately develop the model.

The conceptual model of the simulator, comprising vehicle and pedestrian agents and their behavioral rules was implemented using NetLogo, which is an open source agent development toolkit designed for modeling and simulating agent-based systems. Model calibration and validation was carried out after implementing the tool. Calibration of the model is necessary to ensure that the output results are reproducing the real-world traffic conditions and behaviors. If unexpected problems

or unrealistic traffic behaviors were observed, internal microscopic parameters (vehicle speed, acceleration, deceleration, driver behaviors) should be modified until the model is complying with the actual phenomena. Validation focuses on demonstrating the ability of the model to replicate the observed traffic patterns in real world conditions other than the ones used for calibration. Validation requires macroscopic-level data, such as flow rate, speeds, and queue time, which can be easily, compared with real traffic data (Lansdowne, 2006).

Results

Nagel & Schrekenberg (1992) suggest that a suitable way to verify a traffic simulator's macroscopic properties is to generate and analyze the fundamental diagrams such as flow-density diagrams. Our simulator has modeled the traffic flow of the *Kiribathgoda* junction realistically as the flow density diagram.
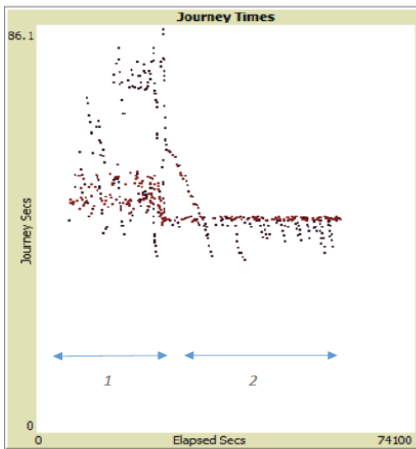
Figure 11: Seepage behaviour
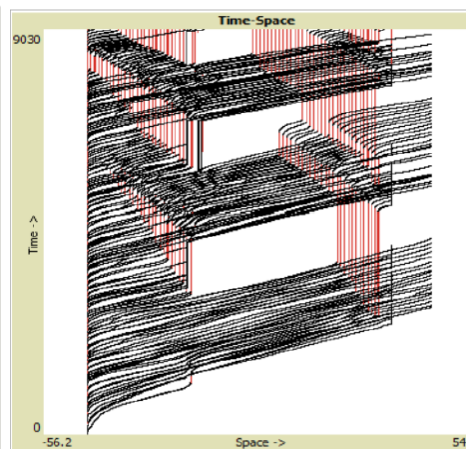
Figure 10: Result of test bed

In Figure1, red (dark) dots represent the small vehicles type and blue (light) dots represent other vehicles. Part 1 of Figure 1 shows the journey time of vehicles when small vehicles follow seepage behavior and part 2 shows when all vehicles follow vehicle following behavior which proves that seepage behavior of small vehicles increase the journey time of all vehicles. Thus, measures to control the seepage behavior would contribute significantly to reduce the congestion.

The simulation study of the *Kiribathgoda* junction through the aforementioned model revealed two key causes for the traffic congestion in the area. In Figure 2, the red lines show where the speed of vehicles gets affected which proves that there are two bottlenecks of the road. By considering the space axis coordinates, we were able to found that those are the pedestrian crossing and the side roads connecting to the main road.

Conclusion

In this study, a traffic simulator to study the heterogeneous traffic congestion based on agent-based modelling approach has been proposed and implemented using NetLogo. Features and indicators that have been implemented include vehicle-following, seepage behaviour, pedestrians/crossings, traffic lights and results are interpreted using graphs of traffic flow, journey times and time-space relationship. The simulator has been calibrated and validated with real data, and the validation assessments have shown that the simulator accurately models traffic flow in the conditions under which it is being tested.

The agent approach to traffic simulation is well justified, since vehicles and traffic control features can be represented directly as intelligent agents. The most challenging requirements for the tool to address were modelling seepage behaviour and vehicle following behaviour. Since the model is for the *Sri Lankan* context, both behaviours must be considered. Resulting macro-level vehicle behaviour is mostly realistic; however, it could be improved through further analysis. Psychological characteristics of Drivers were not modelled; however, vehicles do have individual maximum speed/acceleration resulting in a degree of perceived driver characteristics. Future work on this research includes further calibrating inputs/behaviours, verifying simulation output and implementing more features/indicators. Other applicable features to consider are incidents, adaptive traffic signals, including more vehicle types enhance pedestrian behaviour, other traffic reducing solutions *etc*.

This study verifies that traffic simulation is applicable in *Sri Lankan* context and is capable of simulating Sri Lankan traffic conditions. The users could change the specified parameters of pedestrians, roads, drivers and vehicles in the simulator and observe cause and effect relationship of those controllers and traffic congestion, apply different strategies to reduce traffic congestion and evaluate the results of them which proves that this is a worthy and cost-effective tool.

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Social media mining for post-disaster management - A case study on *Twitter* and news

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Abstract

A natural disaster is a natural event which can cause damage to both lives and properties. Social media are capable of sharing information on a real-time basis. Post disaster management can be improved to a great extent if we mine the social media properly. After identifying the need and the possibility of solving that through social media, we chose *Twitter* to mine and News for validating the *Twitter* Posts. As a first stage, we fetch the *Twitter* posts and news posts from *Twitter* API and News API respectively, using predefined keywords relating to the disaster. Those posts were cleaned and the noise was reduced at the second stage. Then in the third stage, we get the disaster type and geolocation of the posts by using Named Entity Recognizer library API. As a final stage, we compared the *Twitter* datum with news datum to give the rating for the trueness of each *Twitter* post. Final integrated results show that the 80% of the Twitter posts obtained the rating of "3" and 15% obtained the rating of "2". We believe that by using our model we can alert the organizations to do their disaster management activities. Our future development consists mainly of two folds. Firstly, we are planning to integrate the other social media to fetch the data, i.e. Instagram, YouTube, etc. Secondly, we are planning to integrate the weather data into the system in order to improve the precision and accuracy for finding the trueness of the disaster and location.

Keywords: API, Data mining, Disaster management, Social media, Twitter

Introduction

A natural disaster is an event such as a flood, landslide, earthquake, tsunami or hurricane which is capable of causing great damage to properties or loss of lives. The loss of lives and property damage will increases globally (Alexander, 1993). Even though some disasters can be predicted earlier it very hard to stop the impact fully. Therefore, post-disaster management plays an important role to get back to the routine life. Data Mining is a process of extracting knowledge hidden, from large volumes of raw data. The knowledge must be able to use for various purposes. According to Frawley et al. (1992), data mining is defined as "nontrivial extraction of implicit, previously unknown, and potentially useful information from data". Data mining is one of the tasks in the process of knowledge discovery from the raw data.

Twitter is a promising channel through which we can explode to explore for situation awareness because of the availability of open Application Programming Interfaces (APIs) that give access to almost all of the communications in real time. Unlike traditional communication technologies such as cell phones, *Twitter* communication is largely public and can be monitored, and members of the disaster-affected population can be employed as a sensor network (Rogstadius et al. 2013). Further, during disasters, all the conventional communications generally stop functioning. At

this time interval, social media services stay active. Online social networks allow the establishment of global relationships that are domain related or can be based on some need shared by the participants (Velev and Zlateva, 2012).

With the increase of natural disasters that have occurred in the past years, it is expected their frequency will continue to increase in the coming years (Velev and Zlateva, 2012). So, if we find a mechanism for finding the disaster and its location, it will be more useful in many post-disaster activities such as warning others who are not affected by the disaster to not to go there, sending information to rescue team etc. However, the trueness of the disaster for which are being posted on the social media is always a question. That also needs to be addressed when mining social media. In this paper, we therefore try to explain our approach in order to find the disaster and location by using Twitter posts and how we validated them using online news.

Literature review and related works
Social network platforms turn out to be a valuable technology for collecting data of different types, making such technology very useful for emergency management (Pohl et al. 2012). At present, there are studies available which use Social Media applications in disaster management for before, during or after a disaster (Ahmed 2011). In Imran et al. (2013) have described automatic methods for extracting information from micro-blog posts. Specifically, they focused on extracting valuable "information nuggets". Their system grasp machine learning method called state-of-the-art machine learning techniques to classify messages into a set of fine-grained classes and to extract short, self-contained structured information. In Earle et al. (2012), have presented and evaluated an earthquake detection procedure that relies solely on *Twitter* data. A tweet-frequency time series constructed from tweets containing the word "earthquake" showed large peaks correlated with the origin times of widely felt events. To identify possible earthquakes, they used a short-term-average, long-term-average algorithm.

Methodology
The whole project was implemented in the Java environment using NetBeans IDE. Figure 1 describes the basic steps in the roadmap of our social media analysis for post-disaster management approach.
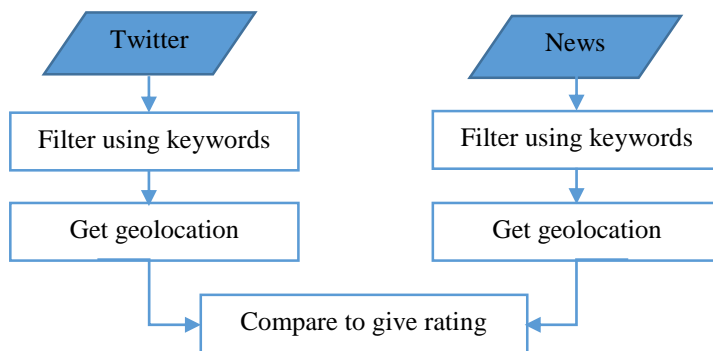
Figure 1: Our high-level design methodology

For the analyzing purpose, as a sample, we have fetched the post from 2017 July to 2017 December. The filtering component was used to extract the data from Twitter and news and filters out noise from them. In order to filter the posts and news from the social media, developers' API provided by each media (*Twitter* provides "REST API", "Streaming API" - Available at http://Twitter.com, News provides "News API"

- Available at https://newsapi.org) were used. We used the main disaster-related keywords such as landslide, earthquake, tsunami, storm, floods etc. Each single-word searches from *Twitter* produced a vast amount of 'noise', and sometimes they may not relate to disaster situations. Some of the examples are;

> *"My puppy could run for mayor and win by a landslide. I have no idea how she's so popular. Date at posted: Sun Dec 31 05:28:31 IST 2017"*

> *"Accidental codeine addicts fear a 'tsunami of pain' | Aisha Dow http://toplocalnow.com/au/sydney/at/10#t11324476. Date at posted: Sun Dec 31 05:04:12 IST 2017"*

Further, in order to reduce the noise further, the posts which do not contain location were omitted. We used Named Entity Recognizer (NER) library to find the location in the text (posts). NER labels sequences of words in a text which are the names of things particularly for the 3 classes; person, organization, and location. By using this library, we got the location information from the posts. A sample for location detection from a Twitter post is given below;

> #USGS #breaking #earthquake   M 0.6 - 9km NE of Aguanga, CA
> https://earthquake.usgs.gov/earthquakes/eventpage/ci37842207 …
> #alert #tsunami #prayfromjapan
> Date at posted: Sun Dec 31 05:00:35 IST 2017
> Location: [Aguanga]
> tempCountry: [USA]
> Disaster: earthquake.

At the final stage, for twitter posts, the distinct values were obtained by checking the disaster type, location details, and date as a whole. After that, each disaster from the twitter was compared with news to give the rating of 3, 2, 1, and 0. The rating of 3 which means "more accurate" was given to *Twitter* posts which should satisfy all the three parameters; disaster type, location details, and date with the news. "Moderately accurate" is the number 2 rating in which *Twitter* posts should satisfy disaster type and one of the other parameter location details or date with the news. The rating of 1 which means "less accurate" was given to *Twitter* posts which do not satisfy location details, and date with the news but satisfy disaster type. "No correlation" is the number 0 rating in which *Twitter* posts do not satisfy any of the three parameters.

Results

We compared *Twitter* posts with news in order to avoid the false data. Because some of the users of social network may spread some rumors regarding the disaster unethically. By comparing the twitter posts with news, we can achieve high accuracy and precision for trueness of the disaster and its location. But there were more news posts that do not distinguish by twitter posts. This result implies that lots of Twitter were filtered by us when filtering using keywords and geolocation. What we are suggesting is, there should be some sophisticated mechanisms to follow in order to reduce the noise but not to eliminate the disaster-related posts and location-related posts. It is very important to get much information as possible during the disaster period. This will help to manage recovery teams such as Red Cross, NGOs, UNICEF and some local well-wishers etc., and to make decisions (Pohl et al., 2012). There is a huge amount of data produced from different sources. The ultimate objective is to abstract high-level information from low-level data.

When using APIs to collect data from social media sites, only a limited amount of data can be obtained daily. Further, there were some cases that previous disasters

were reminded back as a memory. For example, December 26th 2004 tsunami was reminded back in 2017. This post was reminded in news also. So, we got a match that the tsunami is on December 26th 2017. But when we handle the system in real time, we can eliminate this problem by adding an extra filter. That filter should omit the posts which contain dates, months, years other than the current date. Further, Chatfield and Brajawidagda (2012) presented that only 47% of users included their location in tweets, a fact that enabled placing them on maps. It seems that less and fewer users are adding their location to tweets. Further, most of these geotag refer to the user rather than the message subject (Rogstadius et al. 2013). Moreover, when handling the location, the locations mentioned in shortened form or spelling mistakes were not captured by NER. So, a lot of twitter posts were omitted. It is also a serious limitation faced by us.

Conclusions

Twitter API and News API were used to get the public data about the disaster. Filtering techniques used to reduce the noise. Location of the posts was extracted using NER. Finally, each *Twitter* datum was compared to news posts to find the trueness of the Twitter posts. We believe that our system is successful up to some extent as we validated the *Twitter* data with the news. Further, our next plans are; (i) Integrating weather data into the system. (ii) Integrating other social media such as Instagram, YouTube, and Facebook, etc. to fetch the post. (iii) Reducing the noise from the posts while increasing the accuracy of the posts fetched.

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An efficient data perturbation scheme for preserving privacy on a numerical database

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Abstract

The data retention within an organization may increase rapidly with time. In order to reduce cost of organization, they may choose a third-party storage provider. There is a leakage crisis when provider cannot be trusted. Another scenario is a dealer collects all transaction data and provides it to a data analysis company for marketing purpose. For these reasons and beyons, preserving privacy in database becomes an important issue. This paper concerns the prediction of disclosure risk in numerical database. It presents an efficient noise generation that relies on Huffman coding algorithm and builds a noise matrix that can add noise intuitively to original value. Moreover, we adopt clustering technique before generating noise. The result shows that the running time of noise generation of clustering scheme is faster than non-clustering scheme.

Keywords: Database privacy, Disclosure control, Huffman coding, Micro aggregation, Noise matrix

Introduction

The data within an organization may increase rapidly. Instead of building up a storage space by itself, they may send these data into the data analysis company for some marketing purposes. Hence, the data mining techniques play an important role in the Knowledge Discovery in Databases (KDD). However, a malicious data analysis company may record personal data when organization publishes statistical database of the company. If the company is not trusted, there is a leakage crisis. For these reasons, privacy research has become popular in recent years. Statistical Data Bases (SDBs) are used to produce result of statistical aggregates such as sum, average, max and min. The results of statistical aggregates do not reveal the content about of any single individual tuple. However, the user may ask many legal queries to infer confidential information from gaining database responses.

In recent years, enhancement of the security of statistical database has received much attention. The problem of security in classical statistical database involves three different roles (Traub et al., 1984): statistician: who interest is to gain aggregate data; data owner: who desires individual records are security; database administrator: who needs to satisfy both of above roles. The privacy challenges in statistical database can be classified into two aspects (Lu & Tsudik, 2011): for data owner, he should avoid data theft by hackers, data abuse by service provider, and should restrict user access right; for user, it should hide query content, and database does not reveal query detail. There are many approaches that have been proposed. Navarro & Torra (2012) have introduced four categories as follows: a) *Perturbative methods,* which modify the original data to reach a degree of privacy. They usually called noise, b) *Non-perturbative methods,* the technique masks the data without introducing error. Data is not distorted, c) *Cryptographic methods,* which use classical cryptography system,

d) *Synthetic data generation,* which generates random data while retaining relationship with the original data. In order to protect confidential information in database, Statistical Disclosure Control (SDC) is mostly used for privacy preserving solution on statistical database. Micro-Aggregation Techniques (MATs) are considered to the family of SDC, and are belonged to perturbative methods. The method of micro aggregation has many attractive features including robust performance, consistent responses, and ease to implementation (Fayyoumi & Oommen, 2010).

This paper focuses on a combination of two or more non-confidential attributes such as age, weight that can be used to link an individual. Such set of attributes is collectively called a quasi-identifier. A popular approach for replacing original data is to use clustering-based technique to prevent identity disclosure. Hence, the adversary may be confused when the original data is replaced by grouping measure. Although the data in the dataset is homogeneous by clustering-based technique, there is a problem of prediction disclosure.

Methodology

a)   MST Clustering

The paper adopts Prim's minimum-cost spanning tree clustering technique which was proposed by Lazlo and Mukherjee (2005). The technique is constructed based on all records in the dataset. Prim's algorithm is a greedy algorithm that finds a minimum-cost spanning tree for a connected edges undirected graph. Initially, it finds a subset of edges to form a minimum-cost spanning tree that connects to all nodes, where the total weight of all edges is minimized. Some notation is defined to facilitate the discussion. Each record with more attributes in the dataset D can be converted to data point on the coordinate systems and is considered a node u in the minimum-cost spanning tree. The node u can be connected to the other node v in the dataset D and forms an edge e(u,v), u,v∈D. All of edges can be computed to a value by random two nodes in the dataset. That computed value can be used to as a weight w for each edge. According to Prim′s algorithm, it first selects a single node u∈D and builds a minimum-cost spanning tree F={u}, no edges. The next step of Prim′s algorithm selects another node v∈ F-D, where v is closest to the set F and is closest to the node u. There is a new edge e(u,v) be formed by two nodes u,v∈D, and node v points to parent node u, and add v to the set F, F={u,v}. Each node points to its parent node in the tree, but the initial node points null. In this case, the node u points null. This is an iterative process until F=D. Prim's algorithm selects a single node, regarded as a root of tree, in the graph to grow to a minimum-cost spanning tree.

Next, in order to partition all nodes to form clusters in the MST, we should consider how many edges in the MST are removable. The idea is to visit all edges in the MST from longest to shortest, and determine the edge cutting while retaining the remaining edges. After edge cutting, the MST partitions to several subtrees and these can be formed cluster. All of edges are assigned to a priority queue Q in descending order. Then, we obtain an edge $e(curr, parent)$ in sequence from the priority queue Q, and consider each edge whether is removable, where $curr$ is visiting node and $parent$ is parent node of $curr$. We consider the two subtrees size from visiting node $curr$ and parent node $parent$ respectively, and determine each size is greater than k which preset by protector. The edge $e(curr, parent)$ is removable when both of two subtrees sizes are greater than k, respectively. In the contrast, the edge $e(curr, parent)$ is not

removable. First, we obtain a subtree size from visiting node $curr$ by $Traversal_{curr}$, where $Traversal_{curr}$ is used to obtain subtree size from node $curr$. Second, we consider the root node from visiting node $curr$ toward its parent node $parent$. Then we obtain another subtree size by $Traversal_{root} - Traversal_{curr}$. To illustrate briefly, we suppose that these two subtrees' sizes are greater than k, and edge $e(curr, parent)$ is removable. We remove the edge $e(curr, parent)$ from priority queue Q, $Q - \{e(curr, parent)\}$, and replace the parent pointer of $curr$ to $null$ to represent it is a root node of subtree.

Final step is a simple processing for all nodes partition to disjoint cluster. Each root of subtree can be formed cluster by traversal its descendant nodes. We have found that all the nodes whose parent pointer is $null$, and assigned to a set of root $R = \{r_1, r_2, ..., r_n\}$. The parent pointer with $null$ which represents root of subtree, and each subtree can be formed cluster c_i, $c_i \in C$, where C is a set of clusters, $C = \{c_1, c_2, ..., c_n\}$, where $c_i \nsubseteq c_j$. We have obtained a root node r_i from front of root set R, and traverse all descendant nodes $\{d_{i1}, d_{i2}, ..., d_{in}\}$ by following the root node r_i of subtree. After traversing the subtree, the root node r_i and its all descendant nodes $\{d_{i1}, d_{i2}, ..., d_{in}\}$ can be form a new cluster $c_i = \{r_i, d_{i1}, d_{i2}, ..., d_{in}\}$. And then remove root node r_i from R, $R - \{r_i\}$. We can find next cluster follows above procedure. This is an iterative process until $R \in \emptyset$. Finally, all nodes are partitioned into disjoint clusters.

b) Noise generation

After clustering all data points, the next step is generating noise based on centroid of these groups. Our scheme is based on Huffman coding which proposed by Huffman in 1952 (Huffman, 1952). Huffman coding algorithm is popular on data compression technique (Gonciari et al., 2003; Kavousianos, 2007). We can identify the distinct data point by building Huffman coding tree, because Huffman coding has some features such as 1) each character has a corresponding Huffman code; 2) the character with higher probability has shorter Huffman code. In the contrast, the character with lower probability has longer Huffman code. These features can be used on generating noise to preserve privacy in database. There is longer noise to be injected to original data with lower probability, easy reveal privacy, to confuse adversary. In the other words, the data with high probability means, it is not easy reveal privacy for personal.

Results

We consider running time of noise generation that calculates per unit time in milliseconds. In order to estimate the precise time, we obtain the average of 61 times of running time of noise generation. Our experiments were conducted to explore time changes between non-clustering and clustering. Which the non-clustering scheme has not included in MST clustering technique. Moreover, the clustering scheme has various k in which the group size preset by data protector. We also discuss the time changes of instances from 10 to 1,000.

The experimental results show the running time of noise generation will be slower when the records are increased. The running time of noise generation of clustering scheme is faster than non-clustering scheme. In the experiments, we also find a noise in the running time in clustering scheme but overall the growing of time is very smooth. In addition to running time examining, we also explore the data quality after noise injection procedure. The measure of data quality is follow Domingo-Ferrer proposed in 2002. The experimental results show less information loss in non-clustering scheme. Nonetheless, all of the information loss results are not exceed to 50 percentages. However, it is a trade-off between minimum information loss and

value disclosure risk. Summary, our proposed scheme is an efficient to generate noise to preserve privacy in database.

Conclusion

We present an efficient noise generation scheme which relies on Huffman coding algorithm. We also build a noise matrix that can add intuitively noise to original value. Moreover, records in the dataset are partitioned to disjoint cluster before generating noise. Our scheme can only be used in numerical database or statistical database. In the future, we will consider non-numeric values and propose a conversion mechanism. The mechanism is adaptive to our scheme and can be converted between non-numeric value and numeric value. When all non-numeric can be converted to numeric value, it can adapt to our scheme and can extend this study.

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Determinants of successful implementation of Green Supply Chain Management: From literature review perspective

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Abstract

The purpose of this study is to identify the Green Supply Chain Management (GSCM) best practices and explore the factors influencing the succesful adoption of green supply chain management practices. The authors have used a systematic review of literature approach to collate 27 articles ranging from automobile, beverages, construction, electrical, hospitality, power generating and, general industries. The findings are revealed under five categories namely; green procurement, green design, green packaging, green operations, green manufacturing and reverse logistics incorporating 48 critical success factors under five themes, namely; Organizational Commitment (OC), Knowledge Base (K), Operational Dynamics (OD) , Market Pressure (MP) and Exogenous (E).

Keywords: Green manufacturing, Green procurement, Green supply chain, Reverse logistics, Sustainability

Introduction

Supply chains have been developing with time since the inception of commercial trade and barter system (Rao et al., 2012). The emergence of the Green Supply Chain practices and its industrial terminologies are the key jargons that fascinate recent studies in the field of SCM. Various studies cited the importance of having strong internal and external environment on par with the sustainable business operations. On the other hand, it has been noted that some organizations have robust supply chain policies in parallel with the executions and at the same time it was executed merely to satisfy external parties. As per the (Gawande and Dube, 2011), GSCM evolves for many different reasons: forced due to laws and regulations, to gain competitive advantage and for survival. Prevailing organizations are focused on implementing Green Procurement, Green Design, Green Packaging, Green Operations, Green Manufacturing and Reverse Logistics (Amemba, 2013); (Vinh et al., 2014); (Charbel et al., 2013); (Green et al., 1998) as green supply chain initiatives. The successful implementation of the above practices purely depends on identifying the critical success factors behind them. The drivers of GSCM encourage industries to adopt GSCM practices to reduce environmental hazards in their supply chain (Narwal and Dhull, 2017). During the last two decades, environmental considerations have become a significant issue in purchasing (Igarashi et al., 2013). Still in the large corporates, Greener Supplier Selection (GSS) is considered as the pivotal role to enhance the performance of green purchasing. Hence, across industry there is shift in the focus of GSCM creating value for customers and shareholders. Therefore, it is vital to identify the most influential critical factors to successfully adopt the GSCM practices within the corporates and different industries. This is an effort to sum up the GSCM practices and critical success factors highlighted in the recent literature reviews in relation to supply chain management.

Methodology

Following the systematic review of literature in the field of green supply chain management the authors identified various articles published in the area of Green Supply Chain management for a period of more than two decades (1995 - 2017). The relevant literatures were collated via online databases such as Google Scholar, Emerald, JSTOR, Elsevier, and EBSCO and in the reference lists of the articles reviewed. The initial search yielded a total number of articles larger than 50 and after screening for relevance and context; the final review consisted of 27 articles.

