Rescue Service Alert System with Level Specification for Vehicle Accidents Case Detection on Expressway

Nay Win Aung
GIS Lab and FIS
University of Computer Studies
Yangon, Myanmar
naywinaung@ucsy.edu.mm

Thin Lai Lai Thein
GIS Lab and FIS
University of Computer Studies
Yangon, Myanmar
tllthein@ucsy.edu.mm

***Abstract* — Delivering accident information and conducting the rescue procedures in time are the main components to diminish the risks related to traffic mortalities in Myanmar. The aim of this paper is identifying the statuses of expressway accident victims by utilizing the data from the Sensor Fusion-Based Algorithm and comparing those sensor values with pre-defined dataset to specify the minor or major or critical accident level and, with the Object Detection in Fence Algorithm, the victims can receive the medical assistance from the emergency services. Since the user friendliness is the main preference in this paper, these algorithms are designed for applying in the smartphones built-in high technology sensors, which connects with the GIS, GPS and Geofence technologies.**

Keywords — Accident Detection, Rescue Station, Sensors, GPS, Geofence, Dataset

I. INTRODUCTION

In today's world, the road accidents are considered as one of the primary factors of raising the death rate while many people believe that the drivers do not notice about their speed limits of vehicles during the travel. When we think about the causes of death related to expressway accidents, exceeding threshold speed limits is not the only factor of the accident. There are other factors to increase the fatality rate such as the un-identifying of accident location and delay in sending the alert messages to the rescue services. According to "Road Safety in Myanmar 2017", stated that the linkage between fatality rate and expressway vehicle accidents was significant because the number of traffic mortalities were doubled within eight years, which was from 1853 cases occurred in 2008 to 4688 in 2016. Based on the declared information, it is possible that the increase in death rate was due to the late arrival or absence of emergency services to the accident location. Thus, it is essential to get the prompt response for saving the injured persons and minimizing the level of traffic mortalities rate as lower as possible. Therefore, the smartphone installed with powerful detective sensors are considered as one of the solutions to verify the accident data and deliver the prompt response to the rescue stations.

II. OBJECTIVES

The objectives of this paper are preventing the users from any hazardous circumstances on expressway by using built-in high technology sensors in smartphone, detecting the accurate accident place by applying GPS technology and GIS system, validating the status of accident with the values transmitted from accelerometer and gyroscope sensors, maintaining the data of emergency services by using Geofence Technology, and delivering the alert messages to the nearest rescue stations after validating the victim's status with the assistance of Object Detection in Fence Algorithm.

In 2011, Chris T., White J., Dougherty B., Albright A. and Schmidt DC.[1] "WreckWatch", a model of smartphone-based client/server application was designed to function with built-in sensors and communication interfaces to identify the reasons of accidents arisen and send the messages to the relevant emergency units. However, there is a week point occurred in this application that cannot recognize the risk of accident when the car is driven with lower speed, which is under the configured speed limitation of the application.

In 2013, Danish karim and Jaspal Singh [2] introduced the "Development of Automatic Geofencing and Accidental Monitoring System based on GPS Technology". It is able to identify the accident and protect the vehicles from the theft by using a single shock sensor installed in this system even though the predefined datasets in database to collect the users' information and the possibilities of the occurrence of accident. Besides, it is not indicated where and how the contacts of emergency services are kept even if it was said that the system should transmit the automated alert messages to the rescue stations. Therefore, there is a high possibility for the users to obtain limited information from the sender.

In 2013, the accelerometer sensors in the Smartphone were developed by Patel K.H [3] to obtain the information of accidents. By using GPS, this application automatically produced the location of accident and sent via pre-recorder voice message to the hotline of rescue services in India. However, this application was likely to misinform to the rescue services when the smartphone inclined or fell in any time while the driver drove the car even though a real accident did not occur.

