



## Development of Digital Accident Detector with Android Phones

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### ABSTRACT

The rate of road accident occurrences on our roads is very alarming. Most of these accidents are fatal and results in loss of lives. Some vehicles are embedded with crash detector, but these vehicles that have this facility are very expensive. In this research paper, a less expensive system that can be widely used to reduce the time to report and respond to vehicle crash was developed. The system consists of a mobile-phone-based application, any traveler can install the App in his/her android smart phone. The App uses the in-phone accelerometer and GPS to detect a crash and its location coordinates respectively, and then a notification is sent to a concerned agency. A concerned agency location coordinates with phone number is stored on a Firebase (cloud database) that is created. The App fetches the agency phone number from the firebase and send an SMS with the location coordinates and the Google map image of the crash site in real-time.

**Keywords:** Android Phones, Accidents, vehicle and Applications.

### INTRODUCTION

When a vehicular accident occurs, it is usually the good Samaritans that report such accidents to the emergency responders. The time between when an accident occurs to the time where such emergency centers are notified is a key indicator to saving lives. Waiting for good Samaritans to report accident will lead to wasting precious time which the victims may not have. Having an automatic notification system that can notify the emergency center that is closest to the accident site will go a long way in reducing the level of casualties. In addition, the various in-built car crash detection and alerting systems are mostly available in luxury cars. These cars are mostly saloon and have maximum sitting capacity from 5-9 people commuting per vehicle. The majority of cars on our roads don't have this facility. Android smart phones are one of the cheapest smart phones available and it is believed that at least one in every five people possesses it. Utilizing these facilities in android smart phone to come up with an accident detection system will reduce the fatality rate of accidents.

Traffic is on the rise as the demand for vehicles is getting higher day by day, so transportation needs improvement as there will be more possibility of vehicle accidents. Consequently, if people can't get help on time especially for fatal accident. Poor emergency response to accident sites is one of the major causes of death

whenever an accident occurs. Figure 1 show collision between two cars, but in this case the accident is not a fatal one. The accident detection system in one of the car sends a message to a first responder, but in this case the first responder will only come to the accident site for dispute resolution and to calm situation if the need arises. The low cost of smart phones compared to other traffic analysis and accident prediction system makes them an appealing alternative to in-vehicle accident detection and reporting systems. Specifically, smart phones travel with their owners, providing accident detection regardless of whether or not the vehicle is equipped with an accident detection and notification system, (White *et al.*, 2011).

Narendar and Teja (2013), posited that, controlling a vehicle speed automatically in real time could be too difficult to realize, instead a system that can be alerting the driver about the speed limits and can also detects accidents was proposed. The system can detects when a driver of a vehicle exceeds the speed limits and ignores the warning. Using the GSM technology incorporated in the system, an SMS will be sent

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to a patrol corps with the location of the speeding vehicle. In a world that is becoming more motorized, impact sensors in conjunction with GPS offers a timely, objective and potentially acceptable method of detecting and reporting accidents, (Njuguna, 2012). Yogesh and Rane (2014) carried out a review on the various accident detection system available and proposed an embedded system. The system proposed was Advanced RISC Machines (ARM) Based Accident Detection Using GSM, GPS and Micro-Electro Mechanical Sensor (MEMS). They also proposed some steps that

will be helpful in reducing the rescue time. These steps are firstly, fast and accurate accident detection and reporting to a Public Safety Answering Point (PSAP). Secondly, Fast and efficient evacuation of occupants trapped inside a vehicle. The proposed system used sensors like opt coupler, ultrasonic, alcohol sensors and subsystems like MEMS, GSM and Software interface with GPS and Google Map API for location. The system was proposed with no actual procedures on how to integrate the various components together.