The categorization of the articles is presented in Figure 1 and Table 1.
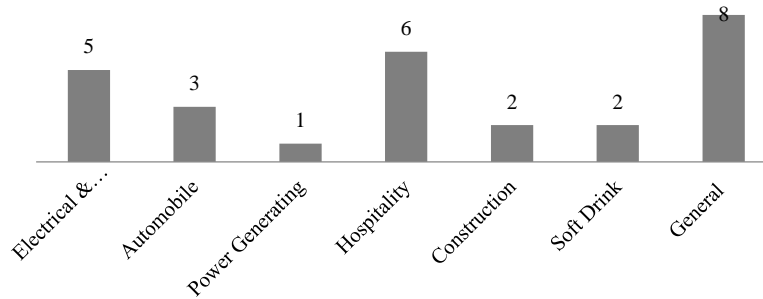
Figure 1: Number of articles referred in seven classifications

Table 1: Classification of the literature under the predefined themes

Research Study	Themes				
	OC	K	OD	MP	E
(Amemba, 2013)	x	x	x	x	x
(Balasubramanian and Shukla, 2018)		x	x	x	
(Charbel et al., 2013)	x		x	x	x
(Choppra, 2017)	x		x	x	x
(Green et al., 1998)	x	x	x	x	x
(Zhu and Sarkis, 2006)	x	x	x	x	x
(Walker et al., 2008)	x	x	x	x	
(Font et al., 2006)	x	x	x	x	
(Vinh et al., 2014)	x	x	x	x	x
(Gandhi et al., 2015)	x		x	x	
(Huang et al., 2017)	x	x	x	x	x
(Igarashi et al., 2013)	x		x	x	x
(Zhi and Chen, 2016)	x		x	x	x
(Rozar et al., 2015)			x	x	x
(Large and Thomsen, 2011)	x		x		x

Results

The systematic review conducted has derived 48 Critical Success Factors (CSFs) that might influence the adoption of GSCM practices. Specially, the recent research studies suggested that these critical success factor presence drives and absence hinder organizations in terms of adapting the GSCM practices. Therefore, it was required to identify the critical factors at the outset. These factors were further divided into sub-categories based on the underlying themes. As per the thematic analysis five themes were identified as CSFs: Organizational Commitment, Knowledge Base, Operational Dynamics, Market pressure and Exogenous.

Table 2: Classification of the CSFs under the predefined themes

Common Themes	Critical Success Factors
Organizational Commitment	Top management perception and values, Personal commitment, organizational perspectives, employee involvement, employee commitment and timeline.
Knowledge Base	Previous experience with environmental management systems, self-awareness and interest, human and technical expertise.
Operational Dynamics	Company management, material purchase, vendor allocation, warehouse, packaging, economic transport, employee management, established procedures, corporate environment policy, cost efficiency, capacity, manufacturing, use of the hazardous inputs, product recycling, size of the company, competitive advantage and brand image.
Market Pressure	Pressure by customers, customer requirements, customer focus, customer complaints and role of the suppliers, environmental collaboration with suppliers.
Exogenous (Macro environment)	Institutional pressures, competitiveness and government involvement, public awareness of environmental issues, legislative and regulatory compliances, regulations and standards.

Conclusion

The study explores the strategic importance of GSC practices in the past literature reviews and identified 48 CFs under five common themes. Findings would have managerial implications in terms of devising GSCM practices to enhance the efficiency and effectiveness of business operations. Further research can be done on studying and analyzing the critical factors for various types of industries based on the business models and should focus on the relationship between GSCM factors and practices. Further, the results and analysis can be applied irrespective of whether the enterprise belongs to the private or the public sector. This knowledge will facilitate practitioners in the field of supply chain to design and apply GSCM practices efficiently and effectively to enhance firm's financial, market and operational performance indicators.

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Abstract No: SE-09   **Systems Engineering**

Applicability of crowdsourcing for traffic-less travelling in Sri Lankan context

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Abstract

Traffic is one of the most significant problem in Sri Lanka. Valuable time can be saved if there is a proper way to predict the traffic and recommend the best route considering the time factor and the people's satisfaction on various transportation methods. Therefore, in this research using crowdsourcing together with data mining techniques, data related to user mobility were collected and studied and based on the observations, an algorithm has been developed to overcome the problem. By using developed techniques, the best transportation method can be predicted. Therefore, people can choose what will be the best time slots & transportation methods when planning journeys. The algorithm correctly predict the best traffic-less traveling method for the studied area of each given day & the given time. Throughout this research it has been proven that to determine the best transportation method in Sri Lankan context, data mining concepts together with crowdsourcing can be applied. Based on a thorough analysis by extending the data set of the collection stage, it was shown that this research can be extended to predict the best transportation method with consideration of existing traffic in all the areas.

Keywords: Big data, Crowdsourcing, Data mining, GPS

Introduction

With the enhancements of technological arena such as Internet, Wireless Communication, Big Data Analytics, Sensors Data, Machine Learning; a new paradigm is enabled for processing large amount of data which are collected from various sources. Crowdsourcing, which is a relatively recent concept that encompasses many practices. This diversity contributes to the fact that its limits are blurred, and it is usually identified with any type of Internet-based collaborative activity, such as co-creation or user-innovation (Enrique & Fernando, 2011), is one of the greatest mechanism that can be used to get a huge amount of data. Modelling big data is a current trend and combining that with the Internet of Things and crowdsourcing is an interesting area for a research work. In recent years, smart phones become prevalent in people's daily lives. With such devices it has become easy than ever of tracing people's outdoor mobility using location-based applications. In actuality, GPS receivers have no problem receiving signal as long as the receiver has at least 4 partial view of the sky. The GPS satellite constellation consists of 24 satellites (plus some spares) orbiting in six different planes. Each of these planes are inclined 55° from the Earth's equatorial plane. The satellites are positioned in their respective planes in such a manner that from almost any place on Earth, at least four satellites are above the horizon at any time (Ashby, 2003). With this configuration, every receiver is nearly always guaranteed to be in view of the minimum number of four satellites needed to get an accurate fix (assuming there are no obstructions). If enough satellites are in view, an accuracy within two meters can be achieved (5-10 meters is a realistic expectation (Wolf, 2006). This spatial accuracy coupled with GPS satellites' extremely accurate clocks allows for great representation of a user's mobility. According to Kardashyan (2011), due to the

complicated traffic networks, traffic speed and the huge number of the traffic participants, the safety cameras and other existing traffic management methods are not good enough for controlling and managing traffic in any situation and in any location. Processing GPS data encompasses the following: filtering, smoothing and interpolation. Processing is defined as repairing or putting through a prescribed procedure. Each feature individually performs an essential task that ultimately determines unfavorable attributes and either identifies them or removes them. One prime reason for the processing of a collected set of GPS streams is to replace the impossible task of visually inspecting the collection (Jun, 2005). Tripathi presents an algorithm for detection of hot spots of traffic through analysis of GPS data by analyzing two data clustering algorithms (2010): the *K*-Means Clustering, and the Fuzzy C-Means Clustering. After the clustering process stops, a cluster center can be selected, which will display the membership grades of all data points toward the selected cluster center.

In this research the data related to user locations, are collected using the devices such as mobile phones etc. which are connected to the Internet, is mined using data mining techniques and come up with an algorithm to model & analyze those big data to identify mobility pattern, determine best routes & transportation method considering traffics, transportation method satisfaction etc.

Methodology

As objectives of this research we need to experimentally determine the traffic predictions & designing an algorithm to find the best transportation method. Survey research approach was not in line with research objectives, as this study was for generating algorithms related to efficient transportation system in Sri Lanka. Therefore, Experimental research approach was more preferable in this case.

a) Data collection

Data Collection part was done by using an Android application (Figure 1) named as "Best Method". In this application the user had to choose the transportation method that the user was using and the satisfaction of current transportation method by giving a rating while the mobile phone was connected to a data network or Wi-Fi network and the status of the GPS Service was turned to on. The collected data was uploaded to a cloud storage and was used in the later steps. Individuals were asked to use this application when they were travelling between Bambalapitiya and Pettah, Bambalapitiya and University of Colombo,
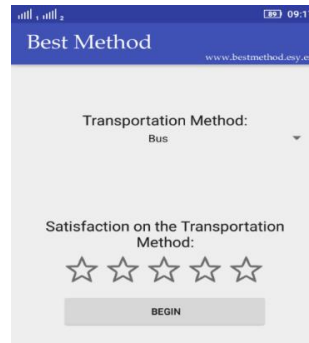
Figure 12: Data collecting app

Pettah and University of Colombo in the period of 1st November 2017 to 30th November 2017 and in the time periods of 7 AM to 8.30 AM & 5 PM to 6.30PM. The location of the device & the current date & time were picking automatically from the device. Apart from that to determine the GPS Signal strength, additional measurement was also checked how much satellites are connected to the device.

b) Processing & segmentation

Processing was done under 3 steps known as filtering, smoothing & interpolation and after that the segmentation was started. If the moving speed was <1 mph and the number of GPS data in a consecutive time period was low that data was filtered out programmatically. There was an exception when the transportation method of the filtering row was "Walking". In that case the rule of speed <1 mph

couldn't be applied. Therefore, traffic prediction was not applicable if the transportation method was walking.

c) Map matching

In the context of this system, the map-matching module was used as a refinement step to make the final adjustments to each GPS point ensuring they are usable and correct. Another purpose behind the map-matching module was to remove large portions of the collected data without jeopardizing the integrity of the data. This step performed the bulk of the logic behind all of the filtering. It turned a raw GPS trajectory into a reduced (by removal of unnecessary points) and adjusted (points were snapped to the road network) route.

d) Transport method prediction

After the GPS data was processed and verified, the remaining modules performed the tasks necessary to start training prediction models. The clustering module used the K-Means algorithm to cluster the processed data based on the location and the transportation method. The last two modules were used for model training and finally prediction/labelling. The training module currently utilized the decision tree algorithm to predict the traffic. Based on the results the best transportation was determined.

Results

At the end of the period the cloud storage contains around two hundred & sixty thousand records which contains individuals' data. The collected data set contained individuals' spatial data along with other necessary data (device ID, transportation method, satisfaction and the GPS Strength).

Initial step was to filter out the records which has weak GPS strength. Then in these filtered records there wasn't a field to say where the user was heading (i.e. the user may travel from A to B or B to A). To determine direction a script had been used based on the consecutive GPS data points of individual users. The next step was to identify the location based on the latitude & the longitude of the records. Since there was no point of analyzing each & every latitude & longitude, the GPS locations were clustered using K-Means clustering algorithm to derive the spatial data to more meaningful stage. After the new derived table was generated using the clustered data, next step was using the Google Geocoding API. Since the data set contained the geographic coordinates, reverse geocoding was used to convert geographic coordinates into a human-readable address. Then based on the average ratings of the satisfaction of the transportation method and the moving speed, the traffic status was generated. Figure 2 visualize the status of the attributes & records in this aggregate data set which is using the "Best Transportation Method" application.
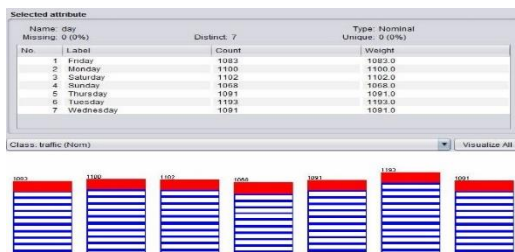
Figure 13: Visualization of the daily traffic prediction in a week

In the following visualization, represents that there was no traffic and represents that there was traffic based on the prediction.

After all these steps the derived dataset was used together with the end user application. In this application user has to select the parameters accordingly. Then based on research results the best transportation methods will be recommended.

For validation, another android mobile application was distributed to the same set of users, solely for collecting the data. In this mobile application, the user had to select the transportation method together with the current location, and whether there was traffic or not. The data was collected and stored for an additional period of one week separately from the above research data and using Weka libraries two data sets were analyzed using decision tree classification algorithm to validate the results. The original research dataset was used as the training data set and the newly collected dataset was used as the testing dataset. Based on the Weka analysis, it had given the correctly classified instances with a percentage of above 97 (97.29%). This proved that the result of the study can be validated.

Conclusion

The objectives of this research were finding applicability of crowdsourcing techniques related to user movements, identifying mobility patterns of people, identifying traffic times of the focused travelling routes and applying data mining techniques to determine traffic-less travelling. The study was done using the mobility patterns of people who were travelling in the Colombo area. After the validation process, it was proven that the predicted traffic and the recommended transportation method was the most suitable for the given parameters. Since the predicted output is valid, this research can be extended to predict the best transportation method in all the areas in Sri Lanka by expanding the data set. Throughout this research it has been proven that to determine traffic-less travelling, the data mining concepts together with crowdsourcing can be applied. By using the same original data set we can expand the research areas into few other major areas such as determining the travel patterns of people and identify the places where the people usually travel and the places which the traffic can occur regularly and take necessary action based on the outcome.

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A smart system based on wireless sensor network for monitoring and controlling mushroom growing conditions

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Abstract

The word mushroom may mean different things to different people in different countries. Mushrooms can be used as food, tonics, medicines, cosmeceuticals, and as natural biocontrol agents in plant protection with insecticidal, fungicidal, bactericidal, herbicidal, and nematocidal activities. Plant growth is affected by various factors. The most important factors for the quality and productivity of plant growth are temperature, humidity and light. This research presents the design and implementation of a smart system based on the wireless sensor network for monitoring and controlling mushroom growing conditions for farmers. The system contains five main units; namely sensing, transmission, decision making, controlling and monitoring. The system contains two main unit named as transceiver unit and receiver unit. The humidity sensor, temperature sensor and soil moisture sensor measure current environment condition and send the sensed value to the receiver unit using ZigBee. Then the ZigBee module which contains in the receiver unit receive the sensed value and gives to the Arduino board. Then Arduino board compares sensed value with pre-set value and ON or OFF pump, fan and heater automatically as well as send the SMS to farmer's mobile phone using Global System for Mobile Communication (GSM) module. Therefore, farmer is able to monitor the mushroom cultivation room in remotely instead visiting the mushroom cultivation room and can save time and labor which is needed to cultivate mushrooms.

Keywords: GSM, Mushroom cultivation, Wireless sensor network, ZigBee

Introduction

Mushrooms show an incredible impact on agriculture and the environment, and they support to build a great socio-economic impact in human welfare on local, national, and global levels (Chang and Wasser, 2017). Mushrooms are not just like plants, they derive their all energy and growth material from their growth field. Therefore in the mushroom cultivation, it is especially important to consider the environment condition of the mushroom cultivation room. When considered the environment condition impact to well growth of mushroom, it is related to the humidity level of around 95-100% and substrate (growth medium) moisture level of 50-75% (Mile and Chang, 2004). Therefore in the mushroom cultivation, there should be a correct combination among humidity, temperature and substrate moisture level.

In this research, we consider only about the indoor mushroom cultivation. In the indoor mushroom cultivation, farmer builds windowless, purpose-built buildings for cultivation. Indoor mushroom cultivation helps to tightly control the light, temperature and humidity while excluding contaminants and pests. There are six steps in the indoor mushroom cultivation (Wuest et al., 1988). They can be identified as composting, fertilizing, spawning, casing, pinning and cropping. Preparing the growth medium for the mushroom is the first step of the mushroom cultivation. Then they are placed on the trays in the mushroom cultivation room.

In the spawning stage, humidity in the room should be 70-80% and temperature should be 250 - 280. The traditional mushroom cultivators in the Sri Lanka spread wet sand on the land of mushroom cultivation room to maintain the humidity of the room environment. They also spray the water to maintain the humidity of the room. If we can automate this process to help farmers to save the time, labor.

The aim of this system is to automate the environment controller of the mushroom cultivation room. The main objectives of the system are to increase the harvest, quality of the harvest, number of the cultivators, control the pest diseases, supply according to demand and increase the demand of local and international market.

The proposed system uses ZigBee module to send the sensed values from transceiver unit to receiver unit (Chaitanya et al., 2013). ZigBee module is lower power, cost effective and it is suitable wireless option for medium range of network (Moorthy et al., 2013). Using the proposed system farmer can be monitoring the filed remotely using SMS received from the GSM module in the receiver unit. GSM can be used to set up a distance communication between farmer's mobile phone and proposed system (Mingming & Liangshan, 2010).

Methodology

This proposed system can be divided into transceiver units and receiver unit. Following Figure 1 describes the block diagram of the proposed system. The transceiver unit and receiver unit get power from battery and the battery is charged from solar panel in the daytime. The transceiver unit contains a temperature sensor, a humidity sensor and a soil moisture sensor. These sensors are connected to the Arduino board. The ZigBee module is connected to the Arduino board and it wirelessly sends the data to the receiver unit.
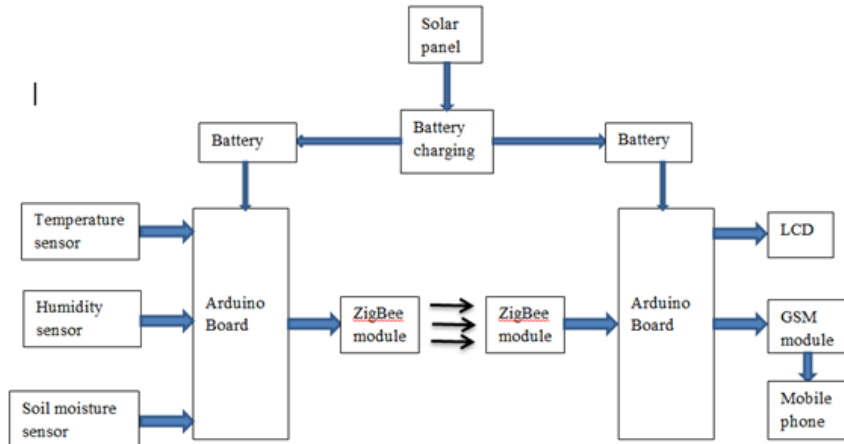
Figure 1: Block diagram of the system

The receiver unit contains a ZigBee module which receives the data and gives it to the Arduino board. Then sensed values collected from sensors are compared with pre-set values and automation is takes place. Then Sensed values and controller ON/OFF status are displayed in a Liquid Crystal Display (LCD). The automation process is taken place according to arguments in the Table 1. Then GSM module with active SIM card connected to the receiver unit sends a SMS to the farmer's mobile phone informing current status of the mushroom cultivation room. Therefore, farmer can monitor remotely the environment condition of the mushroom cultivation room without visiting site. Farmer does not need to ON or OFF the motor, fan or heater because they are fully automated on the variation of the environment conditions.

Table 1: Environment conditions and component automation process

Environment condition	Status	AC	Heater	Water pump
Temperature	HIGH	ON	OFF	ON
	LOW	OFF	ON	OFF
Humidity	HIGH	OFF	ON	OFF
	LOW	ON	OFF	ON
Soil moisture	HIGH	OFF	ON	OFF
	LOW	ON	OFF	ON

Results

The proposed system uses a prototype for testing the reliability and feasibility of the system. The prototype includes DHT11 temperature and humidity sensor and soil moisture sensor. A fan used as an AC, a bulb used as a heater, a mini water pump used as the pump and LCD for displaying the current status of the prototype. Following Figure 2 shows the prototype of the system.

Using prototype, we conducted two experiments. The first testing collected data from prototype for seventeen hours by using the control procedure. The second testing collected data from prototype for same period without using control procedure. These two tests were done to ensure the ability of the system work without any problems and how the system works to achieve its goals. Following graphs show mushroom cultivation room parameters collected from prototype with control and without control. According to following results, the research confirms that this proposed system can be used to effectively control the mushroom cultivation room environment conditions to get a qualitative harvest.

Figure 2: Prototype of the system
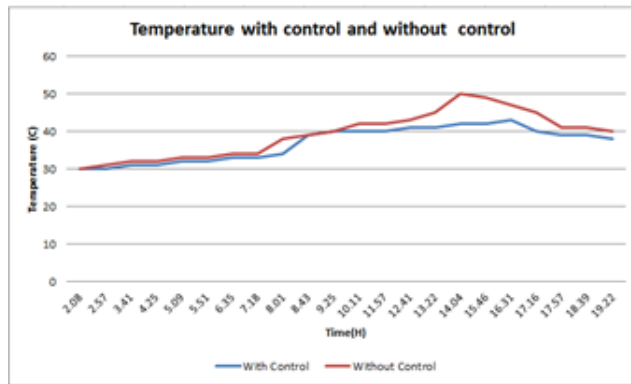
Figure 3: Temperature variation with and without control
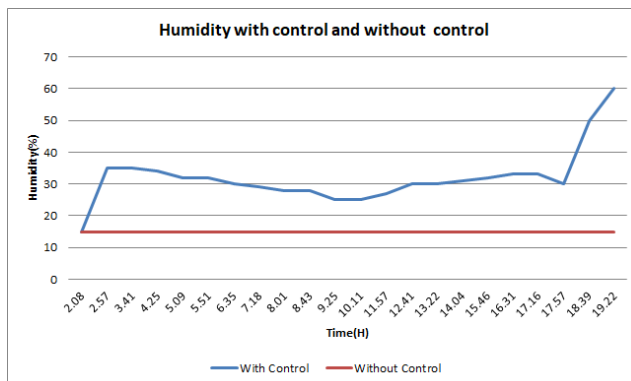
Figure 4: Humidity variation with and without control
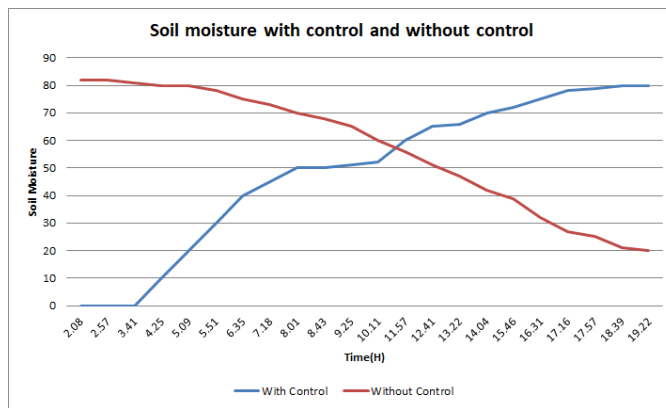
Figure 5: Soil moisture variation with and without control

Conclusion

The proposed system achieves its main goal which is environment condition control automation and other goal that is to remotely monitor the field by sending SMS to the user. This system uses a temperature sensor, a humidity sensor and a soil moisture sensor as the sensors and ZigBee module to communicate between transceiver unit and receiver unit. GSM module is used to communicate with farmer. This system helps farmers to save their time and labor and also to get a qualitative harvest without using manual ways.

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Vehicle type validation for highway entrances using convolutional neural networks

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Abstract

Vehicle type validation for Highway entrances using convolutional neural networks is an approach taken to automate the highway toll systems of Sri Lanka. Available automated highway toll systems in the world use sensor-based validation systems to validate the vehicles that are entering the highways. Mainteneance cost of these systems is high. A vision-based validation system has not been implemented, as yet. This paper introduces a vision-based method to validate vehicles for highway systems which can reduce the cost while increasing the efficiency and safety. A Convolutional Neural Network (CNN) model was developed to achieve this objective. The CNN model employed here uses a binary classification to categorize vehicles as allowed vehicles and non-allowed vehicles for entering the highway. The model developed here showed 86.69% accuracy. The model was manually tested for different vehicle types using a GUI based application and all the test images were successfully classified into their classes.

Keywords: Convolutional neural networks, Image classification, Machine Learning, Vehicle classification, Vehicle validation

Introduction

In Sri Lanka, the entrance to the toll booths for highways are manned by workers and by police officers. This use of human resoruces is costly for the Road Development Authority (RDA) of Sri Lanka and may not offer the service levels expected from users of the highway, due to worker fatigue and the monotonousnous of the task. Past incidents have proved that it is also dangerous for workers inside the toll booths, due to drunkard and sleepy drivers. As a solution, processing of vehicles entering the highway can be automated. Therefore, the RDA can use these workers for alternate work at other RDA projects. In order to facilitate, the automation process this study provides a vision-based method for validating the vehicle types that are entering through the individual booths or terminals.

As shown in Figure 1, Sri Lanka does not allow bikes, motorbikes, carts, three-wheelers, and tractors to enter the highway system. Hence it is needed to identify prohibited and non-prohibited vehicles for the highways. Therefore, it requires a validation procedure for vehicles if the entrance system of the highways is to be automated. The Convolutional Neural Network (CNN) model introduced in this research can be used to achieve this goal by reducing the cost compared to present manual system. The model only requires images of vehicles to be validated as inputs. One of the most helpful feature in CNNs is we can use them for vehicle classification without taking help of image processing to identify features. Therefore, there is no need to specify how an object looks like. With CNNs the researchers only need to concern about how they can do the classification with minimum requirement of

hyperparameters. For an example, Alexnet is a CNN trained with 1.2 million images which can classify images into 1000 different classes (Krizhevsky et al., 2012).

Figure 1: Vehicles which are not allowed on highways

Methodology

This research was done in a supervised learning manner. It contained five main parts. They are collection of data, preprocessing of data, training the CNN model, evaluation, and testing.

a)   Collection of data

The correct procedure for gathering image data for training the model was to capture the images of vehicles at the highway entrances, but it was not possible to gather a lot of images to train model in that way. Therefore, to train the model, vehicle image data was gathered from http://www.image-net.org. The images of the dataset did not have a definite size (width × height). All the gathered images were color images. The image dataset consisted 4332 images.

b)   Preprocessing of data

As the first step, all the images were taken into a definite size (100 × 100). This size was the maximum value we could obtain with the available hardware. Then, the gathered images were labelled with its authentication value for entering into the highway (i.e. ok and not_ok). Here the images labelled with 'ok' represent the vehicles which are allowed to enter into the highways and the images labelled with 'not_ok' represent the vehicles which are not allowed to enter into the highways. After that images were shuffled and separated into two categories as training set and testing set (Training set was for training the model and testing set was for testing the model). Then all the images were processed into grayscale images before feeding into the CNN. The images were processed into grayscale because it reduces the computational requirements (Kanan and Cottrell, 2012).

c)   Training the CNN model

The model was tuned by changing the hyper-parameters until a reliable model could be obtained. The final obtained model by us contained four convolutional layers, three pooling layers, and two fully connected layers. We employed Rectifier Linear Units (RELU) for activating all the convolutional layers and first fully connected layer because it increases non-linear features (Nair and Hinton, 2010). Max Pooling layers were used to progressively reduce the spatial size of the matrices, Softmax function was used on second fully connected layer to normalize the values and select values between 0 and 1. The Adam optimizer algorithm was used to optimize the model because its valuable features compared to other optimization algorithms. In order to obtain a reliable model, exponential increase in the accuracy with respect to time, and an exponential decrease in loss value with respect to time were expected (Kingma and Ba, 2015). Learning rate was chosen as 0.0001. The model was trained for five epochs until the increment in accuracy was negligible with respect to time.