In 2015, Dipesh Suwal, Suresh Manandhar, Shashish Maharjan and Ganesh Dhakal, [4] designed "D-Fencing Application", which could be used as smartphone to send alert message about the Geofencing Post Disaster Scenario. The system administrator sends alert messages of disastrous areas when the user approaches to those places. However, the system is not flawless as system administrator with the knowledge of Geofence performs the manual update of disaster information in database and delivers the warning notifications to users, who requested the information. If the system administrator is unavailable, it is likely to occur the high risk of receiving outdated information by users when the disaster takes place in the region in which the user enters. Therefore, it is obvious that the application is undependable because it is lack of automatic facilities to collect accident data, transmit the accurate alerts to the users and manage the database information.

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III. METHODOLOGY

The accident detection system is operated in two main stages, which are gathering data with data processing and connecting to the nearest rescue stations. First of all, collect the values from Accelerometer, Gyroscope, GPS and then, managed those values in the accident detection dataset. Next, the system analyzes the collected data by comparing with the predefined dataset to specify the level of accident, which is defect of minor, major or critical. When the accident is confirmed, the system applies the GPS values received from accident detection dataset and starts looking for the Geofence technology generates the circular polygons that indicate the accident location as a center point. Finally, the system retrieves all rescue station's contact information in the selected polygon from the rescue service dataset and then, seeks the contact info of the nearest rescue service from the accident spot.

If there is rescue station unavailable in the first polygon, then the Geofence creates the new polygon with broader edges until it finds the nearest rescue station from the accident location. Then, the system informs the rescue station, which describes accident location, the information of user and vehicle and level of incident. To obtain the exaction result of prediction, sensor projected data stored in centralized database such as fixed data, rates of false alarm and death of accidents performs the main roles to predict.

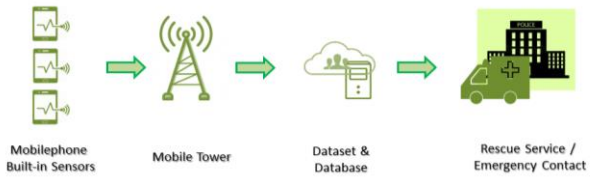

Fig. 1. Accident Detection and Rescue Alert System

Sensor Fusion - Based Algorithm

Sensor Fusion-Based algorithm is selected to promote the dependability of data quality by combining the data received from different sensors while there is a concern of data insufficiency between the single sensors. The information generated from automated sensors cannot be reliable all the time. In this algorithm, the information can be obtained from various sources such as automated sensors, historical sensor data maintained in the central database and the non-automated sensors, examined and evaluated to attain the best output. To get the premium input data is crucial in this system. The following Sensor Fusion-Based algorithm can be used to receive the most relevant outcome of the accident detection process:

$$xi(t) = Ai\ xi(t) + Bi\ ui(t) + Wi(t)$$
$$yi(t) = Ci\ xi(t) - vi(t),\ (i = 1, 2, n)$$

Where t denotes the time and i denotes the total number of subsystems (i.e. accelerometers, gyroscopes and so on) to generate the data. The value of the subsystem xi(t) can be received by adding together of the value of noise at the period Wi(t), the existing state of the source xi(t) and, the signal value sent at the specific time ui(t). Once the value of xi(t) is obtained, the redundant noise value vi(t) is needed to remove from the current value of xi(t) to get the result of the subsystem yi(t).

Object Detection in Fence Algorithm

Once the accident is validated, an approximate of 1000 square meters range of polygon will be produced, and the accident is indicated as center point of the polygon range. Then, Object Detection in Fence Algorithm starts to seek the of rescue services near the accident spot in the range. If the rescue contact is unidentified, the Geofence will produce another polygon with larger edges and the rescue contacts will be sought by applying Object Detection in Fence Algorithm until the nearest contact is found. Then, the accident alert message indicating the information as well as the accident location will be sent to the closest rescue station. In this paper is that the system informs the rescue teams can take a prompt action to victims of accident.

There are three input values (P, Q and S) in Object Detection in Fence Algorithm. P is stated as a location of accident and Q is noted as polygon created to enclose P. S points out the available rescue services marked on Map. In some cases, the early values of inside is specified as 'False' when the searching process initiates in Polygon. However, the final inside value will be indicated as 'True' if S falls within Q or else, it will be shown as 'False' if S is not detected in the range of Q.

