AN EFFECTIVE METHOD OF TRAFFIC ACCIDENT DETECTION SYSTEM FOR RESCUE REPORTING ON EXPRESSWAY

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Abstract

Traffic accidents are becoming a major disruptive issue and emergency services play a key role in rescuing injured people from traffic accidents to reduce the loss of life and property. Today's technologies can trace the current place of the traffic victims and send the user's information with that location to the nearest emergency station to get the timely rescue service. The Motion Sensing Method can detect traffic accidents from the values of the sensors in the smartphone, and determine the accident levels. The Difference Angle Method shows the intended destination of the automobile with endless GPS signals. To obtain detailed results, the Modern Positioning Method is used to communicate with the sensors to get the accident location and track the victim. The Object Detection in Fence Algorithm searches for the nearest emergency services to provide medical assistance by sending the accident information. This system can detect the location of injured persons, analyze the severity levels of accidents, send timely messages to rescue stations, and identify the nearest routes.

***Keywords*: Accident Detection Dataset; Sensor's Value; Rescue Service; GPS; Geofencing.**

1. Introduction

Traffic accidents on the roads are directly related to the population growth of the world. The high mortality rate by accidents is due to the difficulty of identifying the accident location in a short time and timing delay when rescue services receive information. By using smartphones with built-in sensors, time can be efficiently used for rescue procedures and effective rescue operations can be carried out.

Many road crashes are the main reason for the loss of lives among the people in Myanmar. Although having the powerful infrastructures in the developed countries such as speed limit sensors and effective detection systems, there are no effective and efficient accident detection system in the developing country like Myanmar and it leads to face the delay in rescue procedure related to the crashes happens on the road.

Nowadays, with the advancement of smartphone technologies by assembling with many functional sensors are widely used and they can detect drops, flip and the locations where the accidents occurred can be applied to have a better the communication channel. Although the smartphones embedded with powerful detecting sensors are widely being used in Myanmar, it is still lacking a system to classify the traffic crash and notified them to the emergency rescue promptly is not available yet.

This research proposes to plan and apply an automation system built into a mobile phone to detect traffic crashes and inform to the closet emergency rescue teams to be able to minimize the loss of lives as much as possible. In addition, by using GIS and GPS on the expressway intended to be used in this new system, the accident place can be easily and effectively identified in a moment.

The accident detecting system calculates obtained necessary values from the accelerometer, gyroscope and GPS by confirming the crash place. The Motion Sensing Method works to diminish the false alarm rate and identify

the level of traffic accidents. The vehicle's direction according to continuous GPS points can be collected by using the Difference Angle Method. The Modern Positioning Method in this system receives signals from smartphone sensors to locate the location of the accident and track the injured person. The Object Detection in the Fence Algorithm validates where the vehicle is crashed, explores the nearby emergency teams and directly sends information about the incident and guides to the nearest routes.

2. Related Work

In 2011, ChrisT., WhiteJ., DoughertyB., AlbrightA. and SchmidtDC. [1] designed "WreckWatch: Automatic Traffic Accident Detection and Notification with Smartphones", a smart-device based client server architecture can detect whether an accident has occurred or not. There is a weak fact appeared that can't identify the vehicle crash when slow speed, which is underneath the organized speed limit.

Sneha R.S. and Gawande A.D, 2015 [2] developed the vehicle crash announcement called "E-call", which operates the mobile network for data transfer. However, there is a possibility to transmit the false notifications if the system retrieved the accelerometer while the vehicle is unattended.

Patel K.H, 2013 [3] to collect the information of vehicle crash "Utilizing the Emergence of Android Smartphones for Public Welfare by Providing Advance Accident Detection and Remedy by 108 Ambulances". This system auto-produced the location of calamity and notified pre-recorded voice SMS to the hot-line of emergency team. But, this system was possible to misrepresent to the emergency teams after the mobile phone was disposed off or drop while the user flocks although a traffic crash has occurred or not.

Dipesh Suwal, Suresh Manandhar, Shashish Maharjan and Ganesh Dhakal, 2015 [4] designed "D-Fencing Application", which admin sends alerts SMS of hazardous areas when the user come near those areas. If the admin is not accessible, it is possible to appear the high-risk of getting outdated information. Thus, the application is unreliable for the reason that it is lack of upgrading to gather accidental information, report the alerts to the users and manage the data side.

In 2004, Marwan Abboud., Lina Mariya Abou Jaoude. And Ziad Kerbage. [5] designed "Real Time GPS Navigation System". This system relies only on GPS and the traffic road geographic points. The downside is that it can only notified specific directions to drivers in other areas, not just in Beirut. Also, the entrenched GPS device may not be able to distinguish the location from any location if the weather conditions are bad.