Figure 2 shows the architecture of the CNN model developed with minimum hardware requirements.
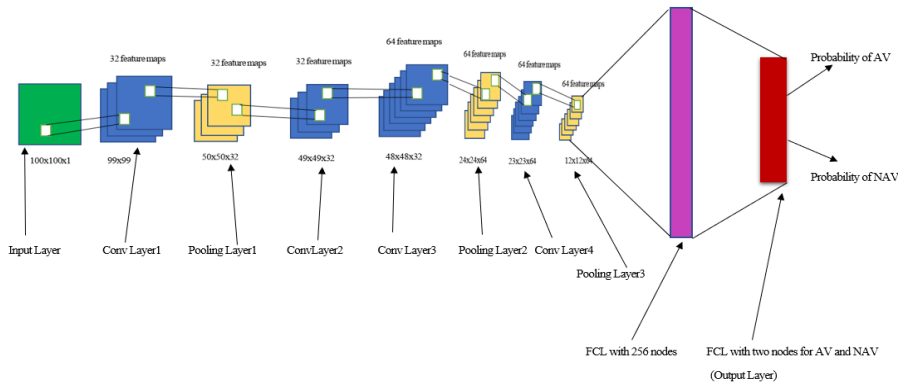
Figure 2: Architecture of the CNN model

d) Evaluation

As a result of the training process, we acquired an accuracy of 86.69%, and the loss was minimized up to 0.3242.

e) Testing

The developed CNN model was tested manually with 35 test images which are randomly selected from the highway entrance, and regular roads. These test images contained 10 images which belong to the allowed vehicle type category, and the other 25 images belonged to the non-allowed vehicle type category with 5 images for each vehicle type.

Results

The CNN model obtained through the training process showed an exponential increase when accuracy is plotted against iteration, and also showed an exponential decrease when loss is plotted against iteration. According to Figure 3, accuracy value has passed 0.800 and, according to Figure 4, loss value has decreased up to 0.3242. Tuning hyperparameters more than the achieved model did not increase the accuracy in a considerable amount.

Figure 3: Accuracy against iteration
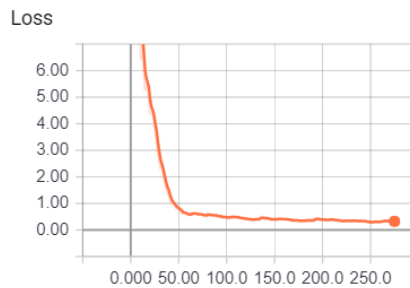
Figure 4: Loss against iteration

After testing the model, we manually checked the average accuracy given by the model for each vehicle type. The results obtained by this testing process are shown in the Table 1.

Table 1: Manually tested model results for each vehicle type

Vehicle Type	Category	Accuracy
Car	Allowed	92.69%
Scoot utility vehicle	Allowed	89.27%
Bus	Allowed	73.02%
Lorry	Allowed	71.43%
Van	Allowed	96.66%
Bike	Not Allowed	99.66%
Motorbike	Not Allowed	99.52%
Cart	Not Allowed	96.77%
Tractor	Not Allowed	92.92%
Three wheelers	Not Allowed	75.07%

Conclusion

In this paper, we developed a CNN model to validate vehicles which are trying to enter the highways in Sri Lanka. We have trained and tested the CNN model using randomly taken images which are entering the highway and vehicles which are travelling on regular roads. Finally, we were able to gain an accuracy of 86.69%. The accuracy with respect to the time increased exponentially, and the loss with respect to the time decreased exponentially giving a reliable model.

In order to implement this model, we suggest a central server-based system which is connected to every toll of highway entrances via a network. At each toll there should be a camera watching with vision-based sensors. Whenever there is any change in the vision (intensity or colour) an image is to be captured and transmitted to the central server for validation. This technique is to be planned as the second phase of this research. Using more training images, this model can be extended for a vehicle type classification which would be useful in many security purposes, intelligent parking systems and management of traffic on busy hours by directing heavy vehicles on alternate routes.

Although the vehicles can be correctly validated by this CNN model, it needs to be developed further to validate the behaviour of the vehicles which enter into the highway. For example, cars cannot enter the highway with luggage tied to the roof. But issues like this which are visible to naked eye, can be solved by training more images. However, this proposed model may not be able to validate the behaviour inside the vehicles (E.g. Illegal number of passengers in the front seat of a car).

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Abstract No: SE-12   **Systems Engineering**

Evidence of maturing of the Colombo Stock Exchange: Informational efficiency perspective

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Abstract
Due to the dynamic nature of capital markets, understanding the informational efficiency of financial markets has become crucial for investors. An implication of an efficient market hypothesis is that no excess returns can be gained from available information, since it is believed that information is priced already in the stock. The objective of this study is to assess market efficiency of the Colombo Stock Exchange (CSE) in Sri Lanka, which is one of the emerging markets in the world. In order to test for weak form efficiency, stationarity of the selected time series is tested using *Augmented Dickey-Fuller* test. Sri Lanka stock market as a whole and the top three sectors with the highest market capitalization, exhibit random walk processes. Event study methodology is used to assess semi-strong efficiency. Preliminary analysis using both market model and *GARCH* model revealed that information disclosure of the selected companies has no significant impact on the returns in the CSE as a whole or on the returns of the particular sector.

Keywords: Event study, market efficiency, *GARCH* model, market model

Introduction
The Colombo Stock Exchange (CSE) has seen investor focus ever since the end of the conflict situation in 2009. CSE has been constrained by its size (approx. rupees 3 trillion), ill liquidity and limited local investor appetite in risky assets. However, with economic development, international investors have shown interest with foreign inflows amounting to over 105 billion last year as per the latest CSE statistics. The informational efficiency of the CSE indicates that it is maturing. Initial studies suggest that CSE is not even weak form efficient (Fernando and Peter, 2014). Previous studies also report evidence to support weak form hypothesis (Fernando and Jayasinghe, 2010). Edirisinghe (2015) however, do not find support for the market becoming semi strong form of efficiency. With the change in global investor sentiment towards Sri Lanka, especially over the last 3 to 4 years, it is prudent to review whether the previous findings of weak form and semi-strong form of efficiency still holds.

Methodology
The sample was drawn from 295 companies representing 20 business sectors at the CSE. The initial sample consisted of companies that were listed during 2014 to 2016, traded actively during that period, showed unusual or unexpected changes in the dividends (a fifty percent change of dividend was considered as a change) and had high market capitalization (market capitalization to total capitalization ratio of at least 0.3. Market moving announcements such as bonus and rights issues, stock splits in a one-month window period around dividend announcements were not considered. The final sample comprised of 34 companies with a total of 65 dividend announcements. The *Augmented Dickey-Fuller* (ADF) Test was used to test the null hypothesis that CSE is weak form efficient.

A time series with a unit root is said to be non-stationary indicating a random walk process and thus an efficient market. The test takes care of the possible serial correlation in the error terms by adding the lagged difference in terms of the regressors. The null hypothesis of non-stationarity is tested in the following regression equation.

$$\Delta P_{it} = \alpha_0 + \alpha_1 t + \rho_0 P_{it-1} + \sum_{i=1}^{q} \rho_i \, \Delta P_{it-i} + \varepsilon_{it}$$

where P_{it} denotes the logarithm of the price for the ith market at time t , $\Delta P_{it} = P_{it} - P_{it-i}$, ρ are coefficients to be estimated, q is the number of lagged terms, t is the trend term, α_1 is the estimated coefficient for the trend, α_0 is the constant, and ε is white noise.

Event study methodology was used to analyze the efficiency of absorption of the dividend announcement. The event window is 10 days before the event and 10 days after the event announcement with the total event window of 21 days. From the total population, the sample set for each event is selected based on the availability of the date of the announcement of the selected event See Figure 1 for an illustration of an event window.
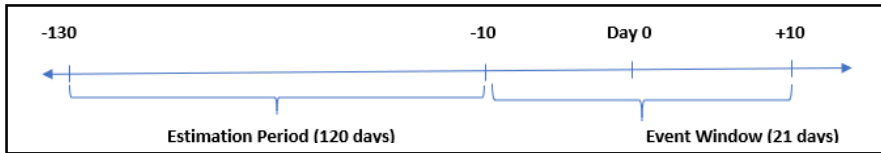
Figure 1: Event window

Estimation period is the period before the event, which is prior to the date of information disclosure and therefore has no effect on the stock price. This study sets estimation period as 120 days. Then, based on the stock price in the estimation period, a regression model is used to predict stock price movements during the event period. Taking into consideration the context of the local stock exchange, market participation and institutional activity, market model and *GARCH* model were used to determine abnormal returns.

The standard market model is used to predict the stock price and is compared with the actual stock price in the event period. The abnormal return (AR) is computed as:

$$AR_{it} = r_{it} + E(r_{it}) \tag{1}$$

Summarizing the aggregated data of abnormal returns, specifically including average abnormal returns during the event day, cumulative abnormal returns (CAR) for each listed company, and cumulative average abnormal returns (CAAR).

$$CAR_i = \sum_{t=0}^{T} AR_{it} \tag{2}$$

$$CAAR_i = \frac{1}{N} \sum_{n=1}^{N} \sum_{t=0}^{T} AR_{it} \tag{3}$$

Equation (1) which corresponds to expected return of security *i* in time period *t* is calculated by using GARCH (p, q) model given by

$$r_{it} = \alpha_i + \beta_i r_{mt} + \varepsilon_{it} \tag{4}$$

subject to condition of error term $\varepsilon_{it} \approx N(0, \sigma_{it}^2)$ where variance in the error term is

$$\sigma_{it}^2 = \gamma_{i0} + \gamma_i \varepsilon_{it-1}^2 + \cdots + \gamma_p \varepsilon_{it-p}^2 + \theta_{i1} \sigma_{it-1}^2 + \cdots + \theta_{ip} \sigma_{it-p}^2 \qquad (5)$$

Equation (4) is a simple ordinary least squares (OLS) model which assumes mean of the error term as zero and constant variance. Equation (5) models volatility expressed in terms of squared lagged error, and lags of volatility itself.

The cumulative average abnormal return (CAAR) over the window period for n number of events is given by

$$CAAR = \sum_{t=0}^{T} AAR_t \qquad (6)$$

where $AAR_t = \frac{1}{n} \sum_{i=1}^{n} AR_{it}$.

Results
ADF test is performed for the overall CSE and separately for the top three sectors by market capitalization, to assess whether share prices follow a random walk.

A unit root is found for the CSE time series and for the individual sectors time series as well, which indicates non-stationarity. This implies that the daily market indices in the selected study period follow a random walk. Therefore, there is insufficient evidence to reject the null hypothesis that the CSE is weak form efficient.

Table 1: ADF test results

	Tau *(Observed value)*	**Tau** *(Critical value)*	**p-value** *(one-tailed)*
CSE	-1.799	-3.396	0.705
Bank Finance & Insurance	-1.495	-3.396	0.826
Beverage, Food & Tobacco	-2.841	-3.396	0.180
Diversified Holdings	-2.145	-3.396	0.519

significance at 95%

Semi-strong form of efficiency
The Market model and *GARCH* model was used to assess the dividend announcements of the 34 companies. The results were assessed for the overall market and by sector. AAR and CAAR in the event window are taken with *t*-test used to test for significance of abnormal returns. Results though not shown here, indicate that the difference in price before and after the dividend announcement is not statistically significant. Hence, there is insufficient evidence to reject the null hypothesis, implying that CSE is moving towards semi-strong form efficiency.

Conclusion
The major aim of this research was to assess informational efficiency of post war CSE. The results found that there is reasonable evidence to confirm that CSE is weak form efficient. This finding is in line with some of the previous studies. However, surprisingly the results also support that CSE is semi-strong efficient. This implies that the information disclosure of the selected companies has no significant impact on the returns in the CSE as a whole and for top three sectors individually during the study period.

This further implies that the market is moving towards semi- strong form efficiency. The improved informational efficiency of CSE based on the preliminary analysis could be driven by factors such as an increased pool of investors, large increase in foreign investment, political changes and favorable government policies, investor

educational programs and CSE's improved operations and technological improvements.

The research findings of this study will be especially useful for foreign and local investors. Movement towards an efficient market implies that assets are correctly priced and if corporate governance code is also strictly implemented, liquidity of the market is enhanced and political stability is ensured, the country will be able to attract global funds to support the local corporates in the country.

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Abstract No: SE-13   **Systems Engineering**

An integration of expert systems and multi-agent technologies in online shopping

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Abstract

Online shopping is a practice of e-commerce which permits customers to directly buy goods and services from the supplier over the Internet. It has revolutionized the business over the years by making anything available at anytime from anywhere in a single mouse click. Due to the uncertainty of the customers, online shopping is not popular among the wood based furniture industry. Hence, the wood based furniture industry is limited to a small market space. The customers should search from store to store for a particular piece of furniture, because the customers do not have the facility to compare the prices as in online shopping. Therefore, this paper aims to provide a new experience for online shopping of the wood based furniture industry with the use of recent advancements in the Artificial Intelligence field such as Expert System and Multi-agents. The expert system captures the customer requirements using a simple application form and predicts the appropriate furniture that matches with the customer requirements based on the knowledge of the experts. It presents the prediction with references in order to shape the trust of the customers. The multi-agent approach is involved in the bidding process. The proposed solution will fulfil the customer expectations in online shopping of furniture industry by eliminating the uncertainty of the customers. More importantly, it models the customer satisfaction that leads to gain the customer loyalty which will be a great competitive advantage in the industry.

Keywords: Expert system, Multi-agent system, Online shopping

Introduction

The Internet connects the entire world through digital devices such as computers, laptops, smart phones, etc. which are available to anyone at any time from everywhere. This digital world is a place full of opinions, learning, ideas and opportunities that can be used at any time when necessary through a single mouse click (Oladipo et al., 2014). Therefore, people's life has become faster, smarter and less complex since the necessities such as information, digital business, bill payment, entertainment, etc. are easily accessible. Digital business is an interesting context in this digital world which provides a global exposure to businesses and it creates a market place where people can purchase products and services online (Lavendelis and Grundspenkis, 2014).

But the concept of online shopping is not popular in the wood based furniture industry because of the uncertainties that are arisen when purchasing furniture online. Therefore, when a customer wants to buy furniture, he has to visit the furniture shop to check the quality of the product that they are going to buy before purchasing (Devi and Rajagopalan, 2011). And also, the customer has to visit to several furniture shops because the customer cannot get an idea of the price and the quality of the furniture by going to only one shop. Although, the customer can compare the prices and quality in online purchasing, most of the time the customer will end up with uncertainties such as whether the selected furniture matches with other furniture in the house,

whether it matches with the wall colors and floor colors that it is going to place, whether the available space is enough to place the furniture, etc (Alasgarova and Muradkhanli, 2008).

According to the furniture shop owner's perspective, the market space is limited to the area that the shop is located since the customers use to visit to the nearby furniture shops (Gawronski, 2007). Therefore, they cannot fulfill the expectations of the customers and shape the satisfaction of the customers (Darlington, 2011). Furthermore, the furniture shops do not have the opportunity to increase their profit because the market space is limited to a very small space even in the local market and they do not interact with the global market.

This research creates a novel view of online shopping in wood based furniture industry with the use of emerging advancements in the Artificial Intelligence field; expert systems and multi-agents. An expert system is a form of knowledge processing which deals with uncertainty with the help of a knowledge base that is acquired by ruling the knowledge of the experts in a particular field (Mansiya et al., 2014).A multi-agent system is a network of agents which interact each other to solve a problem that is beyond the individual knowledge or capacities in a dynamically changing environment (Jureta et al., 2008).

Methodology
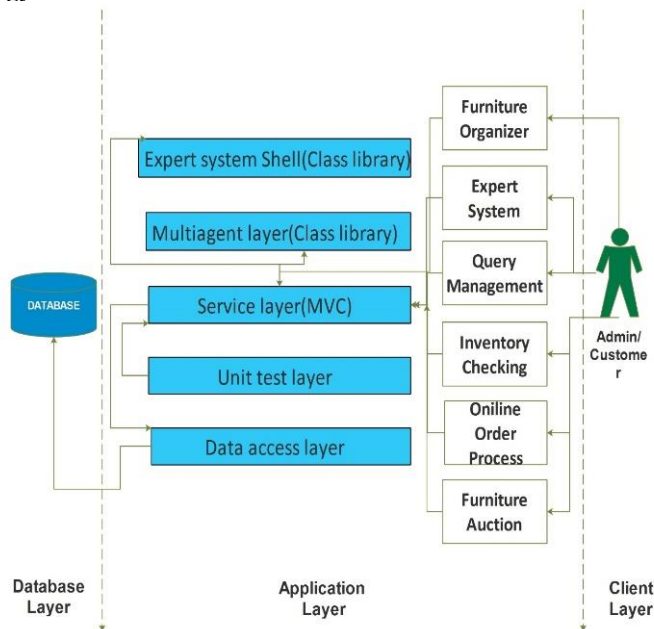
Figure 1: Overall system architecture

Figure 1 illustrates the architecture of the developed solution which consists with three main layers; database layer, application layer and client layer. Application layer is divided into sub layers as data access layer, unit test layer, service layer multi-agent layer and expert system shell. Data access layer is used for all the data access functions to connect with the database. Unit test layer is used to test the service layer functions. The implementation of functions are inside the service layer which is developed using model view controller architecture. Expert system shell and multi-agent framework are developed as class libraries in separated layers in order to avoid

overlapping of expert and multi-agent technologies. All the other layers will be added to the service layer as references.

Each user can use the expert system without logging to the system. Questions are provided in a single page with a list of possible answers. User can select the most appropriate answers according his requirements. Those answers will be queried with the knowledge base using inference engine and the system will predict the most appropriate furniture that matches to the user requirements.

As a technological requirement for the .net MVC 5 framework, a rule engine which will work as a prolog expert system shell was developed. This rule engine can be used when working with logical rules. Collections and generics of C# were mainly used for the development of this rule engine.

When the user inserts a price range, an agent will be created and it will start bidding from the minimum price to the maximum price. A super-agent will work as a manager agent in the middle and it will receive all the bids from user agents. Once bid price is received, super-agent will check it with the current bid price and if it is larger than the current bid price; received bid price will be assigned to the current bid price in super-agent and will send current bid price to all the other user agents. Once the user agents received current bid price, it will check that with the maximum bid price which the user have entered. If the maximum value is higher than the received current bid value user agent will increment the current value and send it to the super-agent. If the maximum bid value is lower than the current bid value user agent will stop the bidding and the agent object will be destroyed. This iteration will occur until the bid end time reaches and the winner will be announced at the end and after that all the agent objects will be disposed and super-agent agent will finalize the bid winner.
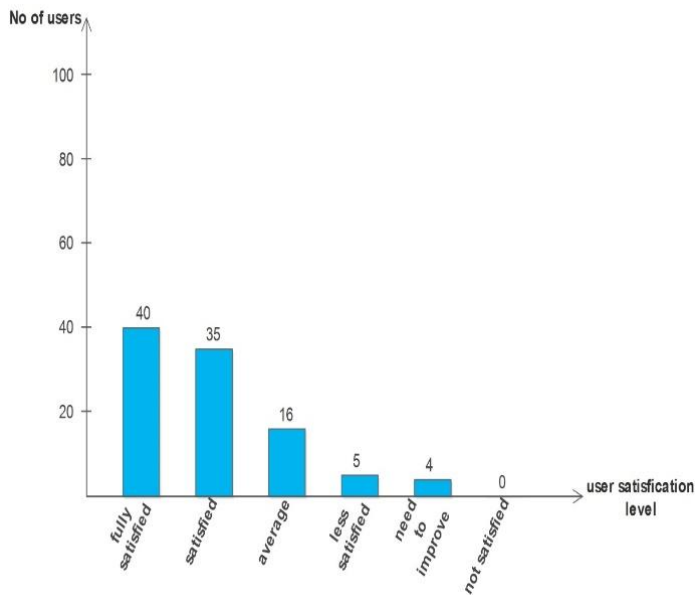
Results

Figure 2: Results of user satisfaction feedback of the system

After the implementation of the system, a feedback collection was done with the end users in order to calculate the satisfaction level of the users. The feedback collection process was held with 100 users by providing them the opportunity to rate their

satisfaction level after using the system. Results of the feedback collection process highlight that the majority of users are satisfied with the developed system. Figure 2 illustrates the summary of the results.

Conclusion

The world is moving towards the front-end base development in software engineering industry and every software architect is trying to reduce the database connection with the system in order to handle data in the application layer. Expert System and multi-agents are currently applicable in two different areas. This research builds a motivating direction to integrate these two technologies in a single programming environment while supporting all developers with an Expert System Shell to .Net version 4.5 framework and upper versions that can be used as an Inference Engine in order to fulfill a technology requirement of the .Net MVC 5 framework. The author is proposing a new concept of using multi-agent technologies and expert system technologies to handle data in the application level because, developers can make knowledge base as a class of C# rather than inserting data to database and instead of stored procedure and functions, multi-agent base business logics can be applied. Usage of artificial technologies in online shopping could fulfill customer satisfaction in many ways. This research was conducted specially targeting the wooden based furniture industry in order to increase online purchasing of customer and reduce customer uncertainty while increasing customer satisfaction. In the literature, the author was able to find out the risk of technological overlapping of expert system and multi-agent technologies but finally the author was able to develop the proposed system without any technological overlapping problem by using MVC architecture and fulfilled all the user requirements.

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Detecting plagiarism in multiple Sinhala documents

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Abstract

Availability of unlimited information resources over the Internet and the advancement of the Internet search engines such as Google to locate those resources much easily have contributed to an increase of plagiarism. Though there are a number of software tools available for detecting plagiarism in multiple English documents, no such a tool is yet available for the Sinhala language. This paper presents a novel language dependent approach to detect plagiarism in multiple Sinhala documents. It uses stemming, stop word removal and synonym replacement for text preprocessing and term frequency-inverse document frequency (*tf-idf*) and cosine similarity for similarity comparison. A prototype software tool was developed and interlinked with an operational Sinhala WordNet to demonstrate the viability of the proposed approach. The prototype tool was validated against a sample of Sinhala assignments from secondary school students. The assignments were also examined by an expert to determine whether they had actually been plagiarized. When compared the results of the prototype tool against those of the expert judgment, we found that our proposed approach for plagiarism detection in multiple Sinhala documents performs with an accuracy of over 80%.

Keywords: Plagiarism detection, Sinhala language, Sinhala WordNet

Introduction

The word "plagiarism" originated from the Latin word "*plagiarius*" meaning "kidnapper". Oxford dictionary (Oxford, n.d.) defines plagiarism as "the practice of taking someone else's work or ideas and passing them off as one's own". The plagiarism has always been a major issue particularly in academia. The availability of unlimited information resources over the Internet and the advancement of the Internet search engines such as Google to locate those resources much easily have contributed an increase in plagiarism at an alarming rate. According to a study conducted by the Center for Academic Integrity (ICAI, 2017), more than 80% of college students have admitted engaging in plagiarism at least once. Further, a survey by the Psychological Record shows that 36% of undergraduates have admitted plagiarizing the written materials. Moreover, a poll conducted by US News and World Reports has found that 90% of students believe that cheaters are either never caught or have never been penalized appropriately (CheckforPlagiarism, 2017).

Under these circumstances, plagiarism detection has been an important research area (Lukashenko et al., 2007) for many languages. The plagiarism detection approaches are generally classified as language dependent or independent approaches. Though the language independent plagiarism detection tools support many languages, they usually fail due to their inability to take language specific grammar rules and semantics into consideration. In contrast, as they focus on a specific language, the language dependent tools always perform better in detecting plagiarism.

Sinhala language which is one of the constitutionally recognized official languages of Sri Lanka, is the mother tongue of more than 16 million Sinhalese. Like any other language, Sinhala also suffers from the adverse effects of plagiarism. Though there are number of software tools available for detecting plagiarism in multiple English documents, no such a tool is yet available for the Sinhala language. On the other hand, the language independent plagiarism detection tools support many languages including Sinhala. However, they usually fail due to their inability to take Sinhala specific grammar rules and semantics into consideration.

In (Basnayake et al., 2017), a recent attempt has been made to come up with a Sinhala plagiarism detection algorithm. Though it has been successful to some extent, this algorithm can only detect plagiarism between two Sinhala documents. Further, it is not generalizable for detecting plagiarism in any Sinhala document as it makes use of a specific set of synonyms, stop words, lemmas and rules in the Sinhala language.

Thereore in this research, we have proposed a more generalized approach not just to detect plagiarism in any Sinhala document but also to examine multiple documents at the same time. The proposed approach uses a Sinhala WordNet (Wijesiri et al., 2014) to search for synonyms of Sinhala words. A WordNet is a large lexical database developed for a specific language. Nouns, verbs, adjectives and adverbs are grouped into sets of cognitive synonyms, each expressing a distinct concept (Princeton, n.d.). Though there are several attempts have been made for building a WordNet for Sinhala language, none of them are fully completed and in an operational state. Thus, we first completed a WordNet for Sinhala language and made it operational. Then a prototype software tool was developed and interlinked with the up and running Sinhala WordNet to demonstrate viability of the proposed approach. Our objective is to address the actual need of detecting plagiarism in multiple Sinhala documents.