Algorithm:
Input: Incident Points as P, Polygon as Q, Rescue Station Contacts as S
P denotes the location of accident
buf is a buffer distance.
Output: true if S contains Q, otherwise false
1: count = 0
2: R is an infinite ray in the +y direction, originating at P
3: for all edges e in Q do
4: if S is within buf of ex then
5: ex,buf = ex -2 * buf
6: else if S is within buf of e or ebuf then
7: return false

Datasets and Technologies Usage

An accident detection dataset or the sensors' primary data is required to verify the accident. Once the status of accident is validated, the recent calibration sensors data is automatically updated in the main server. To specify the level of accident, the accident detection system analyzes the updated data collected from those sensors such as accelerometer, gyroscope and linear acceleration, and compares it with the predefined system data.

Rescue Service Dataset connects Geofence to maintain the emergency service information (for example the contacts of hospitals). After confirming the accident, information including the level of accident and the details of last GPS location will be automatically sent to closest rescue services. Geofence can collect these datasets anytime because the rescue service datasets are always updated on the servers.

In this paper, smartphones are selected as the main theme that inexpensive and versatile machines installed with strong technologies. Android source code is an accessible open-source system and Android Studio assists developers to write the codes with auto-completion tools. Java is one of the most convenient languages with the large set of multifunctional class libraries such as connectivity, sensors and developers can

save their time not to rewrite the codes and, also avoid some unexpected errors.

Geofence produces fixed or modified virtual boundaries in live geographic places. Google Location API provides the powerful and high-level framework to choose the appropriate location provider and management automatically. Unlike the common APIs, Google Location API possesses the activity detection feature. Due to the accessibility to Google Maps Service, the Google Maps Android API is also chosen to show Maps, collect users' responses at the selected location and provide relevant information that the users request.

IV. Results and Discussion

Unavailability of an informer to the emergency services will hinder the victims to receive the required medical treatment on time. The aim of this paper is preventing the victims from the death by providing the timely medical treatment at accident location.

Regarding to the Sensor Fusion-Based Algorithm, the sensors' values are used to estimate the levels of accident. If the smartphone may be tilted or dropped from its dock, the values will be exceeding the accident threshold limit. Then, the user will receive the verification message if these sensors' values exceed the predefined accident threshold of the system. Whether the user replies the message within twenty (20) seconds or not, the Geofencing technology assists the system to automatically generate the visual polygon nearby the accident scene. As a result of the visualized features of Geofence and the application of Object Detection in Fence Algorithm, the accident location along with the closest rescue stations are quickly spotted.

The accident detection system analyzes values received from the sensors such as accelerometers and gyroscopes and specifies the accident levels from defect of minor, major or critical, and then accesses the up-to-date rescue service dataset to retrieve all contacts of the rescue stations inside the Polygon to perform the rescue operations on time. The minor defect level is nominated by accident detection system as an active emergency case while the major and critical levels are determined as the significant damage and the occurrence of multiple fatalities respectively.

The client-server architecture will constantly update the live information on expressway in database server, so the users can retrieve data and ascertain the current situations. This system is intended to operate as the user-friendly version and, encourages the users to provide their personal and other information at the beginning of every trip on expressway. The information of users and vehicles are stored in Database, so the accident detection system can collect and analyze it anytime. The closest rescue station from accident location gets the system message, which includes the accident level, the information of victim and vehicle.

Fig. 2. Accurate Accident Information of System

V. Conclusion

This accident detection system presented is able to operate with the different trained datasets and Google APIs, so the vulnerabilities of similar researches may be worked out. After upholding the well-trained datasets in system, the current user's status on expressway is constantly traced and updated in the database so that the system can retrieve the data anytime to confirm the accident status. With the assistance of Geofence technology, the precise location of accident can be traced without any delay and then, the closest rescue stations nearby the accident will be identified and sent the message to save the victims on time.

The system analyzes the sensors' data to define the level of accident while waiting for the user's response for certain duration; even if the user is unconscious, the system will automatically send the contact message to the nearest rescue station via Geofencing for the medical and other arrangements. Moreover, the latest user information will be attainable from the system's database server in order to confirm the status of accident because the server is continuously synchronizing with the user's smartphone even the phone is turned off.

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