Danish Karim and Jaspal Singh, 2013 [9] announced the "Development of Automatic Geofencing and Accidental Monitoring System based on GPS Technology", that crash detection and guard from the stealing. However, the system is designed to auto notified SMS to emergency team, but does not specify where and how the emergency services' contacts are stored. Therefore, users can obtain limited information.

In 2005, Huub_HCBakker, Ken_AMercer and WyattH _Page. [4] "A Review of Position Tracking Methods". Compiled the factors of various tracking methods, the node of object and the base centre are synchronized to collect the complete result of the location. Therefore, multiple base stations are required to obtain an accurate location, as different distances and measurements will result in incorrect locations.

3. Functions of System

Accident detection system has two main functions, the first step is to collect and process the sensor's value, and the next step is to locate and contact the nearest rescue service. Initially the informative figures are captured the values from Accelerometer, Gyroscope, GPS and then, maintained those respective values in the trained dataset, which is specifically created for this system. The collected sensor values will be compared with values in a predefined dataset, which is important for identifying the accident severity levels of Critical, Major or Minor. Create polygons by using Geofence technology centred around the accident point. Finally, the system sends the information of those injured in the accident to the nearest rescue service so that rescue operations can be carried out as soon as possible. The system will then send the report massage to the emergency team with the accident place and information about the occupants of the automobile with the level of incident.

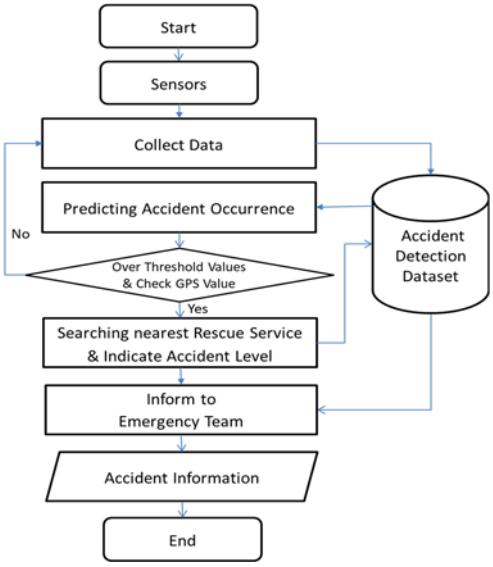


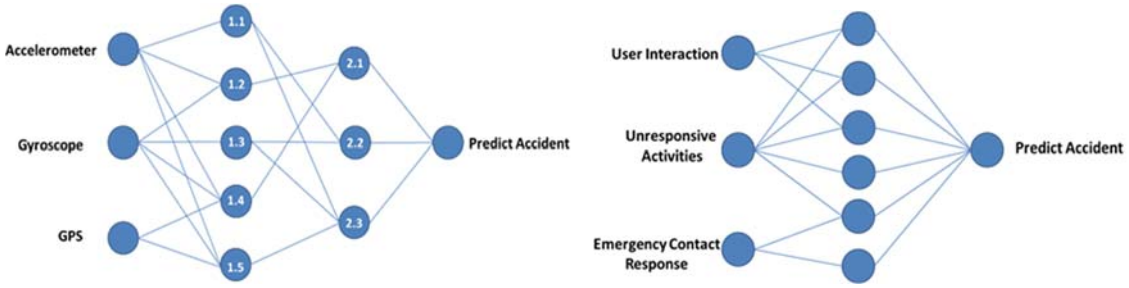
Fig. 1. Depiction of System Functions

3.1. *Motion Sensing Method*

The Motion Sensing Method implements data stability by integrating the data collected by the sensors to reduce communication gaps between the relevant sensors. Other research has found that the values obtained by each automatic-sensor are not computationally exact. In the Motion Sensing Method, the data obtained from automatic and non-automatic sensors are compared with previously stored values to obtain a quality result. Based on the relevant and experimental results obtained to collect reliable values for use in the system, the threshold value of sensors was set to 20 m/s2.

```
ATVx, ATVy, ATVz = Accelerometer_Values();
GSTx, GSTy, GSTz  = Gyoscope_Values();
Predmarks =0;
While(true)
ATVx, ATVy, ATVz = sensorsvalue;
GSTx, GSTy, GSTz = sensorsvalue;
If_not A_x, A_y, A_z in_range_of ATVx, ATVy, ATVz
        Predmarks+=1;
If_not G_x, G_y, G_z in_range_of GSTx, GSTy, GSTz
        Predmarks+=1;
If_Pred_marks>0
        Alert_Accident_Detect
```

In this research, the system will collect and monitor the values from the automatic sensors such as accelerometer, gyroscope and GPS the whole time (see Figure 2-i). The collected sensor values will be compared with the threshold values for a car accident to identify whether a car crash happens. The system will be considered an accident only if the values of all the sensors exceed the specified threshold values. Otherwise, the system will continue collecting and monitoring the sensor values to detect a traffic accident.



