Traffic Signal Management and Accident Reporting System

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***Abstract*-Traffic congestion and road accidents are current issues faced by many people in Sri Lanka. Due to the lack of traffic management, many people waste their valuable time on the road, waste of fuel amount increases, and emergency vehicles get stuck on the road. The number of reported accidents are also keeps on increasing in Sri Lanka. An efficient practical solution has not been found to overcome traffic congestion yet in Sri Lanka. Therefore, to find a feasible solution is the current need of the country. There are a number of web and mobile-based systems existed in all over the world to overcome the traffic problems. However, there is no efficient system to solve the traffic congestions in Sri Lanka at present.**

The traffic management and accident reporting system provides an efficient solution to manage the traffic congestion issues in Sri Lanka with an affordable amount. The system has the ability to manage traffic light schedules based on traffic density on respective roads. The system reduces the time that people spend at the traffic lights of a junction. Furthermore, the system provides notification to the police as well as the other users about roadblocks and accidents on the road. The system uses Flask API, Firebase, and GPS technology has been used to track down the current location of the mobile application user. Since the solution is a mobile-based app, it would be more feasible to implement as most of the people use smartphones in Sri Lanka.

Keywords - Traffic Signal Management, Accident Report, Mobile App

I. INTRODUCTION

Traffic congestions become one of the crucial problems in major cities in Sri Lanka. It is rising day by day, especially in urban cities. Furthermore, the police statistics revealed that around 450,000 vehicles out of the total of over 500,000, which enter Colombo on a daily basis are private vehicles. Ten years back a study found that the nation acquired a monstrous money related and man-hour misfortune because of traffic clog because of the nonattendance of legitimate vehicular traffic in the Greater Colombo area [1]. In 2009, the misfortune was assessed at 32 billion rupees for every annum.

Due to both traffic congestion and bad traffic management, a lot of man-hours are wasted, fuel emission is increased, and ambulances are blocked on the road. In addition to those problems, sometimes vehicles are stopped for color lights even without any traffic on the road. Finally, it causes air and sound pollution in the country. There are lots of facts caused for a traffic congestion such as increasing the number of vehicles on the road, violating road rules, improper placement of pedestrian crossings, and etc.

As a result of the two (2) factors such as increases in the number of vehicles and poor development of road infrastructure, the road accident in Sri Lanka has increased rapidly and the shocking numbers of fatality [2]. The quantity of announced mishaps to the Police has expanded from 26,196 of every 1989 to 52,444 of every 2005. In 1989 an aggregate of 1,454 deadly mishaps was accounted for and 2,141 were accounted for in 2005. Furthermore, the report stated that the main reason for this rapid increase is due to an alarming rate of vehicle' ownership together with inadequate road network development to support the demand.

There are number of web and mobile-based systems existed in all over the world to overcome the traffic problems. However, there is no efficient system to overcome the traffic congestions in Sri Lanka at present. The main objective of the mobile-based traffic management and accident reporting system is to provide an efficient solution by reducing traffic congestions due to the traffic/color lights injunctions to the users. Furthermore, the system reduces the chance of accidents, and report accidents/emergencies. As a result, the system assists to decrease pollution in the country up to a certain level.

II. RELATED WORK

It was able to identify the number of similar types of systems during the literature review. It was found a novel approach for detecting the condition of traffic congestion based on a real-time video in Real-time traffic congestion detection based on video analysis [3]. There was a method that could detect the density of vehicles on a lane. There are two procedures that they have used to detect the density of the vehicles. (1) Moving Vehicle Detection Based on Different between Frames, in their work frame, difference methods were used to detect the moving region of the moving vehicles, (2) Lane Detection Based on Moving Locus of Vehicles. They have focused on structured lanes and unstructured lanes to detect lane region. For a structured lane, they have used the localization of lane borders or lane marking. For unstructured lane, lane detection methods primarily take lane features into account.

In order to detect lane, the region of the lane will automatically have been created by the way of accumulating the locus of moving vehicles. The lane-detection algorithm based on accumulation of the moving vehicles locus mainly involves two procedures; accumulating the region of moving vehicle and using the morphology operation of close to concatenate the area as an entirety region. To estimate the speed of moving vehicles, it is necessary to determine the velocity vectors of a sufficient number of reference points identified on the vehicle. This procedure has three main steps. First, a sufficient number of vehicle characteristic points are selected and these points must be accurately tracked over at least two successive video images. Secondly, the velocity

vectors of the characteristic points are calculated on the basis of an optical flux estimate. To track the moving vehicles, as soon as the camera begins to acquire the image, corner points are selected in real-time from the frame images continuously. For speed estimation, correspondence of each selected point on the first frame on which the vehicle appears for the first time must be found on the next frame. In order to find the corresponding point, there is no prior information other than the point itself, and it seems that it is not also possible to find exactly where the match point is.