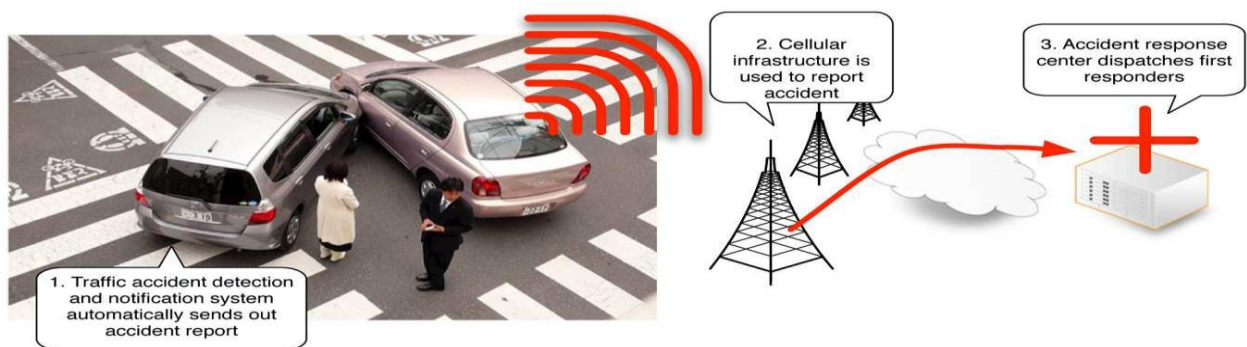


Fig.1: A vehicle-based accident detection and notification system (Source: WreckWatch)

Beramy *et al.*, (2016) proposed accident detection and alerting system that detects road crashes, gets the location of the crash and sends an SMS containing the location to a hospital or police station. The system is a hardware built on a microcontroller board (Arduino board), with a GPS module and a GSM module attached to it. The system uses a 3-axis accelerometer to detect accidents. When an accident is detected the micro-controller gets the coordinates from the GPS and uses the GSM modem to send the notification message. The modules are first turned on, then the GSM module acquires network signal then the system goes into a standby mode. When an accident occurs, the impact sensor gives a positive output and the micro-controller acquires the coordinates of the vehicle location using the GPS module. The coordinates are integrated into the notification message and then sent to emergency services and contacts predefined by the user. The proposed system will be expensive to retro-fit for older vehicles.

module has impact sensors, signal conditioning electronics and accident detection logic unit. Active GPS device with three important capabilities including a GPS signal interface, digital input interface and a wireless interface with transmitting capabilities make up the vehicle tracking module. The surveillance module has a computer with an input interface for a wireless GSM enabled mobile phone. The computer hosts a database for recording accident incidents, accessible through a website, the recorded accident data is displayed at the client workstation against a GIS digital map backdrop, using customized software to authorized users of the system via the website and the internet technology. New accident incident will sound an alarm at the client side to alert the user. This enables authorized users, for example the police and ambulance paramedics to learn about an accident occurrence, allowing them to track and move to the accident site for evacuations. Too many modules were needed before the system can be implemented and this can lead to serious integration problem, (Njuguna, 2012).

Njuguna (2012) designed an instant GPS based motor vehicle accident detection and reporting solution. The system consists of accident detection, vehicle tracking and accident surveillance modules; the accident detection

White *et al.*, (2011) describes how smart phones, such as the iPhone and Google Android platforms, can automatically detect traffic accidents using accelerometers and acoustic

data, immediately notify a central emergency dispatch server after an accident, and provide situational awareness through photographs, GPS coordinates, Voice Over Internet Protocol (VOIP) communication channels, and accident data recording. The system developed is WreckWatch; it was built for android smart phones. It has two phases a client side installed on a smart phone which detects accident, show map and gives provision for registering emergency contacts, and also gives room for eyewitness report to provide situation awareness data, and a server side which provides data aggregation and a communication conduit to emergency responders, family, and friends. It also allows clients to submit accident characteristics (such as acceleration, route, and speed) and presents several interfaces, such as a Google Map and Extended Mark-up Language/JavaScript Object Notation (XML/JSON) web services, for accessing this information. The developed system detects and reports a crash to a first responder not considering the distances of the emergency responders' location to a crash site, (White *et al.*, 2011).

Dang *et al.* (2016) designed automatic fall detection system using smart phone acceleration sensor that works with the accelerometer of the smart phone. A threshold was set for the accelerometer. The system was meant to detect if there is an accidental fall that will be strong enough to trigger the acceleration threshold that was set. The system was tested and was meant for old persons or people with ailment that needed to be monitored constantly to avoid dangerous fall. The smart phone will be attached to a person's body, in an eventual fall, an alarm will be triggered and the Smartphone will make sound for as long as the alarm clock is set. The system is only designed to detect a fall; it is not designed to notify emergency responders in a situation where the fall is fatal, (Dang *et al.*, 2016).