Methodology

Initially, an operational WordNet for Sinhala language was completed. Among the attempts made by several researchers for building a Sinhala WordNet, it was found that the WordNet developed by (Wijesiri et al., 2014) is the most complete attempt. Therefore, the codebase of this WordNet was the starting point and improvements were added to it, subsequently. Then, an algorithm development for plagiarism detection among multiple Sinhala documents was carried out.

Sinhala WordNet

The Sinhala WordNet developed by (Wijesiri et al., 2014) had followed an expansion approach taking "*Princeton English WordNet*" as its source. After adapting necessary improvements to the codebase of this WordNet and then making it up and running, the crowdsourcing user interface was used to add words to the WordNet. We then started from scratch and filled the database with Sinhala linguistic words under guidance of a group of experts of Sinhala language.

Plagiarism detection algorithm

Quotes removal: This step is used to remove text comes inside the quotation marks.

Punctuation removal: Punctuation marks are removed and some special characters are handled in this step.

Number replacement: All numbers are transformed to a dummy value in this step.

Tokenization: In this step, tokens (single words) are extracted from structured text.
Stop-word removal: Wijesiri et al. (2014) have mentioned about stop words in Sinhala language. In addition to that, the University of Colombo School of

Computing, Sri Lanka has proposed a word list with their frequencies that can be used as stop words. In this step, we therefore use words from this list to remove stop words. However, we decided to limit our stop word list to 100 words with high frequencies. This decision was made after taking recommendations from the literature (Garg and Goyal, 2016) and a group of experts of Sinhala language.

Synonym replacement: Use of synonyms is a common practice in plagiarism to fool any detection attempt. In this step, words having the same or closely related meaning are transformed onto a unique identifier before making any similarity comparison.

Stemming: In this step, the different grammatical forms of a word like its noun, adjective, verb, adverb etc. are reduced to its root form. First, a list of suffixes with their frequencies were formed under the guidance of a group of experts of Sinhala language. Then, the suffixes related to this sample dataset was used for stripping.

N-grams creation: In the fields of computational linguistics and probability, an n-gram is a contiguous sequence of n items from a given sequence of text or speech. They can be phonemes, syllables, letters, words or base pairs according to the application. In this step, n-grams are created to detect the minor changes in a plagiarized sentence but not to detect any non plagiarized common phrases in it.

"tf-idf" and Similarity Comparison

In this step, a weight is assigned to each term according to its importance in a particular document. A commonly used weighting method is term frequency-inverse document frequency *(tf-idf)*, which assigns a high weight to a term, if it occurs frequently in the document but rarely in the whole document collection.The values required for calculating weights are available with *tf*idf*. Therefore, after calculating the dot products of query and document vectors, cosine value was calculated.

Design Overview
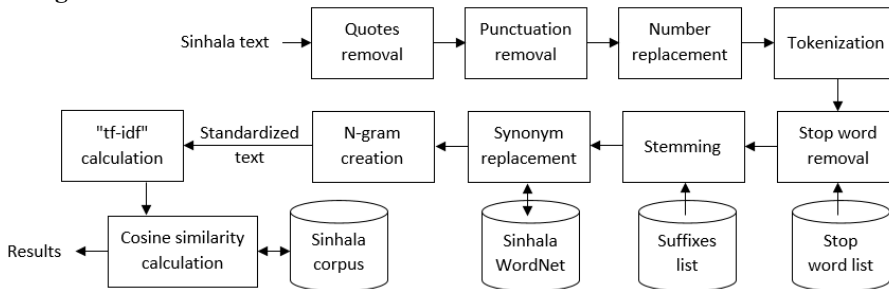
Figure 1: Design overview of the proposed approach

As shown in Figure 1, synonym replacement is getting synonyms from the WordNet. Then, the standardized text is given for the similarity calculation. In this step, similarity among multiple documents are calculated. Finally, the documents are compared with a local database by using a Sinhala corpus.

Prototype Tool

A prototype software tool was developed and interlinked with an operational Sinhala WordNet to demonstrate the viability of the proposed approach. For this purpose, Python programming language and its NLTK library was used. The prototype tool provides two functionalities. First, it compares single document with a corpus of documents. This corpus is created dynamically. Initially, the corpus is empty and when the documents are submitted for the examination, the corpus is built by storing

them in a database for the purpose of future document comparisons. Second, the prototype tool compares a set of documents among themselves and determines the uniqueness percentage and the closest matching documents.

Results

The prototype tool was validated against a sample of Sinhala assignments from secondary school students. The assignments were also examined by an expert to determine whether they had actually been plagiarized. When compared the gap/error percentage per document and calculated mean error of the prototype tool against those of the expert judgment, we found that our proposed approach for plagiarism detection in multiple Sinhala documents performs with an accuracy of over 80%.

Conclusion

In this paper, we have presented a novel language dependent approach to detect plagiarism in multiple Sinhala documents. Empirical validation of the proposed approach confirms that it performs with a promising accuracy of over 80%. Thus, we have achieved the objective of the research set out in the Introduction. However, we agree that Sinhala WordNet is required to be completely filled with Sinhala linguistics before doing any expansions and further analysis. This can be addressed using machine learning in a more effective manner. The prototype software tool developed can only compare documents with the Sinhala corpus stored locally as well as among uploaded documents themselves. Therefore as a future work, the prototype tool can be further developed to facilitate plagiarism detection in Sinhala documents by comparing them with the information resources in the Internet as well.

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Abstract No: SE-15   **Systems Engineering**

Classification of vehicles by video analytics for unorganized traffic environments

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Abstract

Traffic monitoring is essential for infrastructure planning and transportation. The objective of traffic monitoring is to have an effective traffic management system. Traffic management systems would be effective in well-organized traffic environments, where it has very disciplinary behaviors and less in inefficiencies. But in unorganized urban environments like *Sri Lanka*, road traffic behaviours are varying from standard structured ways which lead to discompose the traffic management. An effective monitoring system requires short processing time, low processing cost and high reliability. The paper proposes a novel vehicle detection and classification algorithm based on background filtering and re-engineered with suitable changes in order to be applicable to challenging unorganized traffic environments. The solution is successfully classifying vehicles individually and their trajectories in unorganized traffic environments in order to monitor the behaviors of the drivers. The system gives 74.4% average accuracy in vehicle detection and 55% accuracy in vehicle classification while counting each vehicle passed by. We used *OpenCV* functions for implementing and testing algorithms. Data was collected through pre-recorded video clips from footbridge crossing at *Colombo Fort* in western province Sri Lanka, for the testing. The ultimate objective of this research was to come up with a best-suited algorithm for vehicle detection and classification (hybrid solution) in unorganized traffic environments which would help to analyze the behaviors of road users. The solution will lead to help reduce unorganized traffic congestions by enhancing the efficiency and effectiveness of traffic monitoring and analyzing systems those are used for intelligent traffic management systems and traffic simulation models.

Keywords: Big data, Moving object detection, Traffic monitoring, Video analytics

Introduction

Traffic on local roads has reached such a level that it is necessary to address the issue of traffic congestion and seek complex transport solutions for the city. Countries suffers not only the economic losses but also many other adverse effects such as delays, inability to forecast travel time accurately, wasted fuel increasing air pollution, wear and tear on vehicles, stressed and frustrated motorists, etc.

The main purpose of this research is to devise a method to analyze challenging unorganized traffic environments in order to find solutions for the huge traffic congestion. The study came up with the most suitable algorithm for moving object tracking and classification in object rich environments. This can be used for behaviour analysis of classified vehicles, which will be an input to intelligent traffic management systems and traffic simulation models.

There are several existing traffic monitoring techniques such as Magnetic Loops, Microwave RADAR, Infrared Detectors, Ultrasonic Detectors and Camera Based Systems. In this study we used computer vision and image processing technique

which depends on video camera-based surveillance including methods for acquiring, processing, analyzing and understanding digital images. Main tasks of the video-based surveillance system are detecting, tracking, classification and activity analysis.

For the detection and tracking vehicles, we used the background subtraction method (Rakibe et. al., 2013; Collins et al., 2001) over the temporal differencing, optical flow methods (Arjun et. al., 2015; Aslani and Mahdavi, 2013). The background subtraction algorithm begins with the segmentation part where foreground or moving objects are segmented from the background. The algorithm proposed by Li et al. (2014) for study of vehicle detection and tracking phase, has been selected. Vehicles were classified into a number of classes such as motor bikes, three wheelers (trishaw), light vehicles and heavy vehicles by following the algorithm proposed by Gupte et al. (2002) where it uses the bounding box method. Then we came up with the hybrid solution which is described in the methodology.

Methodology

The experiment study was focusing on three main phases;

    a) Data collection – video capturing

    b) Vehicle detection and tracking

    c) Vehicle classification

Best suited algorithms among several approaches and algorithms were selected for this study and figure 1 illustrates the research methodology. The hybrid solution is based on the two algorithms, Li et al., (2014) and Gupte et al., (2002) which were discovered through the literature. Data was collected via pre-recorded video clips from an over bridge in Colombo fort in the western province. Vehicle detection and tracking were implemented using the best algorithm discovered which is proposed by Li et al., (2014). Testing and statistical performance evaluation vehicle detection and tracking were done afterward. With the accuracy level of the performance evaluation, the method was re-engineered with suitable changes in order to be applicable to challenging unorganized traffic environments (ex: Sri Lankan domain). In the next phase, vehicle classification was done using the selected method which is proposed by Gupte et al., (2002). Then we came up with a novel hybrid version of vehicle detection, tracking and classification algorithm by integrating both the existing detection and tracking algorithm and classification algorithm. In the final phase, the performance of the proposed system was compared with an existing algorithm's performance which is proposed by (Mallikarjuna et al., 2009) for unorganized traffic environments.
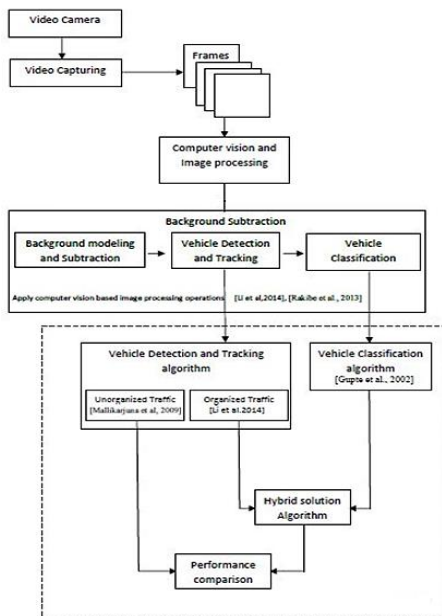

Figure 14: Methodology of the study

Results

The average accuracy of vehicle detection shows as 74.4%. It works best when the traffic scene is less crowded (accuracy 85.7%). Also, in the high density and moderate density scenarios, it showed accuracy rates as 66.7% and 80% respectively. The system was also able to record detected vehicles' classification details. Figure 2 graphs give the graphical interpretation of the results.
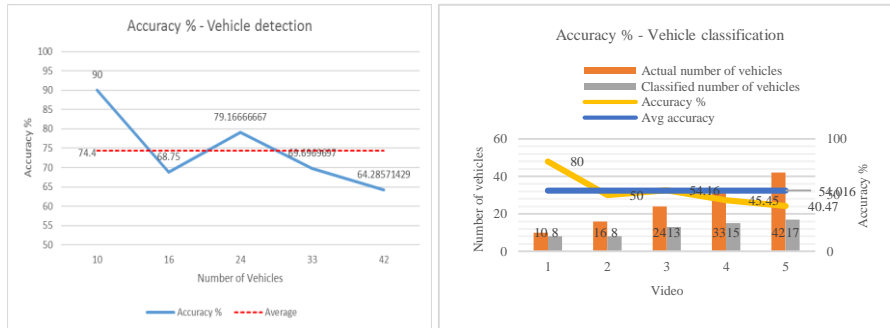
Figure 15: Accuracy of vehicle detection and classification
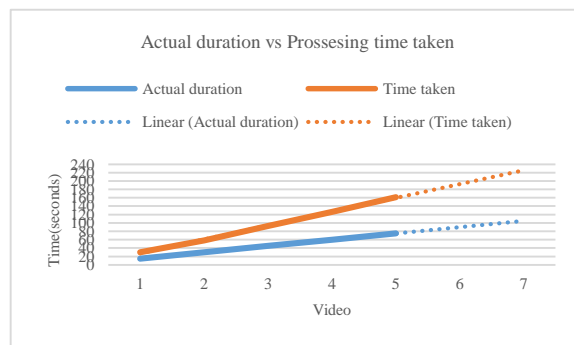
Figure 16: Video processing time with actual length

However, the processing time of the videos gave the illustrated (Figure 3) result which says it takes more time to process longer videos.

The Table 1 illustrates the successive collaboration of the study by comparing the proposed hybrid solution with other two algorithms which are discussed in the methodology.

Table 4: Outcome comparison

Algorithm	Accuracy (Unorganized traffic environment – moderate density)	
	Detection	**Classification**
Gupte et al, 2002	-	63.4 %
Li et al.2014	58 %	-
Hybrid solution proposed in this study	80 %	54%

Conclusion

The background subtraction and foreground object detection technique used is fast and found to be reliable. In this work, we have developed vehicle detector and diagonal size-based models for classifying 4 classes of vehicles –light motor vehicles

(Cars, Vans, SUVs), heavy motor Vehicles (Busses, Lorries, Long vehicles), motorized Bicycles (Two wheelers), motorized three-wheelers (Three wheelers). The detection information recorded by the system can be used to

- Find the number of vehicles present in the camera's field of view at particular time.
- It can also be used to find the traffic flow in each direction of the road.
- Classify vehicles into four categories mentioned in the above and calculate the number of vehicles in each category

The outcome of the study would be an input to traffic analyzers those who engage in decision making processes or traffic analyzing tools which are incorporated into decision making. However, partial occlusion and problems due to shadows may lead to tracking errors.

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Supply chain risk assessment model for a small scale apparel manufacturer

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Abstract

The adoption of free trade, and advances in communication and information technology and transport systems have propelled globalization of trade. Local supply chains have rapidly become complex intertwined international supply chains, facilitating efficient manufacture at very competitive rates. However, this benefit is somewhat offset by the increased risk of the complexity of such supply chains. Any disruption to them will have a major ripple effect beyond the initial direct user and have a crippling effect on the company and the national economy. Supply Chain Risk Management (SCRM), has focused on developing models and frameworks using varying techniques and tools. As a risk, it is very contextually dependent, it is a necessity to analyze risks related to different industries and organizations. The objective of this study was to develop a framework to assess supply chain risks, through a case study of a small scale Sri Lankan apparel manufacturer. A modified version of Risk Numeric Analysis model is used as the basis for developing the framework. Initially, supply chain risks were identified from the literature, using a cause and effect diagram. These risks were then narrowed down with the use of industry expertise from the apparel sector. Then, the risk assessment phase was conducted with the Analytical Network Process (ANP) as the tool. The output revealed a list of risk factors with the most critical risk at the top. The critical risk factors identified were supplier quality problems, human errors, referring to one supplier and lack of production flexibility. These factors were used to calculate a total risk score for the customer order in consideration, with reference to the output from ANP and the relevant probabilities of risks. The initial validation of the framework was done using two contrasting customer orders. i. e. successful versus unsuccessful order. The developed framework was able to discriminate the two orders with varying risk scores, making it a viable and effective methodology for assessing risks in supply chain in the apparel industry.

Keywords: Analytical network process, Apparel industry, Supply chain risk assessment

Introduction

Due to the complexities in dealing with a dispersed network of suppliers, difficulty in satisfying demanding customers, increasingly complex and unique processes, and global competition, both manufacturing and service companies are facing increasing risks of disruption to their Supply Chains (SC). This makes the term SC risk more important and significant for those companies. SC risks can be defined as an event that adversely affects supply chain operations and hence its desired performance measures, such as chain-wide service levels and responsiveness, as well as cost (Choi and Krause, 2006; Zsidisin et al., 2004). Therefore, a critical analysis of SC risks is a must for controlling the aforementioned risks. This leads to the term SCRM that can be defined as the management of SC risks through coordination or collaboration among the supply chain partners so as to ensure profitability and continuity (Tang,

2006). Hence, initial stages of the SCRM i.e. risk identification, risk assessment have to be efficiently managed in order to get a clear understanding of the amount of SC risk. In the Sri Lankan context, it is even more vital to pay attention to this SC risk component in the apparel industry, as the sector is the primary export earner for the country. The companies that are currently operating in the industry are of different scales ranging from small (employing less than 10 employees) to very large (more than 10,000 employees). Even within a company, there are customer orders of differing scales. Therefore, the supply chain risks of companies in the same industry will vary and may be having risks that are unique to them. This shows that there is a definite need for managing these supply chains to ensure them to perform their operations smoothly. Therefore, a logical framework is essential for identifying and assessing these differing supply chain related risks.

Methodology
The Risk Numeric Analysis model (Tserng et al., 2009) was used to form the basis for this study. It is a relatively complete model that begins by identifying the risk factors and continuing until a final score is calculated for the overall project. While this model was heavily used in the context of construction industry, the basic process can be used in even other sectors such as apparel.

Risk Numeric Analysis model was modified with slight changes to the steps so that it can be applied to the apparel industry as well. The modified framework considers the inter-dependencies and relationships among the risk factors. Apart from that, a proper risk identification tool has been incorporated into the framework, which can be used to identify the context related SC risks more easily and logically (Erandi and Peter, 2017). The revised framework is shown in Figure 1, below. It constitutes the risk identification and risk assessment phases in the risk management methodology.
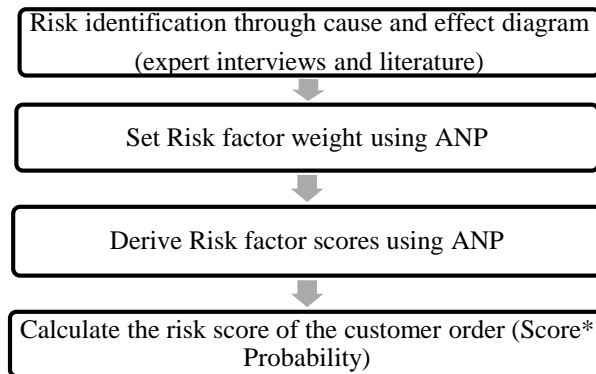
Figure 1: Modified framework

A set of risk factors was identified from the literature using a cause and effect diagram. Then the identified risk factors were adjusted and weights were derived after the pairwise comparison of factors with the assistance of experts in the apparel sector. The output was a list of risk factors with their scores, adjusted in ascending order. As the final step, these scores along with the probability of each and every risk which was obtained using data assimilated from the company, were used to derive the risk score for the specific customer order. The basis for this calculation was to consider both the magnitude and the probability of risk factors.

Results

The list of risk factors identified for a specific customer order type in "XYZ" company was as follows.
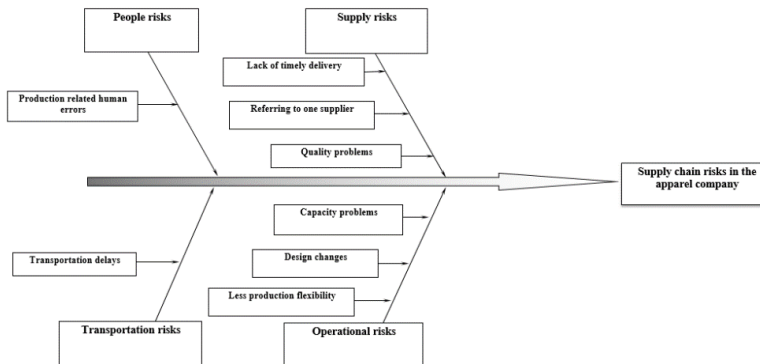
Figure 2: SC risk identification using cause and effect diagram

Then, risk scores were generated for two different customer orders that were considered as successful and unsuccessful. For this, Super Decisions software was used since manual calculation of scores using ANP is complex. Probabilities were taken with reference to the actual data. Finally, the total risk score accredited to each of the two orders were derived as follows.

Table 1: Risk score for successful & unsuccessful customer orders

| Risk factor	Risk score (ANP)	Probability	Risk score
Supplier quality problems	0.2293 (0.1546)	0.280 (0.127)	0.0642 (0.0196)
Human errors	0.1959 (0.3805)	0.330 (0.550)	0.0647 (0.2093)
Referring to one supplier	0.1276 (0.0916)	0.001 (0.002)	0.0001 (0.0002)
Less production flexibility	0.1246 (0.0996)	0.090 (0.060)	0.0112 (0.0060)
Lack of timely Supplier delivery	0.1053 (0.0793)	0.120 (0.100)	0.0126 (0.0079)
Capacity problems	0.0810 (0.0632)	0.120 (0.100)	0.0097 (0.0063)
Design changes	0.0744 (0.0763)	0.057 (0.059)	0.0042 (0.0045)
Transportation Delays	0.0618 (0.0548)	0.002 (0.002)	0.0001 (0.0001)
Risk Score of the successful/ (unsuccessful) customer order			0.1669 (0.2539)

Table 2: Comparison of risk scores of two customer orders

Risk score of the successful order	0.166931
Risk score of the unsuccessful order	0.253937

The resulting risk scores showed that the framework can distinguish between the two orders i.e. successful and unsuccessful. Based on the data gathering, it was confirmed that this order failure was due to human errors, which has been validated based on the scores, i.e. the ANP output generated from the software is same as the actual risk factors happened in the real case study. Therefore, the practitioners can use this

framework as an effective tool for SC risk identification and assessment, since this was checked for its validity and proved applicable to the industry.

Conclusion

A successful SCRM strategy is essential in each and every organization in today's modern world. Risk identification and assessment plays a major contributory role to minimize these risks and reinforces the need to have a proper framework to carry out this assessment. The employment of the framework suggested by the study provides the opportunity to identify the critical SC risks in a more logical and methodical manner. It quantifies the magnitude of each risk factor, making it easier for allocating sufficient budget for risk mitigation. The risk scores generated for customer orders can be used as signals that warn the company about the disruptions that the company may face during similar upcoming orders. This framework can be used for decision making purposes. That is, whether to undertake the orders or not by comparing with the past records of risk scores of the orders of the same scale. Moreover, this framework contributes to the limited awareness about the importance of having a proper SCRM methodology in industries in Sri Lanka, with the government's focus on making the country a manufacturing hub in the region to serve the needs of the European market, India and China.

One of the main limitation of this study is the validation through a case study. Therefore, it is recommended to use data from several companies to make it more reliable and accurate. The study described in this paper lays the foundation for future studies, including calculation of a risk score for the whole organization and thereby building a risk scale which can be used as an effective tool for decision making. This can be customized to other organizations in the same sector or in other sectors. Moreover, other advanced tools such as Fuzzy ANP, Fuzzy TOPSIS, Artificial Intelligence (AI) based models, and Genetic Algorithm (GA) based models could be used to verify the model results.

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Agent based modeling for unordered traffic in Sri Lanka – An investigation into pedestrian behavior

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Abstract

Rising traffic congestion is an inescapable condition in large and growing metropolitan areas across the world. Main entities of a traffic scenario are pedestrians and vehicles. Police make different rules to control the traffic congestions and from an infrastructure development perspective, authorities take actions to construct underground and overhead pedestrian bridges, fences along pavements, islands, etc. However, most of these initiatives end up with unexpected results, mostly since traffic congestion is an emerging macro-level pattern of complex micro-level behaviors of pedestrians and drivers. The study proposes Agent-Based Modeling and Simulation (ABMS) approach, which applies computational methods to study the issues in complex systems. When considering a simulation environment, software agents interact with each other similar to the way real world vehicles and pedestrians behave. This lets us study traffic congestion emerging as a macro-level pattern. Identifying the overall impact of behaviors of drivers and pedestrians to the congestion by extending the previous work, is the aim of this research. The research uses ABMS environment called NetLogo to develop the simulator and Kiribathgoda junction in Western Province, Sri Lanka as the testbed. Coming up with an effective traffic simulator for the unordered traffic conditions in Sri Lanka, which could be used by policy makers to analyze different traffic congestion scenarios and test different solutions to reduce traffic, is the main objective of this research.

Keywords: Agent-based modeling and Simulation, Unordered traffic

Introduction

Rising traffic congestion is an inescapable condition in large and growing metropolitan areas across the world. Peak-hour traffic congestion is an inherent result of the way modern societies operate. It stems from the widespread desires of people to pursue certain goals that inevitably overload existing roads and transit systems every day. Major reason is the unordered traffic behaviors. Since vehicles and pedestrians are the major elements act in a traffic scenario, their behaviors mainly affect to cause a traffic congestion (Banos et al., 2014). Although, the police make different rules to control the traffic congestions, since there is no way to test the result of those rules before processing, most of them have become useless. Successive governments have indicated plans of taking corrective measures but only a few had been done to take control of the present road traffic. According to latest statistics, there are 130 vehicles per 1,000 people, out of which 66 percent would be motorcycles while three-wheelers and four-wheelers (small and large) make up 45 vehicles per 1,000 people (Pilapitiya, 2016). Although there are some solutions to address this issue such as increasing the capacity of the roads, those are the most expensive solutions. However, most of them are ended up with unexpected results, because it is a macro level emerging condition which cannot be predicted.