There was another system to increase the safety of road traffic accidents by applying to cluster [4]. It will give a new approach to predictive management of the traffic processed, based on the collection of data in real-time and also based on accident clusters Based in essence on the Information and Communications Technologies (ICT), the Intelligent Transport Systems (ITS) collect the information on road traffic status from various sources, creating general situation awareness in near real-time. Road accident data is currently being collected with traditional methods for statistical prediction of irregularities and dangers on the roads. It is necessary to develop new methods of analysis to perform sanction of dangerous spots by changing the driver's perspective.

There was a study of Traffic Congestion Causes and Solutions in Talegaon Dabhade City [5]. In their paper, they studied the traffic congestion problems in Talegaon Dabhade, Tal-Maval, and Dist-Pune found out the cause and then proposed a solution. During the study, it was identified five (5) transportation problems that will give them not only increased mobility but also greater economic productivity and a cleaner environment. They have indicated in the past decade Intelligent Transport Systems (ITS) has arisen throw-out the world. Smart transport systems can produce major benefits by reducing congestion, accidents, and environmental impacts, and can make significant improvements to efficiency commercial and public transport fleets.

According to their study, it says the impacts of the congestion as follow; it involves queuing, slower speeds, and increased travel times, which impose costs on the economy and generate multiple impacts on urban regions and their inhabitants. They have identified some reasons behind the traffic; Inadequacy of traffic police, Narrow roads, Illegal Parking, an Increasing number of populations, Higher Purchasing power of the public, Improper planning of city development, Improper planning of city development. At the end of their study they have suggested some solutions for a traffic jams – Strict lane management, restricting routes for Rickshaw, Road Widening, Increasing and developing the manpower, Financial Penalty to the traffic lawbreakers.

Prof. A. S. Kumarage has done a review on Urban Traffic Congestion: The Problem and Solutions [6]. In the study, he said if traffic congestion is something we have to learn to live or if there are indeed initiatives that could be taken to reduce and manage it with tolerable levels. Road congestion means that there are more vehicles trying to use a given road facility than it can handle - without exceeding acceptable delay or inconvenience levels. According to his review, it indicated normally average traffic speeds within the Colombo Metropolitan Region (CMR) is around 20 km/hr. today. The typical corridor (major artery) speed is around 10-15 km/hr. within Colombo City.

The technical knowledge of the researcher may be limited which may result in the inability to implement optimal solutions for certain functions. Difficulties in obtaining certain software resources that are required for the implementation of certain system features may arise. Difficulties in managing to implement all the intended features of the proposed system may arise. As the proposed project is a self-funded project, certain budgetary limitations will apply specifically, when it is required to purchase development software in order to incorporate certain features to the system.

III. Research Methods

An actual visit was made to collect details of vehicle movements, potential phases and all identified traffic movements at a time for the road intersections and their signal cycles for some of the signposted intersections. For further review of the traffic control system's functionality, some videos and photographs were collected. Interviews with selected traffic police officers, pedestrians, and drivers were also performed to define the problems they encountered, and specifications are required in this kind of program. Upon review of the data gathered above, the following details were found.

The traffic management and accident reporting system has three (3) main steps. In the first step, the CCTV camera will capture a video of the junction. The image processing part is done using the captured video in the second step. In addition, the system counts the number of lanes in the junction and the vehicle count of each junction during the second step. Then the system selects the lane that has the highest vehicle count. After that, the system checks whether that lane has a pedestrian crossing request. If yes, the system moves to the next occupied lane of the junction. If there is no pedestrian request to that lane the system sends a signal to the traffic lights to release the vehicles in that lane.

The system is designed to manage traffic signal schedules based on traffic density on the corresponding road/lane. Python is used in OpenCV and Tensor Flow for the process of capturing video through the CCTV and to count the vehicle numbers in the traffic management & control system. Furthermore, the system uses the Flask API to implement a REST API that acts as a communication layer between the application layer and the database layer. By using the REST API, the system will insert data and retrieve data from the database.

Traffic management and accident reporting system is used as the Android platform to implement the mobile application. Through the mobile application, the user can input necessary data such as the location of an accident, details of that accident (pictures and description). Users can also view the list of accidents that happen within that area which are verified by the police. The mobile application shows the traffic congestions of that area and the locations of the accidents through a map as well.