Kaladevi *et al.*, (2014) developed and implemented an accident detection system using an android smart phone. This system uses the heart beat sensor (IR sensor and microphone) attached to the seat belt to measure the heart beat rate, the measured data is then transmitted to the phone using Bluetooth. This is achieved via the control unit (micro-controller) which is connected to the heart beat sensor and is also installed in the vehicle. When there is variation

from the normal heart beat rate, then an accident is detected. The android smart phone then uses its inbuilt GPS to get the crash location and then send the message to an emergency contact. However, heart beat rate is not entirely reliable because it cannot be controlled in certain circumstances, (Kaladevi *et al.*, 2014).

## METHODOLOGY

### The Mobile App Design

The App was designed using android studio integrated developments environment. The interfaces of the App were designed with XML and java programming was used for the events. Pre-defined classes and methods were used to enable the App access GPS facility. For the victim smart phone to be able to detect a crash, an acceleration threshold was set for it through the App. This is the acceleration at which the mobile-phone detects a crash. If the acceleration experienced by the mobile-phone exceeds this threshold, then it concludes that there has been a crash. Intuitively, a very high threshold can lead to false negative and a very low threshold might lead to false positive. Therefore, to set a threshold for the Victim's App, proper analysis is paramount. The acceleration threshold for airbag deployment is 60Gs (around 600m/s<sup>2</sup>), (White *et al.*, 2011). This threshold eliminates any chance of a false positive, but it ignores low speed crashes. Setting a 60G threshold will be too high for it to detect crashes in which the impact is not high enough to deploy airbags. This is because the threshold is a function of the overall vehicle design. Accelerometers attached to the vehicle are what trigger airbag deployment, (White *et al.*, 2011). These accelerometers are physically mounted to the chassis of the car meaning that their motion directly mirrors that of the vehicle and thus experience every force the vehicle experienced. Smart phones, however, are likely to be held in a pocket or in a cup holder. Car safety systems are designed to reduce the force on the occupants of the car during an accident and because of this, the forces and acceleration experienced by the mobile-phone is significantly less than the forces experienced by the accelerometers in the cars, (White *et al.*, 2011). Due to the physical environment of the mobile-phone, the threshold to be set should be significantly lower than the acceleration required to deploy airbags, White *et al.*, (2011) used a threshold of 4Gs, which is

approximately 40m/s.<sup>2</sup>To set the acceleration threshold of the victim’s App, the android smart phone accelerometer designed for the App will have to be integrated with the android device to detect any form of motion. The excerpt from the

code that allows this integration and makes the accelerometer of the smart phone enable in other to detect a crash is outlined in figure 2 from the code excerpt, the acceleration threshold set for the victim App was 30G.

```

CrashDetection

public class SensorService extends Service implements SensorEventListener {
    private static final int NOTIFICATION = 007;
    private Sensor accelerometer;
    private SensorManager mSensorManager;
    private double accelerationX, accelerationY, accelerationZ;
    private int threshold = 30;
    public void onSensorChanged(SensorEvent sensorEvent) {
        accelerationX = (Math.round(sensorEvent.values[0]*1000)/1000.0);
        accelerationY = (Math.round(sensorEvent.values[1]*1000)/1000.0);
        accelerationZ =
        if (accelerationX > threshold || accelerationY > threshold || accelerationZ > threshold) {
    
```

Fig.2: Code excerpt for crash detection

**Creating the Google firebase account**

Android operating system. To use the App, the user must register by filling in information that will be stored on the Firebase and will also be required to start tracking the geo-locations. When a crash occurs, the exact location of where the crash occurs will be part of the SMS that will be sent to the first responders.

Firebase Cloud Messaging (FCM) is a cross-platform messaging solution that lets you reliably deliver messages at no cost. Using FCM, you can notify a client app that new email or other data is available to sync.