(i) Sensor-based prediction (ii) Driver-based prediction

Fig. 2. Two techniques of determining accident detection

When all the sensor values are exceeding the predefined threshold values, the system will send a message to the user whether he/ she is still safe or not. Then the system will wait for the response from the user for 20 seconds. If the system receives a accident confirmation message from the user or if the user does not respond, the system will quickly search for the nearest rescue center and send accurate information to the rescue center in order to save the user in time. (see Figure 2-ii).

3.2. *Difference Angle Method*

Differential Angle Method is chosen to be used to confirm the exact outcome of the accident crush. GPS supports latitude and longitude, but cannot indicate the vehicle's direction. GPS supports latitude and longitude, but cannot indicate the vehicle's direction. The sensor's rate is stored in the smartphone, and if the GPS new value is equal to the previous value is equal, it can be detected as an accident. In the event of an accident, the updated value of the GPS is relative to its last value.
If the traffic crash happens at 1:55:08 p.m., Difference Angle Method repossesses and analyzes the values of GPS seized at together 1:55:08 p.m. and 1:55:07 p.m. If the gyroscope and accelerometer exceed the pre-set standardized value for the accident, but the latest GPS value is not equal from the older value of GPS after the system's check and continues to move, it will not be defined as an accident, it will be considered as a false alarm and false information will be prevented.

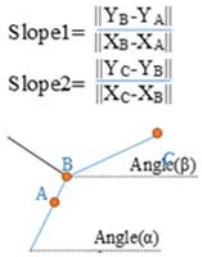


Fig. 2. Calculation of Difference Angles

When calculating this angle difference between the links of current and next, will guide according to Difference Angle Discipline 1 is Є {(0°;180°) Or (-360°; -180°)} => "Turn of Left" and Discipline 2 is Є {(180°;360°) Or (-180°; 0°)} => "Turn of Right". If there are multiple turns, must notified the system well.

3.3. *Modern Positioning Method*

The Modern Positioning Method supports to be tracing the vehicle's location by defining the indicator travel time from the mobile phone to the reliable devices such as the mobile infrastructure or Global Positioning System. The vehicle's location can be gated by using the distance, velocity and time transmitted by the mobile device running the system, and the user's location can be calculated by correlating the origin of the signal. The method equation is:

$$d = v^* t$$

Where d defines the distance among the mobile that transmit the signals and the recipient, while t is expressed as the travel time of these indications to the device and v denotes the velocity of the signals.

3.4. *Object Detection in Fence Algorithm*

After validating the traffic accident, the accident location is set as the centre point, a 1,000 square meter perimeter is established, and the support of the Object Detection in Fence Algorithm, the nearby emergency service is quickly searched. If the nearest rescue team is not found inside the 1st polygon, the system will use Geofence technologies and create a new wider polygon and searching until the rescue service is found with the help of algorithm. This system endlessly obtains the support of these Algorithm till it finds the closet emergency service. When the nearest emergency service is found, system will guide on the nearest route to reach the accident place. Then the nearest emergency service will be notified of the optimal route and information of the incident.
In these Algorithm, three input values (A, P and R) are established as an accident point, polygon created to encircle at incident place and the emergency teams. Sometimes, it is noted that primary values can be fictitious while acting the exploration procedure on Polygon. If R falls within the P or any other value then the last value inside will be showed as 'True', if the R value is not found within the range of the P, the last value inside will be reported as 'False'.

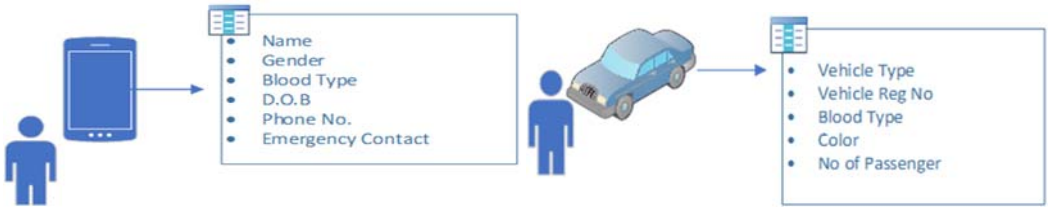
Input: A is crash, P is perimeter, R is rescue,
W is shortest way
A give_accident_point
buf is a buffer_dis

```
Output:  true_if R fall_in P,
         Other.wise_false
         Count '0'
         R is infinite ray_in + y dir, origin_A
         for all perimeter P_n do
         if R is with_in buf of ex_then
                  ex, buf = ex_2 with buf
         function W (A, R)
         shortdist[A]: =0
         For each W in P
                  else if R is within buf p or p buf then
         return_false
```

