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An Automatic Accident Detection System: A Hybrid Solution

[1] Ali Hassan, [1] M. Shahroz Abbas, [2] Muhammad Asif, [3] Maaz Bin Ahmad, [1] M. Zubair Tariq
[1] *Department of Computer Sciences, Lahore Leads University, Lahore, Pakistan*
[2] *Department of Computer Sciences, Lahore Garrison University, Lahore, Pakistan*
[3] *College of Computing and Information Sciences, PAF Karachi Institute of Economics and Technology, Karachi, Pakistan*
E-mail: Alee.leads@gmail.com, shahrozabbas90@gmail.com, astz786@yahoo.com, maazbinahmad@yahoo.com, zubair_success747@yahoo.com

***Abstract*—Over the past few decades, the world has undergone rapid progress in the fields of technology as well as the transportation system. Moving vehicles are not just modernized and efficient but unfortunately cause the number of causalities in road accidents. Unidentified crashes and late rescue create more edgy situation, particularly on unpopulated highways. To lessen accidental mortality rate, a permissible low-cost automatic accident detection system is proposed that automatically detects the crash and sends notification through Short Message Service (SMS) to the emergency services and concerned family member with precise location. The proposed system consists of hardware and software modules. The hardware module is based on the Arduino board with vibration sensor and accelerometer is deployed in vehicle whereas the software part is an Android application that is installed on users mobile. The experimental results indicate that the presented system functions well as intended.**

***Keywords*-Disaster Detection, Arduino, Vibration Sensor, Accelerometer, Bluetooth Device, Android Application**

I. Introduction

Disaster is referred to a sudden event, such as an accident or a natural catastrophe that causes great damage or loss of life [1]. Scientists always tried their best to facilitate humans with several products, strategies and methodologies. As far as there is a concern of the human health issues, lots of way have been carved to accommodate humanity. From emergency actions to a long time patient care, quick response actions are necessary to avoid a lot of damages taking place in human life. In developing countries like Pakistan, a huge number of people die in road accidents than any other reason [2]. The major causes are not just accidents but unknown crash spots play significant role. Even after a couple of hours of the tragedy, spot cannot be located to start rescue operation. In consequences, a lot of precious lives cannot save in time. After keeping human life in mind, this work presents an automatic accident detection system which is a savior of life. The proposed system has the capabilities to automatically detect an accident and quickly inform to the emergency services or concerned family member with precise location through Short Message Service (SMS). The contacted one can send rescue services as soon as possible. Since, there are a lot of occasions on which people have no access to any nearby hospital to get quick medical assistance before the severe loss. In that situation, system will fulfill the gap between identification and alert. The proposed system consists of hardware and software modules. The hardware module is based on the Arduino board with vibration sensor and accelerometer is deployed in vehicle. On the other hand, software part comprises an Android application that is installed on a persons mobile that is driving the vehicle.

The rest of the paper is organized as follows: Section II presents literature review. Proposed system is described in section III. Section IV presents the configuration and working of proposed system. The advantages of the system are given in section V. Finally, conclusion is drawn in section VI.

II. Literature Review

There are a lot of thoughts and ideas behind every product and application which cause new hope for the betterment of human being. Currently, there are few technologies for accidents detection. Most of the systems need a manual operation and the victim of the accident depends on the mercy of others to rush to the hospital. Many times, one accident is unnoticed for hours before help arrives. Owing to all these factors, there is a high mortality rate of the victims of the accident. There are some systems working to facilitate fellow being with some pros and cons.