Traffic simulation is a very cost effective and efficient way which can be used to find reasons to traffic congestions. Using these simulators, real world scenarios could be

simulated and after analyzing the output of those simulators, some strategic decisions can be applied to reduce the traffic congestions. Previous studies had considered seepage behavior of motorcycles and motor tricycles (Agarwal and Lämmel, 2015). However, since factors like pedestrian behaviors also affect the traffic congestion, these factors should be considered when developing a traffic simulator.

The aim of the study is to model vehicular traffic using agent-based modeling to simulate Sri Lankan traffic conditions by considering the drivers' behavior, pedestrians' behavior and traffic rules. Using this simulator, it is possible to simulate different traffic scenarios. After analyzing those scenarios, relevant solutions to traffic congestions could be decided. The simulator is cost effective and efficient and useful to policy makers. The user is able to control the behavior of drivers and pedestrians and can develop different traffic patterns and analyze the situations and apply strategies to reduce the traffic congestion. Therefore, it will be a valuable tool for those interested in finding solutions for traffic congestion in Sri Lanka.

Methodology

The methodology of this research study is agent-based modeling. It can be used to model complex scenarios. Although decomposition is a solution to study complex system, it is not suitable to model these kind of traffic scenarios, because it cannot produce the effect of interaction between agents. Therefore, to model the complexity of traffic, agent-based modeling is the most suitable approach, because this type of simulation is characterized by the existence of many agents who interact with each other with little or no central direction (Axelrod, 1997). Figure 1 describes the overview of the methodology.
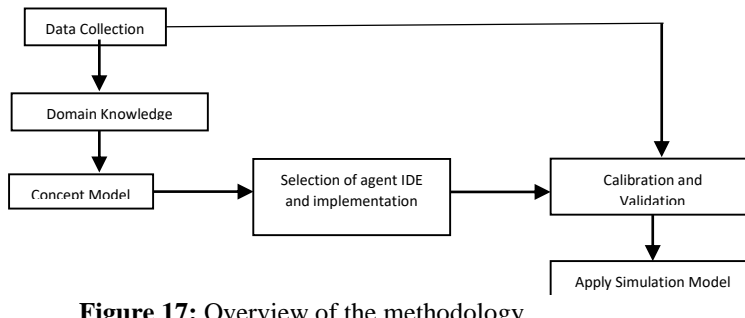

Figure 17: Overview of the methodology

Traffic is a complex and dynamic system. To model it, appropriate data should be available. Calibration and verification increase the reliability of the model. Therefore, accuracy depends on to what extent the filed data is captured by parameters. Therefore, both quantitative and qualitative data is required for concept model as well as calibration and validation. Kiribathgoda town (WP), Sri Lanka is the area chosen for the testing of the simulation tool. To identify pedestrian behaviors video capturing and observation methods were carried out in this area. Define a concept model before modeling and implementation helps to have more accurate knowledge and understanding of the simulation model. Traffic phenomena is the research domain, which is studied in this research. Therefore, the domain knowledge was acquired from the above mentioned data. From that data, the agents, rule set of each agent and the network of each agent can be identified. Then, those identified behaviors and parameters can be used to model the traffic condition in Sri Lanka. To implement the identified simulator in to a modal tool kit/IDE is needed. Popular toolkits/software are Repast, Swarm, MASON, Netlogo and AnyLogic. Netlogo was selected as the simulator.

Results

a) Microscopic validation

This is to analyze the behavior of vehicles under varying conditions. Figure 2 shows what kind of space-time diagram should be expected when a vehicle flows without any traffic jams and figure 3 shows space-time diagram when there is a traffic jam.
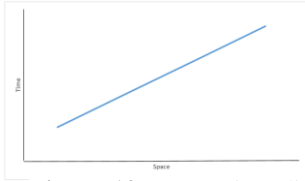

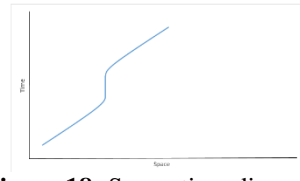
Figure 19: Space-time diagram for free-flow vehicle

Figure 18: Space-time diagram for vehicle when there is a traffic

b) Simulating the Network
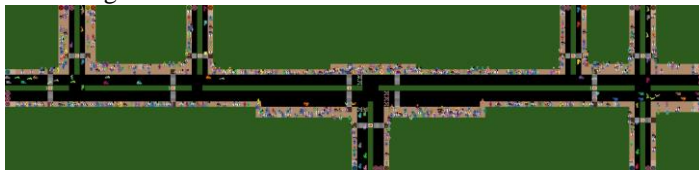
Figure 20: Simulation of test area

Simulation Parameters

- Real traffic signal timing are taken from fieldwork investigation
- Traffic flow from each side is taken from the fieldwork investigation
- Pedestrian count is high
- The simulation was run for one hour of simulated time.

Table 5: Vehicle rates for each end

	Small Vehicles (Bicycles & Three wheelers)	**Other Vehicles (Vehicles apart from small vehicle)**
East End	one for every 3 seconds	one for every 1 second
West End	one for every 3 seconds	one for every 5 seconds
North End	one for every 7 seconds	one for every 6 seconds
South End	one for every 6 seconds	one for every 5 seconds
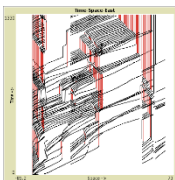
(a) East to West
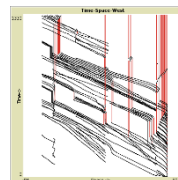
(b)East to West

Figure 21: Time-space diagrams

If two diagrams are considered together, five bottlenecks can be identified. Reasons for those bottlenecks are junctions and pedestrian crossings. On the westbound road, there are several side roads and crossings. The junction with traffic lights also affects the traffic flow. Further, there is a four-way junction at the beginning of the eastbound road. Figure 5-a and 5-b clearly imply that there is a considerable traffic jam in the two sides of the network. The solution is to remove the pedestrian crossings near the east end. According to Figure 6 the previous bottleneck, which was near the crossing is removed. However, a small bottleneck can still be identified because of the junction.

Figure 6: Space-time diagrams for solution

Figure 7: Journey time of the current   **Figure 22:** Journey time for solution

According to Figure 7 and Figure 8, the journey time of a vehicle could be decreased by removing the pedestrian crossings. Therefore, building an overhead pedestrian bridge instead of pedestrian crossing, can be consider as a good solution.

Conclusion

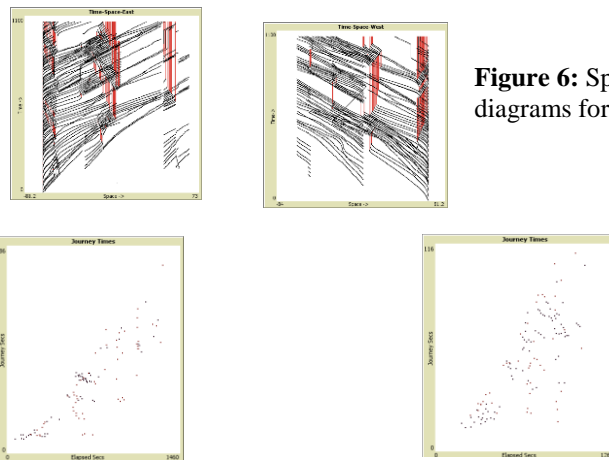In this study, a simulator has been developed using NetLogo. Apart from features developed previously (Amarasinghe et al., 2016), pedestrian behavior, and vehicular behavior when interacting with the pedestrians, are integrated into the system. The simulator has been calibrated and validated with actual data. Test result has shown that the simulator accurately models traffic flow in a variety of conditions. The simulator will a useful tool to identify solutions to traffic flow issues with users able to see visualized output of traffic scenarios. The limited number of factors modeled restricts the actual comparison between actual traffic and simulated traffic. There are limitations of the NetLogo tool, but is good to use with agent-based modeling. However, it has performance issues when it is uses a large number of agents, and the tool cannot plot three dimensionally. Some other behaviors of the pedestrians such as waiting on the island on the road and walking towards a predefined location are not considered. Pedestrians have other behaviors that have not been modeled in the study. Vehicle's interaction in an unsignalized intersection needs also to be studied and modeled and lane changing behavior of the vehicle is needed to be considered for improvement of the simulator.

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Analysis of historical accident data to determine accident prone locations and cause of accidents

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Abstract

Road traffic accidents causes great distress and destroy the lives of many individuals. Inspite of different attempts to solve this problem, it still resides as a major cause of death. This paper proposes a system to analyse historical accident data and subsequently identify accident-prone areas and their relevant causes via clustering accident location coordinates. This system, once developed, can be used to warn drivers and also to aid fully autonomous automobiles to take precautions at accident-prone areas.

Keywords: Autonomous automobiles, Clustering algorithms, Data mining, Global positioning system, Road traffic accidents

Introduction

With the growing population and the relatively peaceful global environment has provived an ideal eco system to raise the next generation of innovators. Certain items that were considered to be a luxury, have now become a common commodity among everyone. A case in point is the mobile phones, which were carried in briefcases earlier by few people, now have become a common accessory. Computers which filled rooms and could be afforded by only large corporations, is an accessory most people carry in their backpacks today. Cars can also be included in this category, with the number of people owning cards especially in Asia, increasing dramatically over the last decade or so. In 2011, it was reported that the worldwide vehicle population topped one billion units (Tencer, 2011).

With this rate of innovation, it is the responsibility of mankind to look back and try to rectify the indirect damages these innovations may have caused. This is also an important avenue of innovation. This research will be looking into vehicles that are causing physical damage to humans, apart from the numerous benefits it provides.

Road accidents are the main issue, other than pollution that can be associated with vehicles. Although we do not recognize this as a severe threat, road accidents leave a massive trail of death and severely disabled / injured people. Nearly 1.3 million people die in road crashes each year, which on average is 3,287 deaths per day. An additional 20-50 million are injured or disabled (Road Crash Statistics, 2016). This is an extremely severe situation and has a huge economic impact on society. It is difficult for countries to afford this impact as in most cases many of those directly affected are its prime workforce. There are many reasons for road accidents which include bad roads, porr training of drivers, bad weather, low visibility over speeding and drunk drinking.

Lack of caution at accident-prone locations, is also a major cause of accidents. For an example, if a specific part of a road has less visibility, and as a result, frequent accidents occur, the drivers may not anticipate such a threat unless the person is from that specific area (Esmaeili et al., 2007).

Methodology

Meshram & Goliya (2013) presented an analysis of accidents on small portion NH-3 Indore to Dhamnod. The data for analysis is collected for the period from 2009 to September 2011. It has been identified that more accidents occurred in Manpur region by faulty road geometry. The pattern of accidents occurred in urban areas (Indore) has contributed to more than 35% of the total accidents in each year. The study done states this may be due to high speeds and more vehicular traffic. In the considered study area, the frequency of accidents is, two fatal accidents and six minor accidents per week. Higher number of accidents are said to be observed from 6pm to 8pm duration because, in that time more buses travel connecting villages and the city.

Shikhar et al. (2016) presented a paper regarding data analytics on accident data for smarter cities and safer lives. The data set consists of the information related to accidents such as the type of accidents, condition of light during the accident, severity of the accident, speed zone, consumption of alcohol involved in the accident etc. The focus is laid on the application of data analytics to predict and reduce the impact of the accidents and uncover the relevant trends by training the system with the past data using decision tree methodology. The major causes leading to the accidents are identified and analysed using some of the relevant attributes such as alcohol consumption, hit-and-run cases etc.

Kaur et al. (2017) discuss predicting the probability of accidents by estimating the severity of accidents based on the type of accident and type of spot. The type of spots considered are straight roads, cross-intersection, r-intersection, y-intersection, toll plaza, narrow bridge and near the curve. The frequency of traffic collision of roads is analysed using correlation analysis and exploratory visualization techniques. They conclude that accidents on state highways occur on straight roads and on ordinary district roads, other type of spots such as cross-intersections, R-intersections and straight roads with the majority cocuring on cross-intersections. Further, the main type of accident that occurs is head on collisions on both highways and ordinary district roads.

In order to address the problem at hand, attributes such as type of accident, the type of vehicle, date and time of accident, location of accident and type of intersection should be taken into consideration by analysing the impact of them in accidents. The data set used was published by the Department for Transport of United Kingdom, licensed under Open Government License. This dataset includes 30 attributes of past accident data. The data set comprises accident data of seven years (2009-2016).
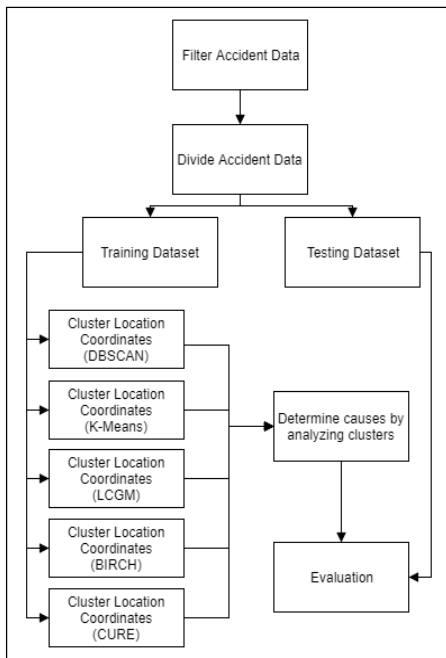
Figure 1: Steps representing proposed Work

The above mentioned dataset contains 33 attributes for each accident reported. Out of them, date, day, longitude, latitude, accident severity, number of vehicles, number of casualties, time, road type, speed limit, junction detail, junction control, light conditions, weather conditions, road surface conditions and special conditions at site are the attributes selected for the proposed solution. The main reason for selecting these attributes is because they can be used to derive a cause of accidents at an accident-prone location.

The dataset can be divided into training and testing. Two of the seven years of data will be allocated as the testing data set. The selected two years are not consecutive years. The training dataset is clustered based on their geographical location (given in latitudes and longitudes) via algorithms, DBSCAN (Density-Based Spatial Clustering of Applications with Noise), K-Means, LCGM (Latent Class Growth Modelling), BIRCH (Balanced Iterative Reducing and Clustering using Hierarchies) and CURE (Clustering Using REpresentatives) which are commonly used clustering algorithms. This solution helps to evaluate the best algorithm or the best combination of algorithms for the purpose of clustering spatial data. Once the clusters are defined, the system will analyse for clusters with common causes. Once the causes are determined, they will be cross-checked via the testing dataset. Figure 1 presents the proposed work steps.

The DBSCAN algorithm was used to cluster a segment of the accident location data. The results were plotted in a coordinate plane with the tool, Matlab. The clusters were represented in different colours which can be seen in Figure 2. The different colours can be identified via various shades of black. The small circles show coordinates identified as noise. The identification of noise is a strong suit of the DBSCAN algorithm.
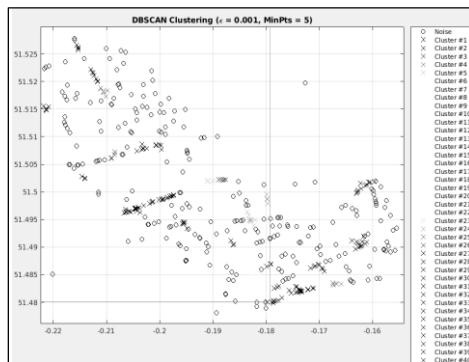
Figure 2: Accident locations clustered using DBSCAN algorithm

As mentioned in the related work, other systems classify all accidents based on attributes such as, the type of road and the weather condition. But the proposed solution suggests a system where the accidents in accident-prone locations are classified separately on attributes such as road surface condition and weather condition, in order to determine the cause of accidents at accident-prone locations. This approach gives more interpretable data.

Subsequently, a mobile application will be developed to inform the accident-prone areas and the relevant causes identified in them, to drivers before approaching them. This will be really helpful to combat accidents due to lack of awareness on the route the driver is travelling in.

Conclusion

This study discusses different attempts made to determine the causes of accidents using different datasets and algorithms and identified different causes for accidents determined such as weather, type of intersection and road geometry. It also proposes a system which can determine the cause of an accident based on historical data. These data can be used for authorities to rectify issues in roads and also for drivers to be vigilant on accident-prone areas. Further, a mobile application is proposed to aid drivers on upcoming accident-prone areas.

The proposed system is still at the concept stage and it needs to be implemented and evaluated for its efficiency. Driverless cars are an emerging field in the recent years, but it has become a reality by now. This system can be used for fully autonomous cars to take precautions at dangerous road sections. Fully autonomous cars can contribute to this system too once an accident takes place. Once such a system is introduced, it will help the community to build trust in fully autonomous cars which is a challenge faced by autonomous car manufacturers (Dikmen and Burns, 2017).

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Abstract No: SE-19   **Systems Engineering**

A solution for reducing electricity in residential sector using image processing

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Abstract

Energy saving is a critical issue that should be addressed in a worldwide scale. In the residential sector of Sri Lanka, there are many houses. Each household on average includes four people and has diverse electronic needs to be fulfilled. This paper proposes a solution to reduce the electricity consumption of residential sector. The solution has the ability to manage the use of electricity consumption of households. It identifies each and every household electric item and connects through *Wi-Fi*. Each household electric item which has the ability to connect to a *Wi-Fi* network, will be connected to the system via the routers *port forwarding* function. The user has the ability to check the system and identify which electric item is wasting energy and then the user can switch it off remotely through the system. Furthermore, the proposed solution is equipped with *image processing algorithms*. Image processing is fast, flexible and opens a whole new world of real time computer vision. A video camera located in several places in the house is used to identify presence of humans and then automatically switch off unnecessary electronic items. The proposed detection process depends on the light condition, camera angle and the efficiency of the real time detection. *Matlab's* SVM classifier people detection algorithm was used as the *image processing algorithm*. One thousand six hundred images were split equally into two data sets as images with humans, and images without humans. The analysis revealed a unique threshold value as 6 220 800 in images to identify humans images in it. In the future, the system is envisaged to connect to an IoT (Internet of Things) platform to derive more benefits to the end user.

Keywords: Energy saving, Image processing, IoT, Port forwarding

Introduction

In the past few years, many studies have come up with various solutions in order to save energy. Since it has a main impact in society's economy, the interest of many stakeholders including the Government has increased (Brandt, 2011). This study presents an optimal solution in reducing primary energy consumption in the residential sector of Sri Lanka. Energy in the form of electricity or oil is commonly used in the residential sector to operate equipment for the safety, efficiency, convenience and comfort of its occupants and users. Such equipment includes emergency systems, air conditioning system, artificial lighting, ventilation and other appliances. In Sri Lanka, electricity is the predominant form of the energy used in the residential sector. Due the lack of natural resources (other than hydro) fundamental to the generation of electricity and with energy demand rising, energy is one of the critical factors needed for the development of the economy. Image processing can be used as a means to save energy consumption (Olstad, 1991).

Methodology

Improving classifier effectiveness has been an area of intensive machine learning research over the last two decades. It has led to a new generation of state-of-the-art

classifiers, such as support vector machines, boosted decision trees, regularized logistic regression, neural networks, and random forests (Manning et al., 2009).To find the boundary for the two distinct data sets, images with humans and images without humans, the SVM approach was used. An SVM is a kind of large-margin classifier: it is a vector space based machine learning method where the goal is to find a decision boundary between two classes that is maximally far from any point in the training data. SVMs maximize the margin around the separating hyperplane. The decision function is fully specified by a subset of training samples, the support vectors. Histogram of Oriented Gradients (HOG) is one of the popular ways of deriving descriptor for a bounding box of an object (Antony & Suchetha, 2016). HOG is based on identifying intensity gradients of object shape within an image. To calculate the HOG descriptors of an image, the image is first divided into small regions and for each region histogram of gradient directions or edge orientations will be computed. Combination of all these histograms forms the descriptor at last.

HOG is calculated with the following steps:
   a) Compute image gradients of each pixel
   b) Accumulate weighted votes into orientation bins.
   c) Contrast normalization for each block
   d) Collect HOGs for all blocks

HSV is so named for three standards—Hue, Saturation and Value. It is an alternative representation of the Red Green Blue (RGB) color model. It was designed in the 1970s by computer graphics researchers to more closely align with the way human vision perceives color-making attributes. The HSV color wheel is depicted as a cone or cylinder. Hue is the main indication of color. Saturation is the amount of gray from zero percent to 100 percent in color. Value works in conjunction with saturation and describes the brightness or intensity of the color from zero percent to 100 percent.
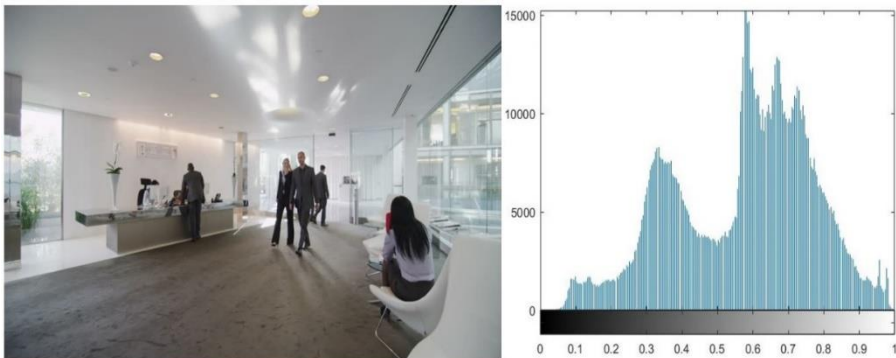
Figure 23: HSV image and its histogram

Results

Since the study is mainly focused on energy saving based on image processing, the accuracy was calculated for image processing. The study was focused on identifying human images when an image is provided. To produce an effective and meaningful value the number of array elements in the RGB matrix were calculated. When an image is input, it is transformed to a pixel matrix. Hence, from that using the "*numel*" function in Matlab, it is convenient to calculate the relevant value for a given image. 800 images which were identified by the SVM classifier as humans in it, were chosen. Then the relevant *numel* value was calculated for these 800 images. Next another 800 images that were identified by the SVM classifier as humans not in it were chosen and the relevant *numel* value was calculated. Altogether 1600 images

with and without humans were used as training data for this study. A logistic regression line was plotted for the trained data. Figure 2 shows the sample of the graph showing 1600 data points.
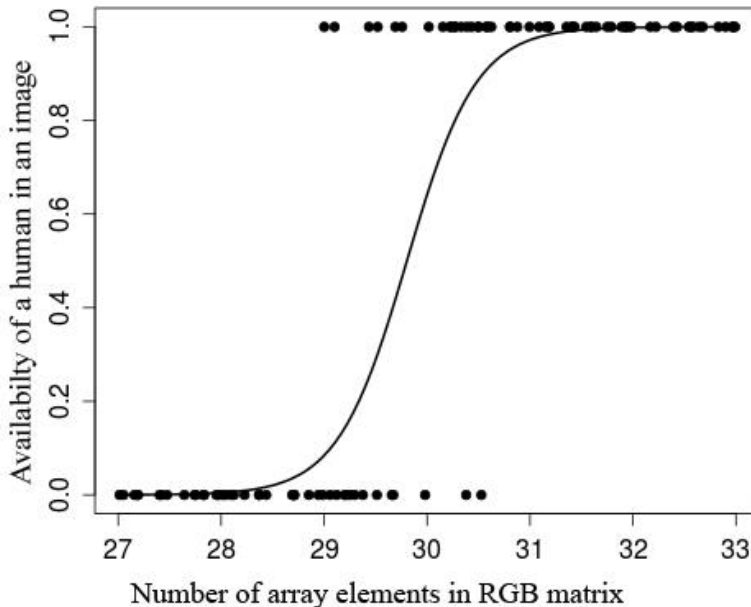
Figure 24: Sample of the *l*ogistic regression line used in this study

The threshold value obtained for this study was 6 220 800. Based on that threshold value the accuracy obtained was 67.33%.

Conclusion

The machine learning approach is a supervised learning approach conducted in order to get a classifier or a class label as the output. Since the study used 1600 training data images, the accuracy received was 67.33%. In the future, it is planned to increase the number of training images to find out whether the accuracy will result in an increment. Further, the study is to be expanded to integrate with the 'Internet of Things (IoT)' platform to benefit the end consumers. It's use could also be expanded for other uses, including possible use as an intruder alarm. When the IP camera video feed is gathered in a given time period of the day and processed it is possible to integrate a system to identify intruders in it. It will only cost an extra IP camera to be stationed at the outside of the house.

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A cross-functional collaborative model for supplier evaluation for the sustainability of a firm

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Abstract

Business organizations have emphasized the importance of sustainability in their business processes. Sustainability of a firm can be measured on social, environmental and economic benefit indicators known as "triple bottom line". Supplier selection process is one of the critical issues of sustainability activities faced by supply chain managers to maintain a strategically competitive position in the industry and supplier selection can significantly affect in achieving the triple bottom line. Given the current context, technological factors immensely affect the sustainability of a firm. Communication and web based systems related technology is a vital factor to build sustainable supply chain relationships. Thus, technological aspects can be taken into consideration under different sustainable criteria for supplier selection, though it has not been considered yet as a major factor. Analytical Network Process (ANP) has been incorporated to compute the supplier evaluated score that was computed by each department against each supplier. Then an Integer Linear Programming (ILP) model has been used to integrate the judgments of the multiple decision-makers. This research addresses the supplier selection decisions by groups of experts, which improves the quality and accuracy of the decisions made. In this model, both subjective and objective factors related to supplier selection are incorporated in order to optimize the procurement process aligning to the sustainability of the firm.