The looping procedure from point A, the design set count '0'. A collision is detected, the several ray's 'R' is emitted in +y direction from A to P. The loop frequently achieves among A and P till the rescue team R is established. When getting the closet rescue R in area P, the procedure is breaks, and exposed as 'True'. If the rescue team R is not recognized in the area P, the loop procedure also breaks and exposed as 'False'. At that moment, the larger polygon is created to reappearance the next looping procedure until the closet rescue R is established.

3.5. *Information of User and Vehicle*

In order to speed up the inform of effective, users are required to deliver personal info and biometrics of drivers and travelers at the start of the highway journey as shown in figure 4. The user information is gathered with single installation. For example, when the user may need a blood transfusion due to a traffic crash, the emergency team can arrange the applicable blood type for the victims on time.



(i) Personal data (ii) Vehicle Information

Fig. 4. Filling User Information

It is necessary to share not only the user's info but also the driver's vehicle info at the beginning of journey. If a mischievous incident occurs on the freeway, the driver or passenger activate the accident detection system to send an SMS that the accurate spot of collision on the desired journey. At that moment, the information from the dataset will be extracted and combined before delivering to the emergency team.

3.6. *Predefined Dataset of System*

The main data collected from the system's sensors requires an accident detection dataset to analyse the crash situation. Once the traffic crash is validated, the recent calibration sensors send the dataset to the host system for automatic updating. Then, datasets include the sensor values from an accelerometer, gyroscope, and linear acceleration that will be analysed to determine whether an accident occurred.

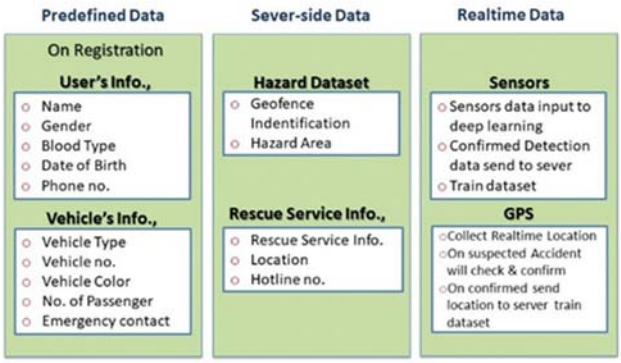


Fig. 5. Predefined and Train Dataset

The Rescue Service Dataset includes highway police stations and fire brigades and connects to Geofence to maintain emergency services information such as local clinics and hospitals. After confirming the traffic crash,

all required messages including the recent GPS location details will be sent to a nearby emergency team. Geofence always updates rescue service datasets on servers so these datasets can be retrieved at any time.

4. Results and Discussion

Lack of timely medical treatment is the leading cause of higher death rates. This is because no one is available at the accident spot to inform the rescue services or the family members of victims, or delay in ambulance arrival. Another reason is that the frequently receiving the false alert can reduce the level of certitude upon message by the emergency teams to prepare the required live saving procedures on time. The main objective is to use the smartphone embedded accident detection system to check the condition of the vehicle and classify the accident level. It will guide the rescue service to arrive by the shortest route in order to lessen the fake messages and save the affected people in time.

The Motion Sensing Method collects the accelerometer and gyroscope value, supports calculating the accident situation and the Difference Angle Method calculates the vehicle's way. In some cases, if the smartphone is slightly moved from its dock, it may receive values that exceed the accident limit. To avoid such a problem and obtain a detailed result from the accident verification process, the Difference Angel Method begins by collecting the newest GPS value and, once the system has identified an accident situation, compares that value to its closest previous GPS value.

Then, the driver and passengers accept the validation message to ensure about the accident if these accelerometer and gyroscope values transcend the system's pre-set accident level and wait at least twenty seconds to get a user's validation message. After passing the waiting time, the system automatically generates a visual polygon with the help of Geofencing technology near the accident site even though none of the user's message is accepted. Figure 6 illustrates that the immediate changes in values of the accelerometer and gyroscope when an accident was occurred. If the accident was identified by the system, the user will receive the system message of "Are you Ok" and the information for the nearest rescue services.