Firebase used to store all the data that enters the system such as accident locations, details of the accidents, and the status of the accident (whether it's verified, rejected, or resolved by the police). It also includes details about traffic congestion locations. GPS technology is used to track the current location by the mobile app user.

Data related accident cluster estimation uses common methods for tracking high-risk sites are list and the inventory map.

- *List* – based on accident statistics, a list is created indicating concentrations with the highest frequency of accidents involving injury. The list is then divided into junctions and road links, specify the number of accidents involving injury per kilometer.
- *Inventory Map* – Regularly updated map with a record of all accidents. Each new accident is located on the map with a colored pin and the color of the pin varies depending on the severity (injury/death) of the accident. This allows you to quickly see the most dangerous places and sections of the road.

The main part of an accident group is based on historical reports of traffic accidents collected over a defined period. The cluster is constantly updated with new reports that are collected at Semantic Web. It will search for websites and announces new traffic accidents daily and collects needed data. Heat maps are particularly useful for presenting cluster results analysis where observations are assigned in subsets so the observations in the same group are similar in some sense. To select a dangerous location and approach they have observed the followings:

- There are road sections with an extremely low accident rate (from the statistical point of view);
- There are short road sections with maximum traffic accident rates, in relation to equal traffic intensity;
- Research of geometrical road components (situational elements: courses, curves, transitions, elements of longitudinal and transversal profiles) shows the presence of the same elements both on sections with low (zero) and on those with high accident rates).

In a traffic study, collection, and processing of data counted from analyzed data the junctions make it possible to determine the maximum hourly traffic rates, which are the basis for sizing the capacity of the intersection. Graphically, the maximum hourly traffic flows are represented by traffic diagrams. Based on simulated traffic flows, capacity analyses were made using the program Syncro and solutions were developed in order to obtain adequate planning of the intersections. As a result of testing with the Synchro program for each junction analyzed, it was elaborated a scheme with the operation of the intersection on the traffic phases, as well as an ongoing plan of the phases characteristic periods for working or non-working days, at different times of the day

IV. Result And Discussion

The system has the ability to manage traffic signal schedules based on traffic density on the corresponding road. Through the system, it reduces the time that people spend at the traffic lights of a junction. Furthermore, there is a mobile app that would notify the police as well as the users about roadblocks and accidents on the road. The system overview is shown in Fig. 1.

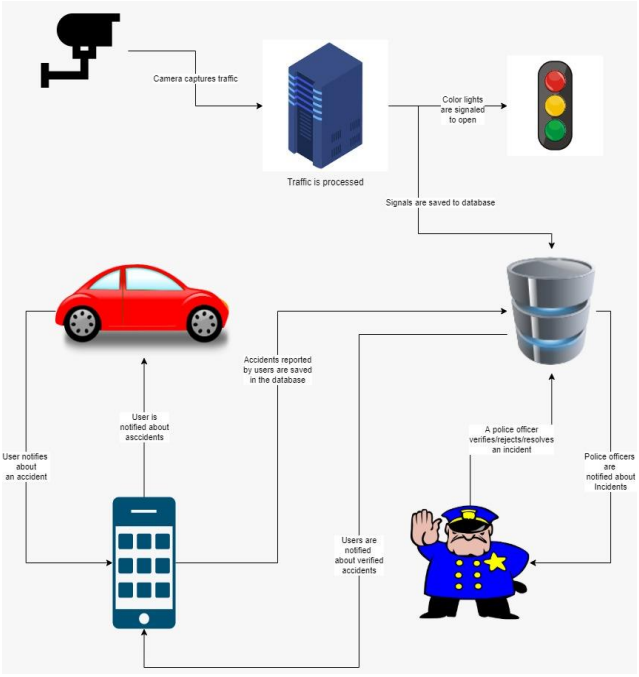

Fig. 1. The system overview

To use this mobile app, users must login by entering their mobile number. The actual screen of the login is shown in Fig. 2. below.

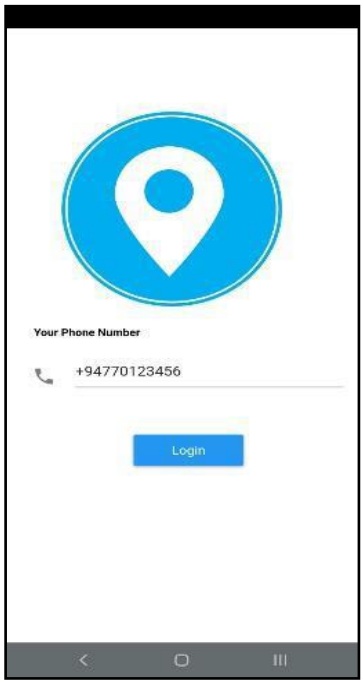

Fig. 2. User Login

Then the system sends a verification code to that mobile number for security purposes. Users must use that verification code to login to the mobile app.