Keywords: Analytical Network Process (ANP), Group decision making, Integer linear programming, Supplier selection, Sustainability

Introduction

Supply Chain Management (SCM) is a business term which has been emerging in the past few decades and it has been gaining popularity ever since. Supply chain is comprised of all those activities associated with the transformation and flow of goods and services, including their attendant information flows, from the sources of materials to end users (Bowersox and Closs, 1996). SCM includes supplier selection and in one of the areas where a strategically competitive position for the organization could be built. Selection of the best and/or the most suitable supplier is based on assessing the supplier capabilities, which is a complicated multi-dimensional problem, as it involves number of supplier selection criteria. Sustainability is simply the long term existence of the company. When a company is focusing on sustainability, it always tries to ensure a minimal negative impact on the global or local environment, society or economy. Sustainability has become a popular buzzword, both in today's business world and within the broader facets of society. Sustainability can be incorporated into the supplier selection process, in order to improve the supplier selection process of a company. However, the idea of including sustainability as a criterion should be considered as a challenge, as traditionally, supplier selection is based on the criteria such as cost, quality, delivery etc. With increasing pressure arising from a contaminative environment and deficient energy and resources, decisions concerning supplier selection should be based not only on

operational and economic benefits, but also upon the comprehensive performance of the economy, environment and society. (Zhang et al., 2014). Sustainability is frequently interpreted as a synthesis of economic, environmental and social development, triple-bottom-line approach (Tsai and Molina, 2016). In this paper, after considering the expert views, a new variable "technology" is also added as an important characteristic for sustainable supplier selection. Currently, there is a huge reliance on technology in solving environmental problems around the world. The low level of technology more or less hinders the technical development of firms. The high level of technology facilitates both buyers and suppliers to work towards the same strategic goals. By incorporating technology, buyers and suppliers can share any business-related information and explore new markets with novel ideas and technologies.

Frequently, supplier selection is made by multiple individuals within the organization. In some cases, the number of other entities along the supply chain (e.g. customers, government bodies, buying agencies etc.) may also be involved in this decision. Most times, there is no standard method to integrate these different decisions. Each decision maker evaluates the suppliers according to their own criteria and thus may compute a performance value for each supplier. Supplier selection decisions by the diversified groups of experts, improve quality and accuracy of the decisions they make than the single person's decision. Therefore, group decision-making technique can be incorporated to integrate the judgments of decision-makers. The process of group decision making is of aggregating to a single decision based on alternative views from different stakeholders. This will aggregate multiple objective factors and subjective expert judgments to enable the strategic evaluation of suppliers and optimize the procurement process. Decision making including number of decision makers has become a current need that needs to be addressed. Since sustainability related risks arise from negative stakeholder reactions, weightings from different stakeholders should be carried out as well to obtain a comprehensive picture of the importance of sustainability (Zimmer et al., 2015). This paper addresses the issues pertaining to the supplier selection process of a company. This is successfully addressed through a sustainable supplier selection process incorporating cross functional collaboration. Sustainable supplier selection is done by using ANP and cross functional collaboration is done by incorporating an integer linear programming model for rank aggregation.

Methodology
Supplier selection is a critical strategic decision making process which directly affects customer satisfaction and thereby the sustainability of the firm. Here we propose a model where in the first step in supplier selection, the decision maker has to determine the suitable criteria for supplier selection. Each supplier is evaluated by each decision maker based on his/her experience and perception. The supplier evaluation criteria are categorized as economic sustainability, environmental sustainability, social sustainability and technological sustainability. These criteria can be further divided into different sub criteria depending on the industry. Analytical Network Process (ANP) proposed by Saaty (1996) is one of the multi criteria decision making techniques which considers the inter dependency among different criteria and the alternatives. Analytical Network Process (ANP) is known as one of the suitable methods to priorities suppliers or to evaluate the suppliers subjectively as it considers the interdependencies between criteria and sub-criteria of supplier selections. ANP gives more realistic results than traditional methods such as AHP since it is capable of defining interdependencies among criteria and handle both quantitative and qualitative criteria when evaluating supplier's performance (Onder and Kabadayi, 2015). There are mainly six steps in ANP. They are a) define decision problem, b) determine dependencies among clusters (outer dependence) and

elements of the clusters (inner dependence), c) pairwise comparisons of the elements and clusters, d) determine the supermatrix and weighted supermatrix, e) calculate the limit supermatrix and f) select the best alternative.

Supermatrix is formed based on specific network structures and then, weighted supermatrix is derived by transforming all column sums to unity exactly. Next, the weighted supermatrix is raised to a limiting power to get the global priority vectors. Knowing the advantages of ANP, supplier selection process can be carried out as above by the multiple decision makers in the procurement department and the other related departments using ANP and it enables to consider the subjective and objective criteria to evaluate each supplier. Let us assume that the evaluated score of the ith supplier by the jth decision maker as r_{ij}. Different decision makers are given different weightage for the selection process and the weightages are denoted as y_j then the weighted aggregated supplier performance Y_i is computed as follows:

$$\sum_{j=1}^{m} (r_{ij} * 1/y_j) \quad = \quad Y_i \qquad i = 1 \dots\dots n$$

Table 6: ILP model for group decision making

	DM1	DM2	DM3	DM4	DM5	**Weighted Average**
Weightage	**y1**	**y2**	**y3**	**y4**	**y5**	
Supplier1	r11	r12	r13	r14	r15	Y1
Supplier2	r21	r22	r23	r24	r25	Y2
Supplier3	r31	r32	r33	r34	r35	Y3
Supplier4	r41	r42	r43	r44	r45	Y4

Yi - Aggregated reciprocal weightage given for supplier i
DM - Decision Maker   rij - Rank of supplier i by j^{th} decision maker
yj - Weighted value given for the jth decision maker
n - Number of suppliers   m - Number of decision makers

An Integer Linear Programming (ILP) model has been developed to minimize the deviation between the individual supplier performance value and the weighted average value. Since the objective function is to minimize the rank value, the reciprocal values of the weightages was considered. This emphasised that a decision maker who has a higher weight should be assigned with a minimum value in order to minimize the deviation. The proposed ILP model is given below:

Objective function

$$Min \, Z = \sum_{i=1}^{n} \sum_{j=1}^{m} \left| (r_{ij-} Y_i) X_i \right| \quad ------(1)$$

Subjected to,

$$1 \leq Xi \leq n \quad \forall \, i(1,2,\dots\dots,n) -------------(2)$$
$$Xi \neq Xk \quad \forall \, i, k \text{ such that } i \neq k ----------(3)$$
$$Xi \text{ is integer } \forall \, i(1,2,\dots\dots,n) \quad ----------(4)$$

Equation (1): The objective function of the model which minimizes the deviation of the final ranking from individual rankings from different decision makers.
Equation (2): Restricts the ranking of n suppliers from 1 to n only.
Equation (3): Ensures that no two suppliers are given the same rank; hence every supplier is given a different rank.
Equation (4): Integer value of the rank is ensured.

Results

The above proposed methodology is applied to a company and different department decisions are derived by using "Superdecisions" software for ANP. Then, the different supplier ranks from different departments are integrated using Excel Solver for ILP. Finally, the best supplier will be selected by integrating ANP and ILP.

Table 2: ILP model using Excel Solver

	DM1	DM2	DM3	DM4	DM5	Weighted Average	Collaborative Ranking
Weightage	0.1	0.4	0.3	0.15	0.05	1	
Reciprocal	10	2.5	3.33	6.67	20		
Sup1	4	4	2	1	2	103.33	3
Sup2	2	3	1	2	1	64.17	4
Sup3	3	2	3	3	4	145	1
Sup4	1	1	4	4	3	112.5	2

Conclusion

Integration of sustainable supplier selection and collaborative group decision making technique was very successful in the above research. The outcomes were more applicable and tested to a real world scenario. The proposed approach will be useful to many organizations who are seeking new ways to build a good procurement system, in collaboration with multiple players in the decision making process while addressing the sustainability of the firms. However, one of the main limitations of this study is, data have been gathered from only one company. Most importantly, the ANP model will be more reliable, and successful, if it has been modeled using the data, knowledge and experience of several companies and their supplier evaluation processes. But the study has been carried out successfully with the use of even one company. If a further study will be conducted in this area, it is highly recommended to collect data from several companies for several requirements, and calculate the percentages of successful applications or deviations, so as to make the model a more generalized one. Furthermore, an algorithm can be developed to solve the ILP model using CPLEX which is much more efficient and accurate.

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A study on classifying the store positioning from the transactional data

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Abstract

This paper describes a customer analysis for store positioning, using data gathered from supermarkets in Japan. Among the retail industry in Japan, there are many types of reward cards used for customer retention purposes. The rewards cards or "Point Card", is originally aimed for customer analysis purposes, but at present the full benefits have not been extracted due to issues in data analytics. This reward card has only become a method of simply distributing "virtual money" to the customer. For the efficient use of gathering data, we propose a classification method of the customer based on the objectives of visiting stores. In this study, the customers were classified into their objectives.

Keywords: Data analyis, Machine learning, Retail, Service science, Management engineering

Introduction

There are so many rewards cards distributed in Japan. This card can provide us customer profiles using the gathered data. However, the retail industry has not been able to use the gathered data, efficiently. The data captured includes; Who, When, Where and Which items and Customer spend. This paper attempts to capture the customer profiles by their objectives of visiting the store and then merging with the POS (Point of Sales) data. Hereafter, we define the merged data as ID-POS (IDentification Point of Sales) data.

The rest of the paper is organized as follows: Methodology discusses the research backgrounds and related work; Results section briefly summarizes the data on the target sector and describes the analytical results and gives some concluding remarks and future work.

Methodology

ID-POS data was gathered for this study over a four week period. Table 1 shows attributes of gathered data. Then, it was classified into four categories based on the monetary value. a) Upper, over JPY 25,000 spent b) Middle, from JPY 10,000 to JPY 24,999, c) Low, under JPY 9,999 and 4) Non-member, respectively. Table 2 also shows the summary of the data. Further, characteristics of the three levels of customer was analyzed. Cluster analysis was used to assess the data. This method is one of the unsupervised learning in Machine Learning. The primary goals of cluster analysis is to group objects based on their characteristics. The process of analysis is a) grouping object (whether to classify the samples or variables), b) identify classification type (hierarchical or non-hierarchical), c) measure distance between objects for classification (assess data similarity i.e. Euclidean distance, Mahalanobis distance, Cosine distance and so on), d) use merging cluster methods (Ward method, Group average method, Shortest distance method, Longest distance method and so on) (Everitt, 1993; Zumel & Mount, 2014).

This paper employs hierarchical data classification while object distances is made using Euclidean and Ward method for merging clusters. As for the number of clusters, this depends on the heuristics with some methods used to obtain optimal number of clusters. This paper employs the CH (Calinski-Harabasz) standard.

The intra-cluster distance sum of square focuses on the cohesiveness of the data in the cluster, The CH standard considers discrete nature between clusters in addition to cohesiveness in the cluster. Therefore, this paper employs the CH standards (Everitt, 1993; Sterne, 2017; Dorismond, 2016).

Table 7: Attributes of gathered data

Store	**Aruk Kotoshimba, Yamaguchi, Japan**
Term	2017/11/18-2017/12/15 (4 weeks)
Source	ID-POS data

Table 8: Transactional summary

Member Category	Monetary (JPY)	Amount (Person)	Deal (Records)	Unit Deal (JPY)	Purchased per Deal	Price per Item (JPY)
Upper	25K =<	1,530	20,662	3,098	15.8	196
Middle	10K =<	2,869	18,794	2,402	12.8	188
Low	1 =< -	9,392	20,256	1,710	9.5	180
Non-Member	-	-	23,206	1,677	8.4	198
Total	**-**	**-**	**82,918**	**2,204**	**11.5**	**191**

Results

From the result of the analysis, the number of the cluster were decided as six groups. They are,

   a) **Vege-Daily**: Primary purchase is vegetables and dairy products such as milk, butter and so on; High membership ratio and high monetary purchase volume
   b) **Veggies**: Primary purchase vegetables, High membership ratio
   c) **Daily**: Primary purchase dairy products; High membership ratio and high monetary purchase volume
   d) **Foods**: Primary purchase foods such as salt, sugar and so on, Low membership ratio,
   e) **Snacks**: Primary purchase snacks; Low membership ratio
   f) **Delica**: Primary purchase delicatessen, Low membership ratio.

Table 3 indicates the clustering summary. Primary purchase category is indicated as a percentage. According to the results, following clusters are distinguished by their visit purpose as follows,

   a) **Vege-Daily**: Correct food purchase combinations, their visit purpose fit for the stores' original store design
   b) **Veggies**: Since they need more foods, they often hop around the shops
   c) **Daily**: Since they need more foods, they often hop around the shops
   d) **Foods**: Their visit purpose is aiming for the target food purchase such as price down sales
   e) **Snacks**: Their purpose is aiming for the snacks purchase like at the time of coming home from the school
   f) **Delica**: Their purpose is aiming for the delicatessen purchase. This category contains the prompt meal, frequently supported by the two-income family.

Table 9: Clustering summary in category

Cluster	Veggies	Fish	Daily products	Delicatessen	Foods	Snacks
Vege-Daily	26.4%	6.7%	21.3%	5.2%	9.7%	7.9%
Veggies	70.8%	2.3%	8.5%	1.5%	4.3%	3.9%
Daily	5.9%	2.2%	64.0%	6.6%	6.9%	5.7%
Foods	5.8%	2.4%	13.7%	6.4%	56.8%	4.8%
Snacks	5.1%	2.4%	14.8%	9.7%	13.4%	46.1%
Delica	5.9%	2.9%	9.5%	60.2%	5.6%	4.5%

Table 10: Clustering summary in transaction

Cluster	Unit Deal (JPY)	Purchased per Deal	Price per Item (JPY)	Member ratio (%)
Vege-Daily	2,822	13.9	203	79.5%
Veggies	1,989	12.1	164	78.9%
Daily	1,695	9.6	177	72.5%
Foods	1,887	9.3	203	65.4%
Snacks	1,741	9.4	185	65.1%
Delica	1,644	7.5	219	58.3%

Conclusion

This paper presents the customer classification using the data gathered from the supermarkets in Japan. Since the primary issue of the research background was facing the complex business problems such as the competing neighbour stores and the declining population and the ageing society, we had to organize the issue for the setting the corporate strategy. We analyzed the transactional data with the customer ID to capture the customers' visit purpose. At first, we classified the customers into the monetary based category. From the result of this classification, this store is insufficient the high monetary volume customer. This result depicts the monetary volume for this store is not Pareto optimal. Pareto optimal includes the 20% of customers constitute the 80% of sales. Then, we need further analytics for capturing the purpose visit. This time we employ the clustering method, one of the machine learning, un-supervised learning. From the result of analyses, six clusters are made by the CH (Calinski-Harabasz) standard. Here is the result of cluster: 1) Vege-Daily, 2) Veggies, 3) Daily, 4) Foods, 5) Snacks, and 6) Delica, respectively. They are originally divided into two visit purposes, such as a) the original store objectives and b) the Convenience store like visit purpose. Especially b) type purpose was indicated low percentage of the membership, the company requires more invitation for the customer enclosure. As for the rest of the cluster, this result makes use of the inventory design, the item recommendation knowledge. This clustering method is also make use of the store comparison with their store positioning. This is aiming to re-design the business strategy facing with not only the neighbour competition, but the B2C industry, the invisible store competitor.

Our future work will include; 1) parameter tuning for the accurate classification, 2) examine another method such as an xgboost, and 3) generate new patterns with meta-heuristic algorithms. This work will require practical experiments and further survey.

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Abstract No: SE-22   **Systems Engineering**

Utilizing mobile based technologies in monitoring solid waste in Sri Lanka: A case study

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Abstract

An exponential increase in solid waste is a crucial concern for all citizens including policy makers. This issue has been building up over a period of time due to inadequate planning and implementation of measures to segregate, collect, tranbsport and dispose solid waste in the country. Despite many initiatives being taken to resolve the problems associated with the collection of waste, the issue of piled up garbage has been a common site. Though technology has advanced and unlike previously many people have access to it and use it, the use of such resources to solve daya to day problems of citizens is poor. Therefore, the current study was focused towards the technological approaches over the collection of solid waste that accumulates more in urban areas, especially in Sri Lanka. IoT, GPS, Geo-fencing and RFID is incorporated to design a model for the successful collection of solid waste on a timely efficient manner. It is expected that the solution will enable customers and policy makers the ability to address this important issue and ensure that the environment is kept clean. In addition, this model will function with minimum cost and will take only minimum to time for customers to use.

Keywords: Geo-fencing, GPS, IoT, RFID, Solid waste

Introduction

It is significant that the rapid urbanization seen in most developing countries are directly associated with the increased tons of solid wastes generated from households and industries. However, disposal is not carried out in an environmentally acceptable manner in both spatial and temporal basis. Due to this improper mechanism and lack of concern of people, they face issues of loss of bio-diversity, land and water pollution, ground water pollution and spreadg of diseases. Currently, monitoring and collection of solid waste from various sites are quite tough as the generation of solid waste has grown exponentially. Additionally, on special days such as when ceremonies, functions, festivals and holidays take place, the generation of waste is at a peak. Schools, NGOs, hospitals, factories and companies are the places where such generation is at a peak. Unless regular supervision is carried out at frequent intervals, wastage can pile up in public places and cause inconvenience to the public. Although, the local authority is faulted for improper collection, the effects of such inefficiency is a threat to everyone. For the municipalities, the difficulties as well as challenges of solid waste management are continuously increasing due to this urbanization (Cheng and Hu, 2010). Disposal of solid waste is an urgent environmental issue in Sri Lanka and at present it has become a national concern, as well. Hazardous solid waste disposal has been identified to be one of the major causes for environmental degradation.However, in the National Action Plan of Sri Lanka, the most common method of municipal solid waste (MSW) disposal still remains to be open dumping (Bandara, 2010). The issue of MSW is most acute in the Colombo municipal area and in the suburbs of Colombo. The residents should take responsibility for their own

waste and be responsible to pass information to the relevant authority for collection. Technology is an effective tool to use to link customers with authrorities to collect and dispose the waste. The primary objective of this study is to develop a system to manage solid waste from collection to final disposal using technology such as GPS, IoT, RFID and Geo-Fencing.

Methodology
This section covers the main factors which influence more on the waste accumulation in most of the territories and their impacts to the environment as well. In addition, this accumulation can be cut down for certain extent while combining technologies especially mobile based towards the successful collection in Sri Lanka.

Influencing factors on solid waste generation
Waste collection and management planning are needed with the adequate knowledge of the waste generated and its composition in the particular location. Along with the mean living standards of the people this can be varied in territorials. Not only that the income level of the individuals, socio economic factors such as cultural patterns, education and attitude towards the society contribute more on the accumulation of waste in a nation. However, per capita retail sales and tipping fees are the significant determinants of waste generation and that income, urbanization, manufacturing and construction do not significantly impact on the waste generation rates. Review of Bandara et al., (2007) showed that per household generation of organic waste increases with increase in property assessment tax value or income level. This is explained by the relatively high food consumption trends of higher income groups. A clear increase in the generation of paper per household with the increase in property assessment tax value or income level while the trend was vice versa with the glass, plastic and metal waste. Moreover, the number of employed people in a household was also shown to be a contributing factor to waste generation.

Municipal solid waste composition in Sri Lanka
MSW of Sri Lanka typically consists of a very high percentage of perishable organic material which is about 65 – 66% by weight with moderate amounts of plastics and paper and low contents of metal and glass. The moisture content in the MSW is also very high between the ranges of 70 – 80% on a wet weight basis (Ministry of Forest Resources & Environment, 2000). The Local Authorities (LAs) are responsible for the collection and proper disposal of waste generated by the people within their territory. Hence, Solid Waste Management is not given much priority within the Local Authority and the budget allocation is rather limited.

Needs for incorporating technologies
In Sri Lanka, public participation towards the successful waste collection and disposal are very much lack in all the parts of the country. Handling and managing are entirely burdened to the Local Authorities which is beyond their limit to manage properly due to the resource and financial constraints. Therefore, there are chances to pile up the wastages by roadsides or abandoned lands. Numerous actions have been taken by the local authorities, governmental and non- governmental organizations to implement the Integrated Waste Management. However, initial step of collection of waste is not properly carried out in most of the urban sites. Nowadays, waste is disposed after recycling to the Land Filling Sites and produced Bio-Gases too. However, the need is there to collect the discarded things at the time of generation and transport towards the proper places. For this gap, technologies can be promoted to bridge between the local people and the local authority to ensure their presence on time for the collection of Solid Wastes.

Approach on developing sstem to collect the solid waste

An innovative and unique approach of the Smart System provides more benefits to both Local people (Users) and Municipal Council / Local Authorities (Administrators) as the solution of identifi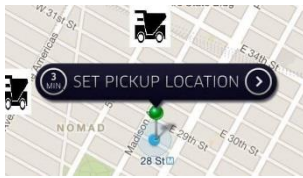ed problems in the previous research activities in Sri Lanka. Therefore, IOT, RFID, Geo fencing and Navigation via the GPS which are easily designable towards the Mobile Applications while those are rare in the usage in Sri Lanka, as well.

Figure 1: System Architecture Diagram

Approaches on users

User can be either individual or the person from local authority who access the system by means of Mobile Application. And also, there is no any need that the author should register in relevant authority.

Mobile applications, IoT and RFID

Internet of Things (IOT) can be incorporated with the Cloud Based Smart Parking System where Smart Phones, GPS and servers relevant Cloud based System can be connected together as the Physical Objects and forms the network where it functions as the automatic system with the use of Radio Frequency Identification (RFID) Technology (Thanh at el., 2015). This method is useful universally and more secure with three different units named as Transceiver, Transponder and Antenna. Here, the Transceiver is used to send the information form the unit of Transponder which contains the coded data received by the Antenna. Secondly, Active Transponder is Re-Programmable via the WIFI Networks while the Passive Transponders are unlimited in its longevity (Mohd et al., 2009). Therefore, RFID sensors can be installed with low cost and detected with the high speed.To accomplish this, RFID tags can be installed at specific distance from one another, for example, every 200 meters while the dustcart has a reader installed on it. Every time the dustcart passes by the tags, the reader picks up the signal codes and sends it to the monitoring system at the central office. To know where a vehicle is, the last code sent in is checked against the database which contains the position detail of each tag.

GPS tracking system and geo fencing

Tracking system based on GPS can be used in knowing the position of a dustcart at all time. To achieve this, a GPS tracking device is installed on the dustcart, and the information about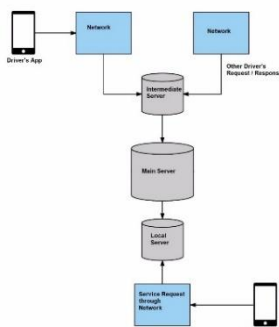 its location made available to the central office. To transfer this information, it is possible to use satellite transfer method or to transfer through a mobile network. For this subsystem, the mobile network transfer method shall be used because it is less expensive than the satellite transfer method, and mobile network is readily available, without any need for installing any expensive components or dealing with complex maintenance problems (Hwang et al., 2012). However, Geo Fencing Technology had not been used for Solid Waste Collection in Sri Lanka. So far, it is very conducive to implement towards the car owners in convenient way. Location Based Services are sent as the massages to the smart phones which facilitate to locate and identify the vehicle of the MC available

Figure 2: Mobile user interface

in close by area by the driver of the vehicle when using the GPS and GPS coordinates through the Google Maps. Therefore, User can locate the suitable vehicle using Smart Phones. In addition, duration of Geo Fencing could be limited by the administrator

by specifying expiration where location of the MC vehicle could be identified in a wider radius using Geo Fencing. It is adapted in this system of Mobile based System due to the lowest power consumption and also User can view it even in the rural area, to locate and identify the nearby vehicle/ dustcart which is suitable to the User, as well. In contrast, most of the other data transactions are defining the boundaries by longitude and latitude or through User-Created and Web-based Maps.

Functions of the intergraded technology in solid waste collection
During the peak piling hours in the public places, any individual who has installed the android application (App) which is available in the Play Store can be accessed for the needed services. While logging into that, user would be automatically pointed out his location (GPS tracking) which is relevant to his authority or not. Within the particular radius, the track/vehicle which is available for the waste collection would be identified and clicked immediately. While clicking, person who is responsible for the waste collection within the area would be given notification through the recognized RFID. Therefore, there is a chance for the particular vehicle/ dustcart to ignore or accept the notification based on his services in somewhere else. If the person notified with "Yes", then he should visit the place on time and collect the waste as soon. Otherwise, if he is notified with "No", User can try for the next radius for another MC Vehicle/dustcart. There are some possibilities that the Authority can click "Yes" and be irresponsible on his services. On that time, system would send the notification again and again while the individual clicking it for the delayed visiting towards the place or else, individual can take action over the relevant authority for their irresponsibility.

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A data mining approach for the analysis of undergraduate examination question papers

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Abstract

Examinations play a major role in the teaching, learning and assessment process. Questions are used to obtain information and assess knowledge and competence of students. Academics who are involved in teaching process in higher education mostly use final examination papers to assess the retention capability and application skills of students. Questions that used to evaluate different cognitive levels of students may be categorized as higher order questions, intermediate order questions and lower order questions. This research work tries to derive a suitable methodology to categorize final examination question papers based on Bloom's Taxonomy. The analysis was performed on computer science related end semester examination papers in the Department of computing and information systems of Sabaragamuwa University of Sri Lanka. Bloom's Taxonomy identifies six levels in the cognitive domain. The study was conducted to check whether examination questions comply with the requirements of Bloom's Taxonomy at various cognitive levels. According to the study the appropriate category of the questions in each examination, the paper was determined. Over 900 questions which obtained from 30 question papers are allocated for the analysis. Natural language processing techniques were used to identify the significant keywords and verbs which are useful in the determination of the suitable cognitive level. A rule based approach was used to determine the level of the question paper in the light of Bloom's Taxonomy. An effective model which enables to determine the level of examination paper can derive as the final outcome.