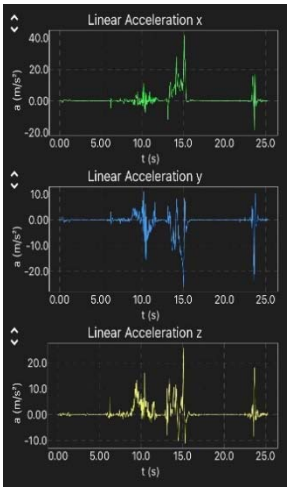


Fig. 6. Senors' Values of Accident Detection

Automatically create a polygon by using Geofencing technologies will be set as the centre, and use Object Detection in Fence Algorithm to easily find the closet emergency service and the optimal route to get there and the system accesses the updated rescue service inside the Polygon to exercise the rescue operations on time. Accelerometer and gyroscope sensor values are set to accident Levels which are analyzed with GPS angle outcomes to classify as Minor, Major or Critical defects. Classified the accident levels by means of the Standardized Values and Results of GPS Track Angle. By using a Low/Medium Result of GPS Track Angle or Low Standardized Value with Low Result of GPS Track Angles, the accident level is defined as minor accident. Similarly, if the result is obtained by using medium or high results of GPS Track Angles or High Standardized Values with Medium or High Result of GPS Track Angle, the accident is classified as Critical defect. Apart from these two categories, if the result is obtained by using GPS Track Angles or Low Standardized Values of GPS Track Angles or Low Standardized Values with the high result of GPS Track Angles, the accident level is considered as a Major.

Figure 7 demonstrates the nearby rescue services from the accident location receives the system message including the details of the victim and his/ her vehicle information.

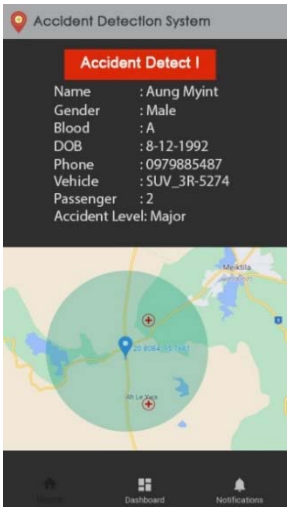


Fig. 7. Accident Information for Rescue Service

Most of the road accidents usually happen due to the combination of driving speed, vehicle condition and drivers' mistake. In this research, the integration of automatic sensors built in the mobile phone and users' response, the system will predict the accidents. In order to predict the accident, the moving object was tested with different speed to detect the sensors values changes. It is found that there is no accident when the values of accelerometer and gyroscope are exceeded from the threshold values but the GPS tracking result is still moving forward. Conversely, when the value of accelerometer or gyroscope is exceeding the threshold value and the GPS value has no changes, the system will determine as an accident and then the system will generate a message automatically to the user. The rescue service also received the system alert message of the accident at the same time when no response is received from the user side.

The system was tested for five hundred times to get its accuracy and the accuracy was calculated by using the confusion matrix. The total outcome values of the experiment results are TP= 452, TN= 38, FP= 5, FN= 5. Hence the accuracy of the system turned out 98 %. This system encourages the users to contribute their personal and other related information at the start every trip. All of the accidents that happened along the expressway can be recorded by creating the traffic accident database of this system, so that the data relating to the drivers and passengers which caused accidents can be retrieved anytime from this database.

5. Conclusion

After studying the current rescue procedures in used, the weaknesses in the existing accident detection system such as speed limits, higher probability of receiving false accident alerts, lack of predefined datasets for objective analysis and non-automatic controls to update the database are significant. After studying rescue plans in use in modern times, it was found that accident detection processes have insufficient pre-setting of speed limits and lack of auto-control, which increases the possibility of receiving false accident warnings. The Accident Detection System can solve the above-mentioned weaknesses by performing various checks with methods and algorithms combining trained datasets and getting an accurate result.

After verifying the real-time data sets in the system by tracking the current user's status on the highway and continuously updating the database, the system is able to restore the data at any time to validate the accident status and it can also monitor the Express-way and update the dataset. Besides, with the help of Geofencing and Google APIs, the exact location of the accident will be tracked quickly and it will then identify the nearby rescue centers of the accident and send a message to rescue the victims in time.

This system is designed as the ease of use version for the users and then waiting the users' response for certain duration; Even if you lose consciousness due to an accident, the rescue report system will continue and then use Geofencing technology to search for the nearest rescue team and send an alert massage automatically with the optimal route. In addition, the server can be continuously synced with the user's phones even when the phone is switched off, so the system's database server can get the most updated user information to confirm the accident status.

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