Once the user login to the system, it provides the below user interface as mentioned in Fig. 3. By clicking on the "Submit" button users can report an accident and by clicking the "Location" button user can get direction to a place that they want to go through a map. That map includes the traffic

congestions on that route. By clicking the "View" button users can display details about accidents such as the exact location of the accident happens, images of the accident, brief description, and severity. When, the user clicks on the submit button, the details transferred to the police.

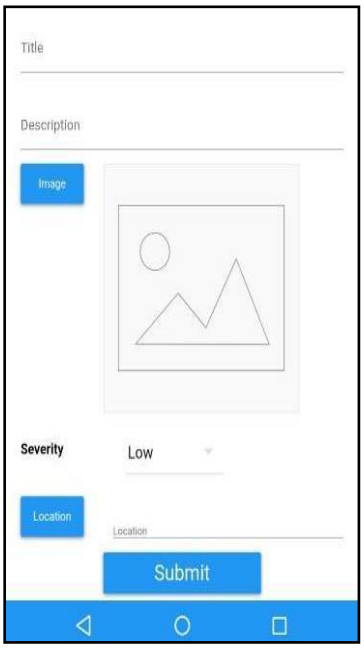

Fig. 3. AIR Reporting UI in Police App

Police Station gets the list of accidents to their mobile app. Users in the Police can view the reported accident details by simply login to the system by providing a username and password as shown in Fig. 4.

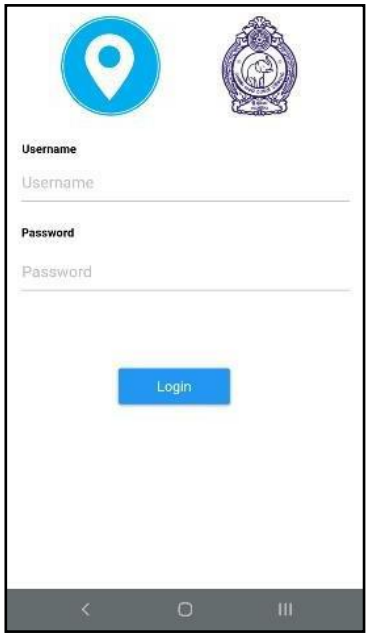

Fig. 4. Login for Police App

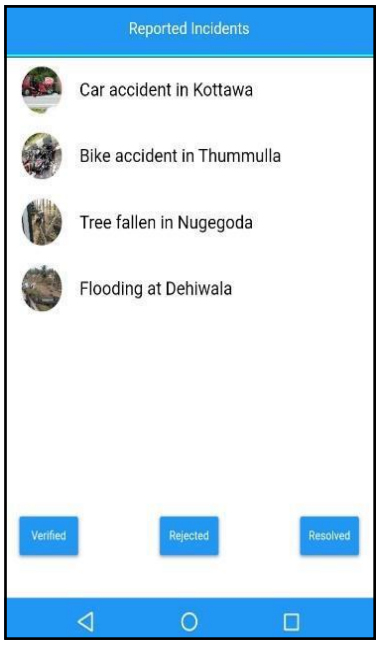

Fig. 5. Reported Incidents in Police App

Fig. 5 shows the interface that the police get after viewing the accident list. Then they can confirm or reject or resolve accidents one by one.

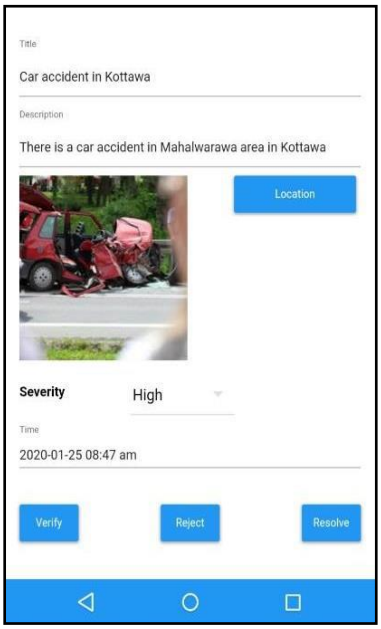

Fig. 6. Incident Verification by Police

There is another interface of the Police App as shown in Fig. 6 to view the details of the accident. Then can select "Verify" or "Reject" or "Resolve" based on the details such as the severity of the accident.