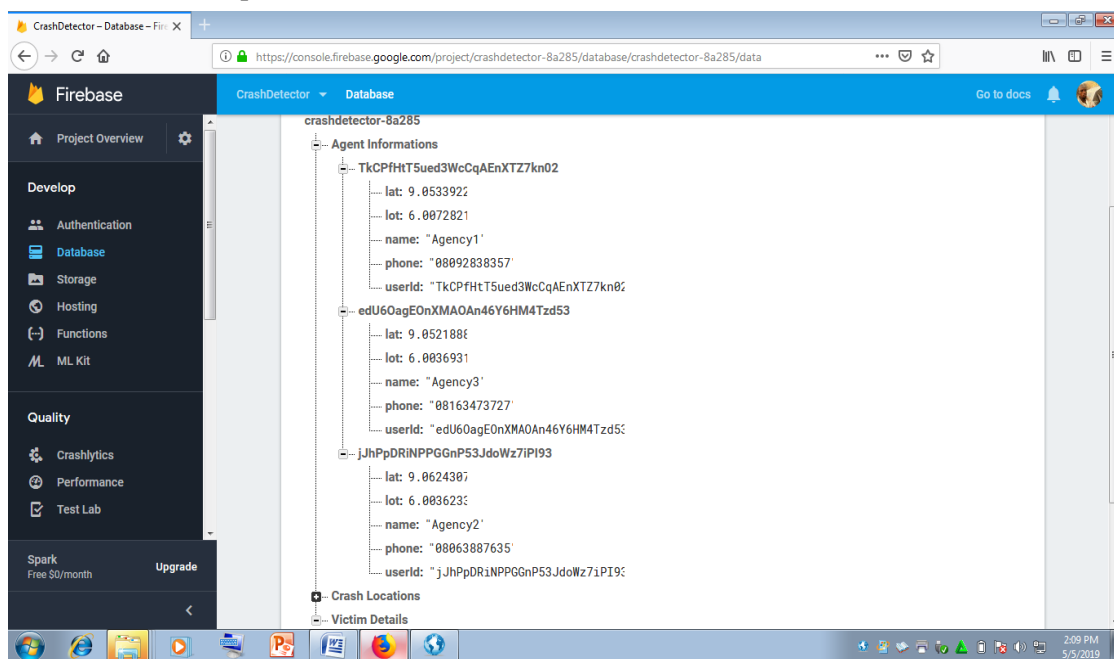


Fig. 2: screen shoot of the Firebase showing agencies and a victim registration

Firestore is also a real-time and a cloud-hosted NoSQL database that lets you store and sync data between users in real-time. It uses JSON structure to store data. To create the Google Firebase account that was used for the system, a Google mail account was created and used in obtaining the token that was used to synchronize the App to be able to communicate with the Google Firebase. Figure 2 shows the display screen with agencies and victim information on the Google Firebase.

### Crash reporting

The App developed and installed inside a vehicle crash victim smart phone detects the

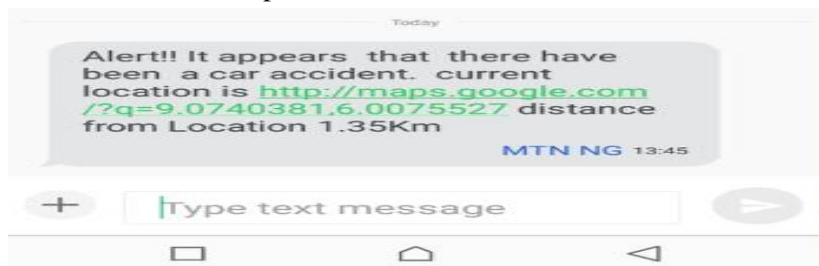


Fig.3: Crash reporting SMS

crash and report it to an emergency centre for prompt response. An algorithm is developed inside the App. In a situation where the acceleration threshold set is triggered, the App access the Firebase and fetch the number of the emergency centre stored on the Firebase. An SMS containing the coordinate's location of the accident site is sent to the retrieved emergency number on the Firebase. The SMS also come with the Google Map imagery of the same location. Figure 3 show a sample of the SMS that was sent.

### Conclusion and Recommendations

This paper developed a mobile phone-based vehicle crash location detection and alerting system that run on Android smart phone. The system if implemented will go a very long way in reducing lives that are lost in fatal accidents because the delay in reporting accidents to first responders is eliminated. It is recommended that 3G or 4G cellular network type should be provided across the country since the system cannot function without cellular internet network.

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