Prachiet al. [3] presented Intelligent Accident-Detection and Ambulance Rescue system prototype that consist of a sensor, Global Positioning System (GPS), Global System for Mobile (GSM) unit. The system is fitted in the vehicle to detect the accident and sends the accident location to the main server unit which houses the database of all the nearby hospitals. An ambulance is dispatched to the accident spot which carries the patient to the hospital and simultaneously monitors the vital parameters like temperature and pulse rate and conveys them to the concerned hospital. Along with this, Radio Frequency (RF) communication is used to provide a clear path for the ambulance. This will minimize the time required by the ambulance to reach the hospital. Although this system is good but it required complete automation of hospitals and traffic signals that increased the cost and time of deployment. SoSMart application [4] detects accident automatically using the internal sensors and

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accelerometer of the smartphone. After accident detection it sends an alert notification with location to pre-selected contact, so the contacted one can send rescue services as soon as possible. This application uses professional and sophisticated algorithms that are developed and tested on real car crash data from the National Highway Traffic Safety Administration [5]. Using these algorithms, it is easy to differentiate the sensitivity of accident whether it is hard, normal and just minor to avoid false alarm.

Kaladeviet al. [6] proposed Android Smartphone based solution to automatically identify the accident and generate alert with the location of the spot. In this solution, heartbeat sensor is integrated with a Smartphone. Since there is a defined standard of a normal human heartbeat rate (60 to 100 beats per minute BPM). If there is any variation in heartbeat rate relevant to given range the system check if it is an accident or not. Then the system sends an alert SMS to the pre-selected contact along with the location of the spot. Actually, in our opinion, instead of accident detection, it can be used as heart failure notification. Sane et al. [7] presented a Real Time Vehicle Accident Detection and Tracking using GPS and GSM. This system is much different from the rest of the systems because it uses PUSH ON SWITCHES on the front and rear bonnet on the car. As soon as there is a collision with another vehicle, the accident detection unit sends signals to interrupt pins of the microcontroller. A key is provided with the system which will be used by the driver if there is a minor collision. If the driver presses the key, the microcontroller understands that accident is not serious so do not alert the others. If a collision has been detected and the key has not been pressed yet, the microcontroller will get the coordinates of the current location and will transmit the alert SMS to the family of the driver through fitted GPS and GSM modules.

Anupriyaet al. [8] proposed a Smart Accident Notification and Collision Avoidance System. In this system almost the working of the system is same as that of earlier systems [3], [4], [6], [7]. The mortality rate of human lives is tried to decrease through this system that is a good step towards human living. In this system, there are major four units working simultaneously for the detection of the accidents and alert the concerned persons. First one is a main front unit called the vehicle unit. It includes the sensors, ZIGBEE, and microcontroller along with GPS to sense the collisions. The main function of this unit is to send the location of the spot of the accident towards the ZIGBEE which will give further instructions. Actually, the GPS sends the latitude and longitude to the main server if accident takes place. Secondly, the main brain of the system takes the position which is called the control unit. The control unit keeps all the record about the nearby hospitals in his database for the patients of the accidents. It notify about the accidents and locations through GPS and ZIGBEE. To support the rescue operation, after getting the notification and the location of the spot where collision is occurred. The ambulance unit is responsible for performing rescue operation. The ambulance unit also consists of LM35 temperature sensor and IR based obstacle sensor. LM35 sensor is used for getting the temperature of the patient and obstacle sensor is used to measure the pulse rate of the patient.

Keeping in view it is prudent to say that most of the existing solutions demand complete information technology infrastructure to utilize. In developing countries like Pakistan, hospitals rescue services and traffic systems are not automated so it is not possible to deploy existing systems. So there is need to develop a simple, user friendly and low cost automatic accident detection and alert system.

III. Proposed System

The block diagram of the proposed system is shown Fig. 1. It consists of hardware and software components.

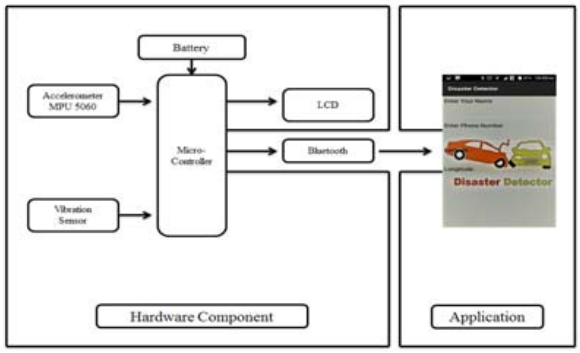

Figure 1. Proposed solution

A. Hardware Component

The Printed Circuit Board diagram of the hardware component is shown in Fig. 2.