Fig. 7 indicates the user interface of the details of the verified incidents in the Police App.

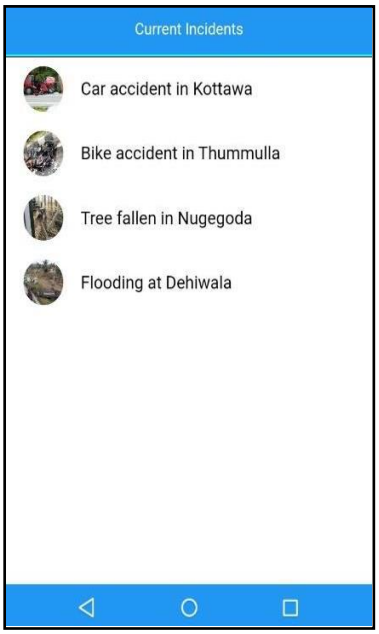

Fig. 7. Verified Incidents in Police App

When the user clicks on the “Location” button can select the current location and the destination location as indicated in Fig. 8.

Fig. 8. Location of the Incident

The route shows a map in Fig. 9. The map shows the traffic congestions of that route and reported accidents on the route (if any).

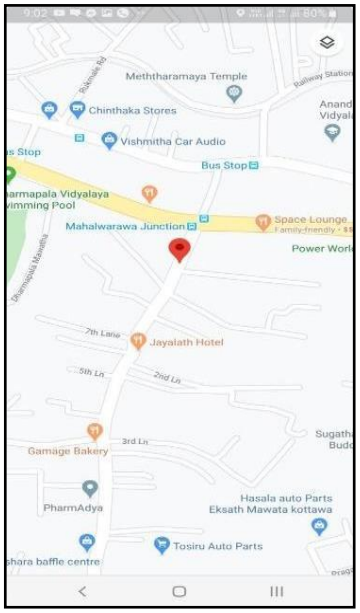

Fig. 9. Location Verification for Users

The list shows verified accident details. Users can view accident details through the below interface as mentioned in Fig. 10.

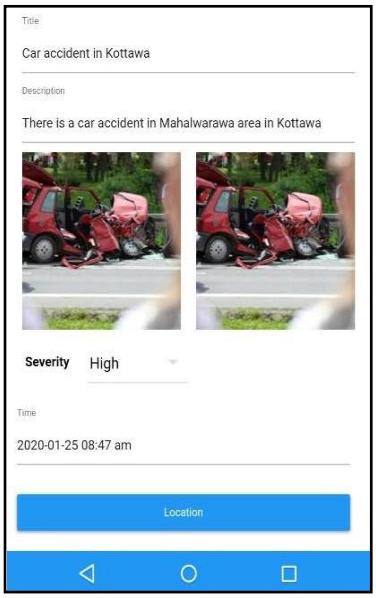

Fig. 10. Incident Verification Details for Users

Due to the limitations of testing the system in the real environment, the testing of the system is done in a simulated environment. In the simulated environment, footage from real traffic monitoring cameras is used to feed to the system. Vehicle count is taken from the source footage using trained models of vehicles. Then the counted number is taken as the actual congestion of a given junction. The data is then transferred to the google firebase and then generated the direction maps to the mobile application users accordingly. Traffic congestions as well as user-reported incidents are marked in different colors according to the severity in the direction map. “AIR Police App” (mobile app for the Police Officers) is also tested through the simulation environment. Because, when an incident is reported, police officers are notified and they can verify the incident.

V. Conclusion

Traffic congestion is one of the crucial problems in Sri Lanka. Due to both traffic congestion and bad traffic management, a lot of man-hours are wasted, fuel emission is increased, and ambulances are blocked on the road. In addition to those problems, sometimes vehicles stop on the road due to color lights even without any traffic. Finally, it causes air and sound pollution in the country. There are lots of facts caused by traffic congestion such as increasing the number of vehicles on the road, violating road rules, improper placement of pedestrian crossings and etc. There is no efficient system to overcome the traffic issue in Sri Lanka at present.

The main contribution of the mobile-based traffic management and accident reporting system is to provide its users with an efficient service by reducing traffic congestions due to the traffic/color lights injunctions. Furthermore, the system reduces the chance of accidents, and report accidents/emergencies. As a result, the system assists to decrease pollution in the country up to a certain level.

At present, most of the citizens in Sri Lanka carrying a smartphone. Therefore, the solution is very much feasible and the users would be able to use the app with less or no training.

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