Keywords: Bloom's taxonomy, Data mining, Natural language processing

Introduction

Assessment of student's knowledge using written examinations is known as the most conventional method. It has become a universal method which is used by a large number of educational institutes and universities all over the world. The objective of the teaching and learning process is to measure student's cognitive level that they have achieved from the learning. Written examinations also provide an effective path to determine the extent which student are adopted to learning theory in a given situation (Omar *et al*, 2012). To evaluate the appropriate knowledge level of specific student group, the examination paper must fulfill various aspects. However, setting up a balanced question paper is still a really hard task for educators. When examination questions are prepared, there should be an appropriate balance between questions which assess the higher levels of learning, intermediate and basic levels of learning. It is difficult to evaluate the level of a question paper during the examination question preparation process. Furthermore, it is difficult to determine the level of each question manually. Without a balanced question paper it is quite difficult to assess the exact knowledge of specific student group.

Examination questions are categorized according to the concepts derived from Bloom's Taxonomy. Education psychologist Benjamin Bloom developed Bloom's Taxonomy in 1956 to categorize intellectual skills, which are significant in the

learning process. The categorization of the examination questions causes to deliver some possible outcomes. It may help the educators to gain experience in developing new teaching materials and exposing the student's prior knowledge (Hadder, 1970). According to the taxonomy developed by Bloom, there are six cognitive levels. The appropriate level of the question is determined based on the keywords defined in those six cognitive levels. In this paper we propose a data mining approach to analyze question papers based on Bloom's Taxonomy.

Methodology

The methodology adopted in this study incorporates some hypothesis. All the questions used for this work belong to one categorized model. It was also assumed that all the questions had been prepared according to the curriculum of the targeted student group and institutional assessment guidelines. After selecting the examination paper, the natural language processing steps were applied for the questions.

Thirty, end semester examination papers (covering the period 2013-2017) related to the computer science stream were randomly selected from the repository of the Department of Computing and Information Systems, Faculty of Applied Sciences, Sabaragamuwa University of Sri Lanka. Over 900 questions were allocated for the analysis.

As shown in Figure 1 after the step of question preprocessing rules were applied for the model. Question preprocessing step is involved in the extraction of keywords. Separation of words, white space removal, removal of punctuation marks, stop word removal and elimination of non-letter were performed during the question preprocessing step.
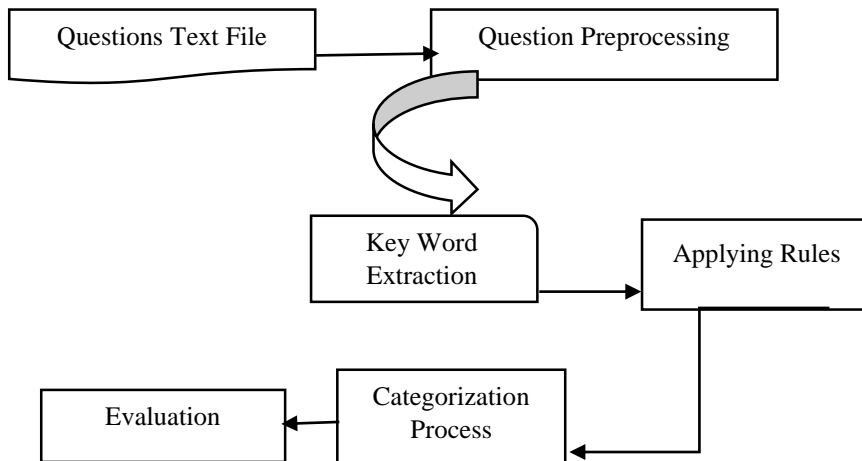

Figure 1: Proposed model for question classification

After the keyword extraction process rules were applied to fulfill the categorization purpose. Rules were defined according to the six cognitive levels of Bloom's Taxonomy. Bloom's Taxonomy has defined keywords to six cognitive levels.
The main rules were defined according to Sivaraman and Krishna (2015). Rule for lower order questions was developed based on the keywords of knowledge and comprehension cognitive levels. Rule for intermediate order questions was developed based on keywords of analysis and application levels. Keywords of other two levels were used to define rule for higher order questions.

Determination of the level of the question paper was done as the next step. According to the percentage of low level, intermediate and high level questions it was determined whether the examination paper was set in a balanced or imbalanced manner. This determination was performed according to Sivaraman and Krishna (2015). They have concluded that a balanced question paper should include lower order questions between 20-30%, intermediate order questions between 40-50% and higher order questions between 30-40%.

Results

The summary of the results of the analysis of end semester examination question papers is presented in Table 1. Accordingly, the developed algorithm has categorized end semester examination papers based on Blooms Taxonomy. It has determined the status of examination papers, whether they are balanced or imbalanced. The derived methodology provides a great support on preparation of balanced examination question papers which is an arduous task for academics. This methodology which generates the percentages of high, low and intermediate level questions enables to determine the overall level of the question paper. By adopting this techniques, academics or lecturers can maintain a correct balance between high, low and intermediate questions. Therefore, it helps to extract the exact knowledge of targeted student group.

Derived methodology benefits not only lectures involved in the teaching process but also students in the targeted group. Students can pay their attention to the questions that cover a high percentage from the examination paper.

Table 1: Percentages of questions included based on methodology

Name of Question Paper	Low level Percentage	Intermediate level Percentage	High level Percentage	Balanced/ Imbalanced
Rapid Application Development	36.78%	40.31%	22.91%	Balanced
Software Project Management	56.11%	33.4%	10.55%	Imbalanced
Software Quality Assurance	70.59%	23.53%	5.88%	Imbalanced

Conclusion

The aim of the study to classify undergraduate examination questions in to three different levels named High level questions, Intermediate level questions and Low level questions in light of Bloom's Taxonomy. Bloom's Taxonomy was the foundation for this study. High level questions were categorized according to the two higher levels: Synthesis and Evaluation. Intermediate level questions were categorized according to the two medium levels: Application and Analysis. As well as Low level questions were associated with the two lower levels: Knowledge and Comprehension. The structure of Bloom's taxonomy proved the effectiveness in evaluating final examination papers in this study. It is fair to conclude that, by striking a correct balance between higher order questions, intermediate order questions and lower order questions to deliver a balanced question paper which enhance the critical thinking of selected student group. The next stage of this work will focus to measure the depth of the question paper based on the subject area.

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An optimization model to allocate most suitable team members for software development projects

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Abstract

Human resource is one of the most important resource that creates value for software development projects. However, this becomes more complex when the required range of skills, knowledge, experience and expertise, increases. Many software development projects have failed due to wrong mapping of team members to expected goals. Therefore, it is vital to fill the optimal number of positions required by the most qualified employees for each project, under each designation and to find the most suitable person for each designation. Practically, there is no specific methodology or a system available to match team members to achieve the scope of a given project, as some of the requirements are subjective and the rest are objective. Therefore, the main objective of this research is to develop a model to determine the optimal number of team positions required to be filled, to contribute most to achieve the project scope, quality and meeting the deadlines. In this case, analytical network process together with application of linear programming determine the position to be filled by whom, to optimize the quality and the scope of the project. This is an effective way of selecting suitable team members while meeting the subjective and objective resource constraints to derive maximum benefits not only for the software development project, but for the company as well.

Keywords - Human resource allocation, Analytical Network Process (ANP), Integer Linear Programming (ILP), Software development project

Introduction

Software development organizations survive in a competitive market by converting developing useful and successful software products. To develop such products, organizations usually follow processes that divides development effort into several activities. Each of these activities requires personnel with specific characteristics such as skills, knowledge and experience. Therefore, software development is a people-intensive activity. The abilities possessed by developers are strongly affect the productivity and the quality of the project (Farhanglan et al., 2015). Thus, one of the most important decisions to be made by a software project manager is to find a precise mechanism to select team members for a given project while meeting the project requirements. Therefore, it is an important issue to be analyzed when software development is undertaken as a value-driven business process.

Numerous models and methodologies are used to optimize human resource allocation in software development projects (Farhanglan et al., 2015). Research in this area fall under two categories; based on subjective factors and based on objective factors (Silva & Costa, 2012). Still, the problems associated with human resource allocation to software projects remain as many projects fail due to the mismatch between project quality and goal vs capabilities of allocated team members. Further, hardly any research considers both subjective and objective factors together (Saaty et al., 2017). The main objective of this research is to overcome the problems of

current practices and develop a model to optimize the selection process to allocate most suitable team members for software project while considering both subjective and objective factors.

Methodology

Initially a detailed literature review was done in order to collect the data from relevant empirical studies to determine the selection criterion and sub criterion. Discussions with an expert group was also carried out to identify different players in software project teams, subjective and objective criteria that affects software development and the practical issues directly related to the human allocation process. An analytical procedure was developed involving two main phases.

Phase 1: Use Analytical Network Process (ANP) modelling technique to evaluate employees under different subjective and objective criteria according to their role or position. Network models are developed for each role in the software project by considering relevant criteria, sub-criteria and alternatives. Figure 1 shows the ANP model developed for selecting software engineers. Four different clusters are considered in the analysis; goal, technical criteria, personal criteria and the alternatives. Cluster 1 is the goal of the process, Cluster 2 and 3 are the technical, and personal criteria considered to evaluate software engineers respectively and Cluster 4 is the alternatives where each of the available software engineer is compared for evaluation. The inner dependency within the same cluster and the outer dependency among the clusters are displayed in the network model depicted in Figure 1.
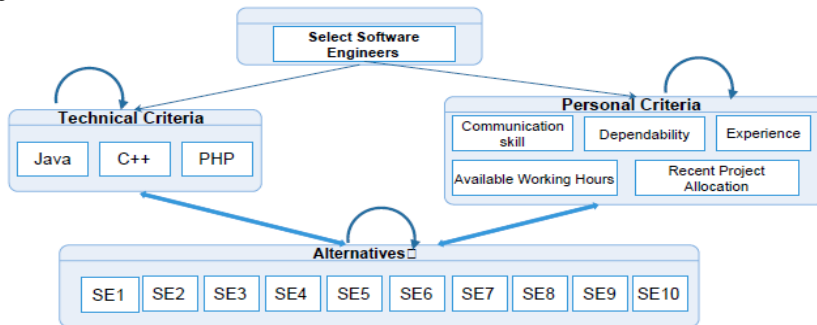

Figure 1: ANP model developed to evaluate software engineers

SuperDecions software is employed to consider the subjective and objective criterion. Pairwise comparison is done among clusters and between clusters according to outer and inner dependency of the attributes required by human resource allocation team. After pairwise comparison, super-matrix is formulated. After normalizing the raw values of the super matrix, ANP compute the competency benefit score of each software engineer. Likewise, super-matrix for business analyst and quality assurance engineers or for any other position can be computed.

Phase 2: This phase involves optimizing the project human resource requirement subject to the unique constraints applicable to each different project. For example, assume that a new software development team needs software engineers, business analysts and quality assurance engineers. In addition, the total members of the project team also should be limited. Further, to provide new comers with work experience, at least few associate software engineers, associate business analysts and associate quality assurance engineers should also be included in the team. Here, an integer linear programming (ILP) model can be formulated to and solved to determine human resource allocation requirements that maximizes the sum of employee benefit

scores. A feature of this ILP model is any number of constrains could be considered according to the project requirement. A generalized ILP model to determine allocation of most suitable employees for a software project while maximizing the competency benefit can be formulated as follows.

Objective Function:

$$Max \ Z = \sum_{i=1}^{n} \ \sum_{j=1}^{m} \ \sum_{k=1}^{p} \ \left| a_i X_{S.E.i} + a_j X_{B.A.j} + a_k X_{Q.A.k} \right|$$

Subjected To:
$$B <= \sum_{i=1}^{n} \ X_{SE \ i} \ <= C$$

$$D <= \sum_{j=1}^{m} \ X_{BA \ j} \ <= E$$

$$F <= \sum_{k=1}^{p} \ X_{QA \ k} \ <= G$$

$$\sum_{i=1}^{n} \ \sum_{j=1}^{m} \ \sum_{k=1}^{p} \ \left| X_{S.E.i} + X_{B.A.j} + X_{Q.A.k} \right| = H$$

n	*Number of Software Engineers available.*
m	*Number of Business Analysts available.*
p	*Number of Quality Assurances available.*
a_i	*Competency Benefit of Software Engineer i.*
a_j	*Competency Benefit of Business Analyst j.*
a_k	*Competency Benefit of Quality Assurance k.*
$X_{S.E \ i}$	*Software Engineer i* *i=1……. n*
$X_{B.A \ j}$	*Business Analyst j* *j=1…….m*
$X_{Q.A \ k}$	*Quality Assurance k* *k=1……. p*
B	*Minimum required number of software engineers*
C	*Maximum required number of software engineers*
D	*Minimum Required number of Business Analysts*
E	*Maximum Required number of Business Analysts*
F	*Minimum Required number of Quality Assurances*
G	*Maximum Required number of Quality Assurances*
H	*Total number of people in the project*

Results
Phase 1: Using the SuperDecisions software and through pairwise comparison among and between Clusters and competency benefit scores were obtained. This was repeatedly done for all 3 different positions; software engineers, business analysists and quality assurances. Computed ANP scores and priority levels for software engineers are shown in Table 1. Competency scores for other positions can be computed in the same way.

Table 1: Competency benefit score for available software Engineers

Alternatives	Competency Score	Rank	Alternatives	Competency Score	Rank
S. Engineer 1	0.1391	2	S. Engineer 6	0.1291	3
S. Engineer 2	0.1019	4	S. Engineer 7	0.0623	10
S. Engineer 3	0.1742	1	S. Engineer 8 (A)	0.0778	7
S. Engineer 4	0.0910	5	S. Engineer 9 (A)	0.0803	6
S. Engineer 5	0.0729	8	S. Engineer 10(A)	0.0707	9

Phase 2: After considering all project requirements, an ILP model was formulated, and solved using Excel Solver. The results are shown in Table 2.

Table 2: Selected project teams

S. Engineer 1 (2)	Business Analyst 1(4)	Q. Assurance Engineer 1(3)
S. Engineer 3 (1)	Business Analyst 2(1)	Q. Assurance Engineer 2(1)
S. Engineer 6 (3)	Business Analyst 5(3)	Q. Assurance Engineer 3(2)
A.S. Engineer 8 (7)	Business Analyst 6(2)	A.Q Assurance Engineer 6(5)
A. S. Engineer 9 (6)	A.Business Analyst 8(6)	

Conclusion

Issues of human resource allocation have attracted interest of researchers since 1960s. Most of these studies are practically not applicable or only applicable with some limitations (Silva & Costa, 2012). Most of the time, real-world scenario team members are allocated intuitively based on the previous records or performance of a particular employee. Therefore, this study contributes to the literature by proposing a procedure that allocates human resources to projects addressing subjective and objective requirements. The criteria and sub-criteria are identified separately for each role. Pair wise comparisons have been made between each criterion/sub criterion and it will prioritize the most important criteria, which increased the project's success. The analytical procedure involves ANP methodology and selects the most valued employees against the project requirement. This achievement covers the first objective of the research. Then, in the next step, an ILP is developed to optimize the project human resource requirement by considering the constraints unique to the project. In addition, if a project manager wishes she can allow more opportunities for novices or new comers to work with experienced members to gain work experience. The results of the proposed model show allocation of most suitable team members for software development project while maximizing competency benefit. In the empirical investigation, only five software engineers were selected out of available ten employees and out of that two associate software engineers were selected while satisfying the constraints. The proposed approach will be useful to many IT organizations who are seeking new ways to manage human resource allocation and allows managers to assign the right person to the right job at the right time. In addition, the proposed model can be applied to other industries such as construction, manufacturing, and healthcare with minor changes in the criterion.

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Computer aided segmentation approach for Melanoma skin cancer detection

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Abstract

Skin cancer is the most common type of cancer in the world and nowadays, this incidence is increasing rapidly. In recent years, there has been a fairly rapid increment in melanoma skin cancer patients. Melanoma, this the deadliest form of skin cancer, must be diagnosed earlier as soon as possible for effective treatment. To diagnose melanoma earlier, skin lesion should be segmented accurately. However, the segmentation of the melanoma skin cancer lesion in traditional approach is a challenging task due to the number of false positives is large and time consuming in prediction. Hence, the development of automated computer vision system becoming as an essential tool to segment the skin lesion from given photograph of patient's cancer affected area and to overcome those difficulties, which were found in the earlier methods. This work was done through image processing techniques. Some of these techniques are widely used in similar applications, as is the case of the canny edge detection for finding the lesion boundary. Other techniques are watershed segmentation for segmenting the lesion from skin, multilevel thresholding for merging the lesion, and active contour for increasing the accuracy. Though the personnel in the medical field had introduced new methodologies to improve the accuracy by addressing the challenges and mainly focusing on the accuracy, the approach in this study achieved 97.54% sensitivity, 97.69% specificity, and 97.56% accuracy.

Keywords: Lesion, Segmentation, Canny edge, Thresholding, Watershed

Introduction

Research is a self-motivated creative work undertaken by researchers on a systematic basis in order to seek answers to questions that arise in their minds. Information technology has changed the human beings' and their life styles and made their life very easier with the growth of technology and applications. In the modernized world, it could be inefficient when many processes are taking place at the same time, at the same place. So, there is a need to digitalize the processes in an efficient manner. Today, research and inventions are becoming a part of our culture. Cancer is one of the main non communicable diseases impacting on people across the world. With the advent of ICT technology, compared to other diseases, capture of data related to cancer is quite extensive (Biliris et al., 2000). Due to the importance of automatic segmentation for melanoma skin cancer detection, a large amount of studies have been conducted in the past years. Many studies have introduced new methodologies to improve the accuracy (Roshni et al., 2010). While the methods have focused accuracy (Vijayarani et al., 2013), the objective in this study is, to assist in the accurate identification of the specific cancer region. This development of an

automated computer vision system is becoming an essential tool to segment the skin lesion from the given patient's cancer affected area. This study has combined all earlier algorithms and proposed a new hybrid algorithm to improve the accuracy of the results.
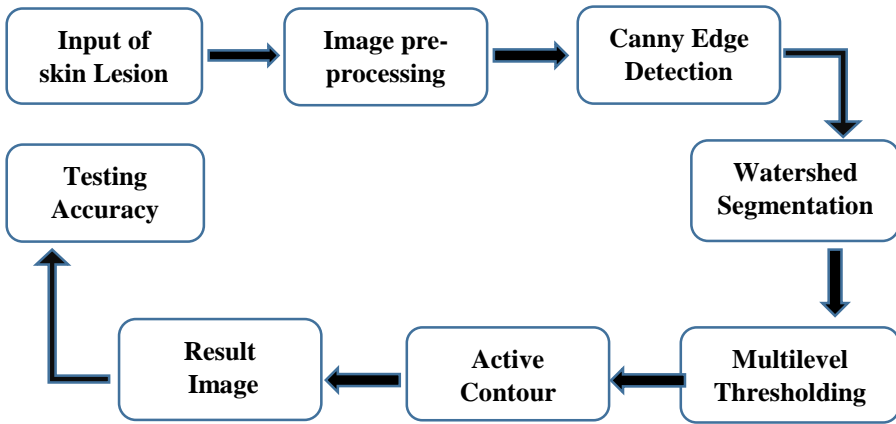
Methodology

Figure 1: Overview of the methodology framework

Figure 1 shows the methodology which was used for the study. The proposed methodology is to implement the segmentation for melanoma skin cancer detection using image processing. For this study, a sample of 250 cancer patients' images were collected from ERC (Ethical Review Center). The input for the system is the image of the skin lesion, which is speculated to be a melanoma lesion image, which is then preprocessed to upgrade the image quality.

Canny edge detection has been carried out to get the boundary of the lesion (Alvarez et al., 1992). However, the canny edge detection image is affected by noise and removed by applying the Watershed based mechanism. The watershed segmentation of the image is to accurately find the lesion region (Pour et al., 2017). Thereafter, there is multilevel thresholding to merge the lesion regions (Sumithra et al., 2015). Next, post segmentation of the image using active contour and finally testing the accuracy of the result image.

Table 11: Methods of Canny edge and watershed segmentation

Canny Edge Detection methods	Watershed Segmentation Methods
Gaussian filtering to remove noise	Convert RGB image to grayscale
Sobel Operator	Compute a segmentation function.
Finding Gradient angle	Compute foreground markers
Tracing the edge in the image using theta (angle)	Compute Background Markers
Non maximum Suppression	Compute the Watershed Transform of the Segmentation Function

Results

In here, experimental result has been shown for the proposed automatic system created for segmentation for melanoma skin cancer detection using multiple features. For this research, experiment has been performed on 250 images. Sample of input and output images has been shown in Figure 2 and Figure 3.

Figure 2: Input image

Figure 3: Output image

When the classification is done, results could have an error rate, either fail to identify an abnormality or identify an abnormality that is not present. Some kind of performance measure to the diagnosis done by the terms of true and false positive, true and false negative. These terms are validation metrics used for verifying the quality of a segmented image. The terms that you referred then would mean:

- True positive (TP): pixels correctly segmented as foreground
- False positive (FP): pixels falsely segmented as foreground
- True negative (TN): pixels correctly detected as background
- False negative (FN): pixels falsely detected as background

According to these terms the clinical performance of a classification is described where sensitivity, specificity, and accuracy are calculated through the following equations.

- Sensitivity(Sen) = TP/ (TP+FN)   Equation 2: Sensitivity
- Specificity (Spe) = TN/ (TN+FP)   Equation 2: Specificity
- Accuracy(Acc) = (TP+TN)/ (TP+FP+TN+FN)   Equation 3: Accuracy

As we can see, this method gives far better results in final segmentation and gives high accuracy rates which is specified by sensitivity and specificity values. The results of a sample image segmented using same method and average of this method has been shown below.

Table 12: Defines sensitivity and specificity parameters for evaluating accuracy for a sample

Image	TP	FP	TN	FN	Spe	Sen	Acc	Acc.rate
Img 1	465725	2495	315617	37	0.9922	0.9999	0.9968	99.68%

Table 13: Defines sensitivity and specificity parameters for evaluating average accuracy for 10 samples

	Specificity	Sensitivity	Accuracy	Accuracy rate
Average	0.9769	0.9754	0.9756	97.56%

According to the results showed, it is clear that this method is more effective for the detection of melanoma lesion.

Conclusions

Use of computational method in the medical sector research in Sri Lanka is minimum. Especially in cancer, the people who are in the medical sector are focusing their concentration by using technology and equipment wisely. They are not familiar with those computational system to identify the skin cancer lesion. However, if they are familiar with those computational system they can easily identify the affected cancer lesion and will take affirmative action to cure the affected patients. Due to the high sensitivity rates per exam, this method can be used as a screening tool for the

first set of exams required indicating suspicious cases that still need to be confirmed by medical analysis. It is the most common type of cancer among humans. In this sense, the proposed methodology can be a useful tool to help specialists in segmenting lesions from skin. Redirecting available qualified professionals to perform less repetitive tasks may contribute to a better use of their abilities.

In this paper we have discussed a computer-aided segmentation system for melanoma skin cancer detection. It can be concluded from the results that the proposed system can be effectively used by patients and physicians to diagnose the skin cancer more accurately, and our approach could achieve 97.54% sensitivity, 97.69% specificity, and 97.56% accuracy.

This tool is more useful for the rural areas where the experts in the medical field may not be available. Since the tool is made, more user friendly and robust for images acquired in any conditions, it can serve the purpose of automatic diagnostics of the melanoma skin cancer. Finally, the proposed methodology is also a financially attractive solution, since it runs on simple computers, which are usually available in hospitals too.

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Evaluation of higher education institutions using aspect based sentiment analysis

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Abstract

Demand for formal higher education programs among the younger generation in Sri Lanka, has grown over the past decade. The demand growth has fueled the opening up of many local and internationally affiliated institutes offering a diverse range of degree programs. The selection of the appropriate course from these institutes is challenging given the wide choice. In order to select the appropriate institute, students use the Internet for reviews and user comments, especially from social network sites like Facebook, Twitter and Google plus. This search, involves a cost in terms of time spent for reading the comments and processing whether the standing of the ratings for the program and the institution are appropriate. This task is challenging because of the difficulty to extract sentiment information from a massive set of online reviews. A solution is proposed, using an aspect based sentiment evaluation system that assesses institutions by considering the reviews provided, to overcome this problem. This concept is based on Natural Language Processing (NLP). A web based, automated application tool that retrieves review data from social media networks on the institution and the features of the program, analyzes the sentiment value and provides a rating has been developed.

Keywords: Natural Language Processing (NLP), Data Mining, Aspect based Sentiment analysis, Online Reviews

Introduction

Social media networks has become popular as a communication tool among Internet users. Social media is the most popular choice among university students to seek and share experiences and inspiration (Laura, 2014). It is reasonable to assume that engagement of social media applications as part of university marketing could contribute to increased enrolment numbers (Constantinides and Zinck Stagno, 2011) and help prospective students make better-informed decisions regarding their study choice and university selection. Online opinionated texts (e.g. Reviews, Tweets) are important for customer decision making (Chen and Xie, 2008) and constitute a source of valuable customer feedback that can help companies to measure satisfaction and improve their services. "*Approximately 90 percent of consumers surveyed said that they read online reviews and 88 percent of them said that they trust the online reviews as much as personal recommendations*" (Stacey, 2015). In other words, making a decision about a particular service whether to select them or not according to online reviews and ratings provided by users and business experts, seem an acceptable method of making a selection.

The younger generation is keen on pursuing higher education. However, State universities have limited resources and has limited intake. It approximately enrolls only four percent of students sitting for the university entrance examination. In comparison, seventy percent of high school graduates in USA entered some kind of a higher educational institution in 2009 (Weerakoon, 2011). Therefore, most of them enter private higher education institutes than state universities.

Nearly six percent of university students drop out after their first year because of bad university selection (Mian et al., 2016). Choosing the right course at the right private higher educational institute is most challenging when there are so many options available.

There are online resources and university ranking websites that can assist in choosing the right course and institution. All these ranking methods do have serious shortcomings. Even the most popular ranking schemes cover only less than five percent of all the universities in the world. University rankings are mired in controversies due to the fact that, rankings could be influenced, made-up, dicey and even include falsified data. However, most local and some international programs on offer are not even on these ranking websites, thus making it difficult for the students to choose.

Gradreports (2016) and Unigo (2016) are consumer review sites that do not use user reviews and user sentiment but focus on collating information from users on a 5-point rating scale. Generally, the ratings are for an overall score and it will be impossible to discern whether the score given was for the institute, study program or the facilities. These shortcomings were the motivation to develop a system which would assist students in their selection process, especially here in Sri Lanka.

Methodology

The section below discusses the most important modules of this system shown in the Figure 1 below.

   a)   Data gathering and processing service

Data gathering and processing service is the main module in the proposed system. This service will gather the data from the external online data streaming APIs provided by various review sites and social media networks. As identified from the requirement analysis this service should contribute to the following functional requirement: i) Gather data from the external APIs provided by various social media networks and review sites, ii) Identify and extract institution aspects from reviews, and iii) Analyze and calculate the sentiment of reviews and comments.

Following is the visual representation of the data gathering and processing component architecture with the workflow.
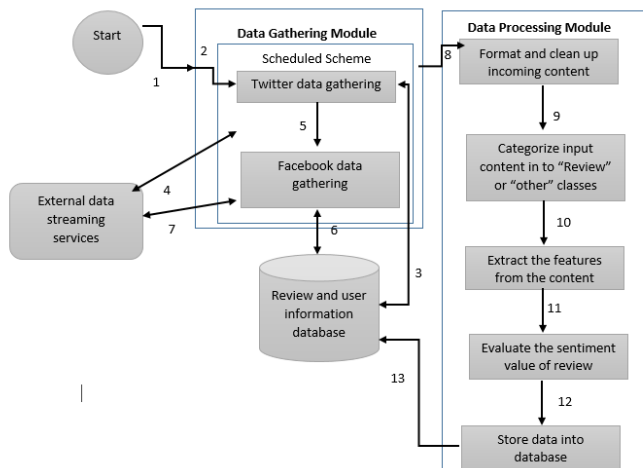

Figure 1: Data gathering and processing module workflow

b) Web application

Web interface and the web service is the interface of this system. The following are the requirements that have high priorities: i) Search institution by institution name, ii) Allow user to enter the date length to filter the data (Comments, Reviews) which is fed into the system by data streaming provider and iii) Show the institution rating as the percentage of positive, negative and neutral in graphical chart.
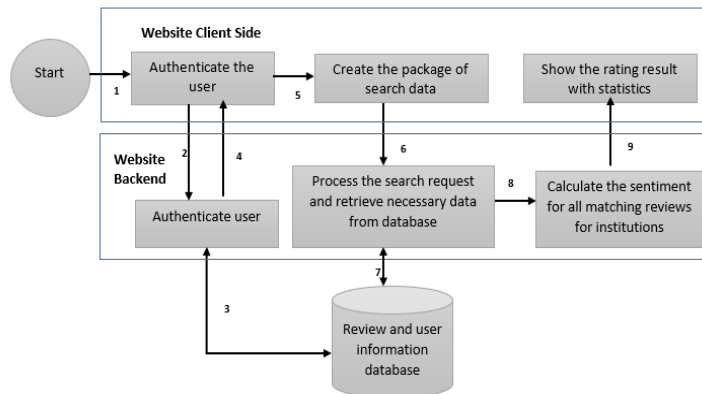
The following is the workflow and architecture of the web application.

Figure 2: Workflow of the web application

Development Process

a) Data gathering and processing module

In this module there are three main processes. Those are classifying reviews, feature extraction and sentiment analysis.

- Classifying reviews - To implement this, help of the Apache OpenNLP is used, since the custom developed ANN was not accurate enough to classify large number of data.

- Feature extraction - In this module, the algorithm will obtain the POS (part of speech) tags and use them to identify the nouns and adverbs and comparative adverbs in the review. Then using them, it identifies features mentioned and the literal values that the reviewer gives them.

- Sentiment analysis - Sentiment analysis is done using the Standford NLP library. This contains algorithm to process the sentiment analysis in order to calculate the positivity and negativity percentage of the reviews. The value for positivity is given as 4 and 5, for negativity 1 and 2, and 3 is for neutral. For example, if a word is considered as positive it will get a value of 4 and it is considered that it has a negativity of 1.

Conclusion

The objective was to develop an aspect based recommendation system for evaluating higher education institutions, the programs and the other relevant features. The test plan for testing of aspect based sentiment analyzer consists of test cases to test the functional requirements. Initially the testing of the prototype was conducted by carrying out unit testing. Unit testing was carried out for all components of the prototype in order to seek and fix errors or any bugs in the prototype. Thereafter, all these components were integrated in order to carry out performance testing since the project plays a major role in responsiveness and stability. This has been done to the web application using apache benchmark tool which will help in load testing. The website is tested for various web browsers to check which browsers support the

website layout styles and fasten the loading process. Performance tests has been performed on the data gathering and processing unit as well as by calculating the processing time of each of the main functionalities of a module.

Accuracy of the system is determined by the accuracy of the StanfordCoreNLP java language analysis library used for sentiment analysis. Since StandfordCoreNLP uses Twitter words to create corpus and it's more generic and due to limited time constraint this has been used for the implementation of sentiment analysis. Generally, accuracy of sentiment analysis studies does not exceed eighty percent since humans have different judgments and vulnerable to make mistakes and errors. The developed system has the accuracy of around seventy two percent, which is an acceptable rate of accuracy at this initial stage of research. This study will set the foundation for incorporating opinion mining and sentiment analysis in higher education institution evaluation. With further refinement and improvement, the tool could be made commercially available to assist students in selecting the higher education institute in Sri Lanka.

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An optimization model for planning milling quantities based on forecasting of paddy and rice prices

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Abstract

Rice is considered as the staple food of Sri Lanka. The conversion of paddy in to rice is a main value creation found in the Sri Lankan agricultural industries. The paper deals with the planning concerns, in the supply chain of rice. The paper discusses various issues related to production of rice at the downstream end of the supply chain and milling management decisions. Small and Medium scale milling plants around Sri Lanka are facing problems of dissolving their businesses quickly, and they are in a need to utilize their capacity in optimal way. An efficient supply chain management framework is essential for the milling to be efficient in sourcing, processing and distribution of rice under an uncertain environment. In the study, the behaviour of the Sri Lankan paddy and rice market prices volatility has been studied qualitatively and the paper discusses the validity of applying different forecasting tools**.** Mainly the SARIMA and Winters model have been used for forecasting. The study identifies and proposes two price regions for forecasting, based on the macro environmental factors. In order to attain the research objectives of optimization, the researcher has used linear programming as a continuous multi period model. The research is significant for the small and medium scale milling community to enhance their livelihood by determining the right time and right quantity for procuring, processing and stocking in a volatile market environment.

Keywords: Milling capacity optimization, Linear programming, Operation research, Sri Lankan agricultural industry, Rice supply chain

Introduction

The supply chains of different agricultural commodities in Sri Lanka face many challenges due to improper management of the sector. Rice industry has always been treated as the subject of agricultural economics but attention to this topic in supply chain studies is relatively low. This study focuses on the management decisions of rice-milling sector such as procuring, processing and stocking.

Rice millers purchase paddy during the harvesting season to build up their paddy stocks to sell when the price become high. Due to the uncertainty of the rice supply chain affected by the weather and other external factors production of the paddy and price are continuously changing (Ariyaratna, 2016). If the Milling capacity decision is not taken optimally, processing unit will not be able to maximize profits. To overcome the above issues, an optimization method for milling capacity which is sensitive to market spot price should be available to the millers.

The operations process of rice processing unit involves cleaning, drying, dehusking, and polishing (Vishal, 2013). The research assumes the whole operation as one process to reduce the complexity. A properly developed production plan is needed for the milling plants to ensure effective and efficient operation.

Methodology

Over the past 12 year time, the monthly spot price of samba and nadu rice, 5 years monthly spot price of samba and nadu paddy have been collected by the Hector Kobbakaduwa Agrarian Institute (HARTI). Samba and nadu are the main two varieties used by the Sri Lankan milling sector(Wijesooriya,2013).
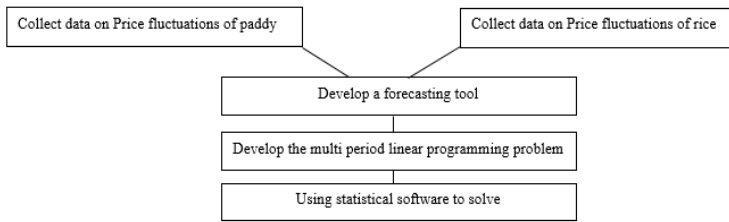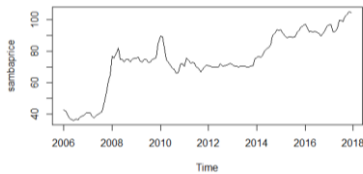

Figure 1: Research design
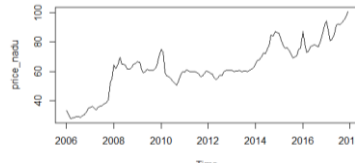

Figure 2: Samba rice time series

Figure 3: Nadu rice time series

Then the observed time series for the both varieties of rice is inspected qualitatively with respect to the macro economic factors which would affect the price behaviour. By partitioning the time series into two major regions, forecasting models are created. From 2008 to 2013 price stability policy was observed as being operated and from 2014 to 2017 a free floating policy was operating under the government policies of safeguarding the consumers and farmers. Therefore, a different forecasting model is applied based on the forecasting accuracy measured using the indicators of mean arithmetic error, mean absolute error (MAE) and mean absolute percentage error (MAPE).Based on the values observed for the errors, winters multiplicative and SARIMA(Seasonal ARIMA) models have been chosen to forecast. For SARIMA modeling the Box-Jenkings methodology is applied. For the paddy prices forecasting also MAPE is used to validate and Winters model has been used for modeling.

Multi period linear programming enables the researcher to find the solution to the research objectives of buying amount, buying period, and stocking amount for each period, producing or selling amount for each period while obtaining the optimal profit level. In developing the model the following assumptions were made.

- ❖ Processed rice lot is not stored.
- ❖ Finite time horizon (three months) is used to make the production plan.
- ❖ Miller is able to find rice and paddy under any forecast price.
- ❖ For calculating the income, only rice selling prices are considered.
- ❖ To reduce the complexity only samba and nadu varieties have been used.

General formation of the multi stage production plan is shown in Figure 4. For this problem month of January, February and March of year 2018 are taken as the stages of the problem. "X" indicates the input stock for each stage "d" denotes the decision variables of buying and processing.
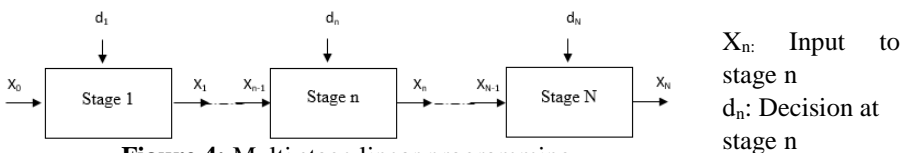

Figure 4: Multi stage linear programming

X_n: Input to stage n

d_n: Decision at stage n

Table 14: Notations used in the linear programming model

No.	Notation	Description
1	N	Number of periods in the mathematical model N; N= {1, 2, 3, 4…N}
2	I	Products types i={Samba,Nadu}
3	$R_{n,i}$	Price of rice n; n= {1, 2, 3…N}, i = {Nadu or Samba}
4	$P_{n,i}$	Price of paddy n; n= {1, 2, 3…N} , i = {Nadu or Samba}
5	K_1	Maximum processing capacity of the mill for a month
6	K_0	Minimum processing capacity of the mill for a month
7	$M_{n,i}$	A decision variable for Processing level (Manufacturing amount) of paddy n; n= {1, 2, 3…N}, i = {Nadu or Samba}
8	$B_{n,i}$	A decision variable for Buying paddy amount for n; n= {1, 2, 3…N} , i = {Nadu or Samba}
9	W_0	Maximum Warehouse capacity
10	$CP_{n,i}$	Processing cost for period n; n= {1, 2, 3…N} per 1Kg rice
11	$CT_{n,i}$	Transport cost for period n; n= {1, 2, 3…N} per 1Kg rice
12	H_0	Holding cost per unit for ending inventory (1kg Paddy for one month)
13	$X_{n,i}$	variable representing the amount of inventory on hand at the beginning stage n; n= {1, 2, 3…N} i = {Nadu or Samba}
14	Pr	Profit for N period considered (Objective function)

The conversion ratio of paddy into rice of Sri Lanka is 75%(Wijesooriya, 2013) and it has been used in the model.

$$\text{Maximize Pr} = \sum_{n=1,i}^{N} \{(R_{n,i} \times 0.75\, M_{n,i}) - (P_{n,i} \times B_{n,i}) - (H_0 \times X_{n,i}) - CP_{n,i} \times M_{n,i}) - (CT_{n,i} \times M_{n,i})\}$$

Constraints for the model are: $M_{n,i}, B_{n,i}, X_{n,i} \geq 0$

$X_{n,i} = X_{n-1,i} + B_{n,i} - M_{n,I}$

Ending Inventory = Initial Inventory + Buying Amount –Manufacturing Amount

$K_0 \leq M_{n,i} \leq K_1$

$X_{n,i} \leq W_0$

Results

For the samba rice prices from 2014 to 2017, free floating time period forecasting model is validated by dividing the time series into two parts. From 2014 to 2016 samba prices data are used to create the model and using them 2017 rice prices have been forecasted. Since it provides a MAPE of 2.10%, which can be considered as a practically reasonable the forecasting model is valid. For the nadu rice, free floating period MAPE is 4.7%. Since there is a clear trend, by using Winters approach, both nadu and samba rice free floating period prices are forecasted.

Table 15: Free floating time period samba and nadu rice price forecasting

Period	Samba rice	Nadu rice
2018 January	104.6962	104.1945
2018 February	103.9257	102.0336
2018 March	101.88	97.83314

For the samba and nadu rice prices from 2008 to 2013, stabilized time period forecasting model is validated by partitioning the time series in to two parts and forecasting error is measured. From 2008 to 2011, data points are used to develop the forecasting model and data from 2012 to 2013 are used to validate. Acceptability of both the Winters and ARIMA models are checked by evaluating the MAPE, MAE and mean arithmetic error. For samba rice ARIMA shows a better MAPE of 1.88% over 2.84% in winters. For nadu rice ARIMA shows a better MAPE of 3.24% over 7.90% in winters. Hence, for both samba and nadu, SARIMA is selected and the ARIMA (0, 1, 1) (0, 0, 1) can be used for a similar stabilized situation forecasting.

For the samba and nadu paddy data, forecasting error is evaluated for the 2016 to 2017 period by using the time series data from 2013 to 2015. For both varieties

feasibility Winters approach is tested since there is a clear trend visible from the data. For samba 9.5% and for nadu 10% feasible MAPE provided by the developed model.

Table 16: Forecasted prices for the paddy varieties

Period	Samba paddy	Nadu paddy
2018 January	67.76540	56.72261
2018 February	62.27462	49.37303
2018 March	62.42329	49.56083

According to the HARTI sources, processing cost and transport cost percentage are 6.6% and 1.8% of the rice price for 1 kg.As per the industry performances recorded at HARTI the paddy to rice conversion ratio for the yield is 65%.By using the solver software the problem was solved and the table is shown below. So the Maximum profit that can be obtained is 1.9 Million rupees.

Table 4: Solution

Month	Samba Buying	Nadu Buying	Samba Manufacture	Nadu Manufacture	Samba Inventory	Nadu Inventory
2018 January	3Mt	22Mt	13Mt	27 Mt	5Mt	5Mt
2018 February	22.4Mt	28.6Mt	11.4Mt	28.6Mt	16Mt	5Mt
2018 March	0Mt	29Mt	11Mt	29Mt	5Mt	5Mt

Conclusion

The main objective of this study is to develop a methodology for production planning for the millers of paddy where a high profitability is to be ensured. Changing weather cycle, Government decision on the control of prices, Government influence in the paddy sector are continuously happening in the market. For all varieties, prices are forecasted for a three month period. In forecasting, alternative approaches are compared with the existing data. By visually inspection of data and subjective consideration of the market environment, it was identified that for the rice prices, there are two price regions existing. In the period from 2008 to 2013 stabilized prices, and in the period from 2013 to 2017, there were free floating prices. For the free floating periods, winters multiplicative time series validity has been tested and adopted using criteria such as arithmetic error, MAE and MAPE. In stabilized price period of samba and nadu, the Winters and ARIMA have been tested since the data does not show a clear-cut trend. For both paddy types Winters model was validated and has been applied. The research proposes the use of modeling options for forecasting by prior conjecturing whether the market is stabilized or free floating. Using these forecasted prices, a multi-stage linear programming method is used to do the production and inventory plan optimally. The proposed approach will be useful to many agricultural processing organizations who are seeking higher profits from the price fluctuations of the market behaviour.

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Abstract No: SE-28   **Systems Engineering**

An approach to coexistence analysis between agility and ERP implementation

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Abstract

Business organizations tend to re-engineer their business processes by adopting Enterprise Resource Planning (ERP) systems in order to gain a competitive advantage. ERPs offer countless benefits by enabling an enterprise to operate as an integrated, process oriented and real time enterprise. But the issue is re-engineering with ERP ranks among slow-moving, costly and challenging processes of an organization. Many ERP specialists regard agile approaches positively, to mitigate the common ERP implementation challenges. Agile implementation of ERPs is still under research area. This research discusses on the need of agile approaches in ERP implementations and how agility and ERP implementations can coexist. In this case our research question is "Can the common ERP implementation challenges be solved by using agile approaches?" and if so, "How these challenges can be solved?" This study also seeking for uplift the level of awareness on the applicability of agility for ERP implementation projects and these findings can be effectively used by ERP Implementers, Vendors, Consultants, Project Managers and Researchers in their respective projects.

Keywords: Agile approach, Coexistence, ERP implementation

Introduction

An ERP system is an integrated software system, typically offered by a vendor as a package that supports the seamless integration of all the information flowing through Business Processes, Business Intelligence, Business Integrations, Collaborations, etc. However, Many ERP implementation projects are failures (Gloger, 2008). Many ERP implementation projects are still executed adapting waterfall or similar traditional methodologies. While the usage of waterfall methodology in IT projects is diminishing, agile approaches usage is mounting (Fair, 2012). Agile movements provide proactive, active and reactive alternatives to traditional approaches by responding unpredictability and rapid volatility with well-timed, flexible and incremental iterations and empirical feedbacks. There are many approaches for agility. Among them agile process management or agile project management can be considered as a broad approach that can be adopted by engineering, information technology, and new product or service development projects (Highsmith, 2004). Agile Software development is one of its popular applications. Although agile based IT approaches are originated in the software development domain, parts of the agile may be applicable in enterprise system implementations like ERP to mitigate many of the current ERP failures.

Methodology

The research methodology consists of two main phases. During the first phase the literature survey is conducted and it is followed by conceptual model development, operationalization and questionnaire development. The second phase is data collection and analysis. It is challenging to define the agile implementation of ERP

success. Based on the literature 1) Incremental Change (IC), 2) Business value prioritization (BVP), 3) Multiple project views (MPV) and 4). Change management (CM) are assumed as major factors affecting agile implementation of ERP systems success. The proposed conceptual model for agile implementation of ERPs is depicted in figure 1.
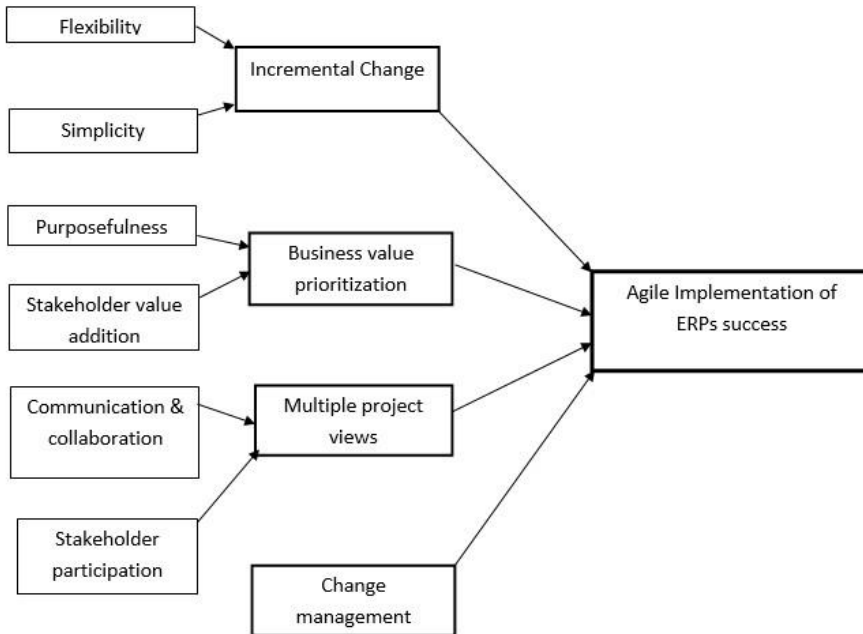

Figure 1: Conceptual model for agile implementation of ERPs

In this study (Wises and Rosemann, 1999) Balanced Scorecard approach (BSC) is used to measure the dependent variable; agile implementation of ERP success. As described in figure 2, BSC is consists of four main strategic perspectives. They are financial perspective, customer perspective, internal perspective and innovation and learning perspective.
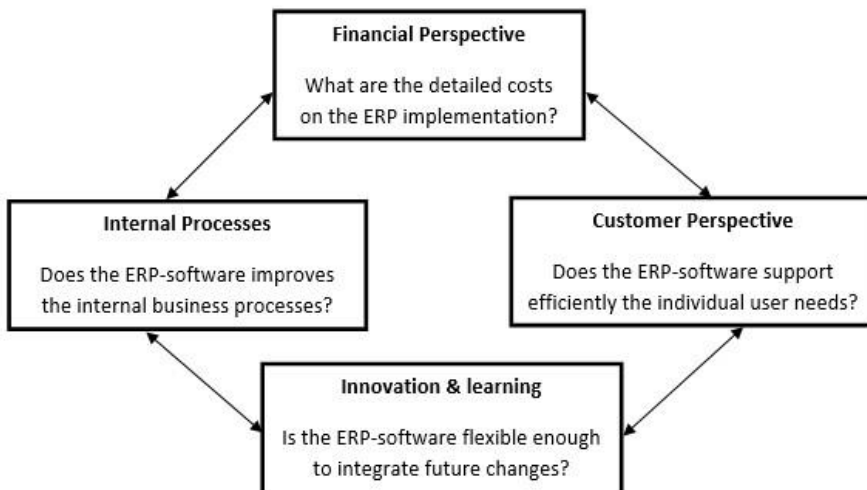
Figure 2: BSC for agile implementation of ERP success

The questionnaire consisted of 40 Likert scale questions. There were 20 questions to measure independent variables and 20 questions to measure dependent variables. A total of 14 companies replied and no of responses from those companies were 42. Both online and printed questionnaire were used for data collection and several statistical tests were conducted.

Results

From the Kruskal-Wallis H test, it was identified that success levels of ERP implementations were different based on the strategy used; (the strategies are agile, hybrid and waterfall). The agile implementations had the highest success value.

Then the Spearman's correlation test was conducted with the intention of identifying the relationship between each independent variable and the dependent variable. The test summarized that there were statistically significant positive correlations between incremental change and ERP success as well as between change management and ERP success. At the same time there were statistically significant moderate correlations between business value prioritization and ERP success as well as between multiple project views and ERP success. Then the model fit of the four independent variables with the dependent variable was checked through the linear regression analysis. It resulted in the following regression model formula.

Agile implementation of ERP success = 0.830 + 0.243 IC + 0.245BVP + 0.243 CM Finally, it could be summarized that all four factors can't take simultaneously for the model. Since the multiple project views doesn't have much impact on success of ERP implementation. Incremental change, business value prioritization and change management impacted heavily for agile implementation of ERP success.

Conclusion

Many ERP specialists regard agile implementations positively as a new approach to mitigate common ERP implementation downsides. But there is a tiny body of research on the relationship between agile approaches and ERP implementations. So this study was set to achieve three main objectives. They are; identify the need of agility in ERP system implementations, analyze the impact of agile approaches for ERP implementations and develop a framework to use in agile implementation of ERPs.

Through reviewing the literature first objective could be achieved by means of exploring different types of ERP system implementation strategies, analyzing the causal factors for success or not success those implementation strategies, exploring existing success measures, studying the core values and major attributes of agile based approaches and identifying the possibility of applying agility in ERP system implementations. The second and third objectives of the research could be achieved through the questionnaire analysis. Based on the findings in literature survey, the conceptual framework was developed by highlighting that incremental change, business value prioritization, multiple project views and change management act as key factors for the agile implementation of ERP success. This conceptual model was validated using the questionnaire analysis. Through a set of statistical tests it was revealed that incremental change, business value prioritization and change management impacted heavily for the agile implementation of ERP success.

The small sample size used in the study could act as a limitation. Therefore, it is much more appropriate to use much larger size sample covering both SMEs (Small and Medium Scale Enterprise) and large scale companies. Analyzing the factors with a bigger sample size would provide more inside to the topic. Moreover, according to the regression analysis the model represented only 67.9%. There could be some other

variables representing 32.1% of success of agile implementation of ERPs. At the same time, it could be noticed that the participants were not willing to respond to the questionnaire. Therefore, collecting responses through questionnaire was very hard. However, the findings of this study have a number of important implications for future practices in agile implementations of ERPs. In future studies in depth case study analysis can be conducted to validate the findings further.

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