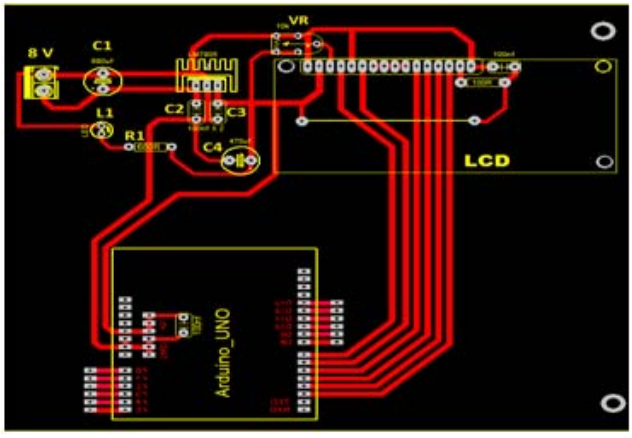

Figure 2. PCB diagram hardware component

The hardware component consists of numerous modules. The following are the main modules:

1) Arduino Board: Arduino is an open-source platform used for building electronics products. Arduino consists of both a physical programmable circuit board (often referred to as a microcontroller) and a piece of software, or IDE (Integrated Development Environment) that runs on computer, used to write and upload computer code to the physical board. In this work Ardunio UNO Rev3 [9] is used. It is programmed using C language [10].

2) Accelerometer/Tilt Sensor: In a moving vehicle, crash not only occurs when there is a collision with another vehicle but it may also occur when there is no proper balance in right and left sides of the vehicle. Sometimes a vehicle may move on the footpaths due to which major accidents occur. Since when a vehicle lose its balance, then the angle of the vehicle definitely changes both horizontally and vertically and the chances of an accident are high. The accelerometer gives the angle of X-axis and Y-axis of the moving vehicle to detect an accident [11].

3) Vibration Sensor: The vibration sensor works on the vibrating technique. The most of the vehicle crash detection systems use this module. In the proposed system, whenever vibration sensor detects any fluctuation of jerk it notifies to the Arduino that a problem has occurred [12].

4) Bluetooth Module: In proposed system, Bluetooth module is used for the communication between hardware and software components. In this work, HC-06 module is used because it gives good performance in data transmission [13].

B. Software Component

The software component is an Android application that is installed on users mobile. The mobile application gets notification from the hardware part and sends an SMS to the concerned person with the precise location of the accident spot. In this work, Microsoft Visual Studio Community 2017 [14] is used as a working environment for the Android application. To create front end of the application, XAML with predefined visual studios feature is used.We worked with c# to handle the back-end using Xamrine platform which is also a very efferent and latest platform in android development [15]. Due to the extraordinary feature of being cross-platform development in Xamrine compelled us to go through that way [16].

IV. System Configuration and Working

None of the product can be declared as a good or bad till it has not been tested in different scenarios and conditions for which it is developed. In order to evaluate/demonstrate the performance/working of proposed system, the hardware component is installed in the vehicle while the android application is installed on driver mobile. Hardware module and users mobile are connected with the help of Bluetooth. After connection step up, enter the drive name and contact numbers for alert notification in the mobile application. Fig. 3 shows the prototype of the proposed system. The following sub sections describe the procedure of connection set up between hardware and software components, configuration of mobile application and working.

Figure 3. Prototype of the proposed system

A. Bluetooth Pairing with Smart Phone

First of all the Bluetooth module of the hardware paired with the Smartphone of the driver. For this purpose, we switched on the circuit through the switch placed near the batteries. Then went to the settings of the mobile and turn on the Bluetooth and searched for the new device. In the list the of the Bluetooth devices, module HC-06 will appear as shown in Fig. 4. Connect the Smartphone with HC-06 module.

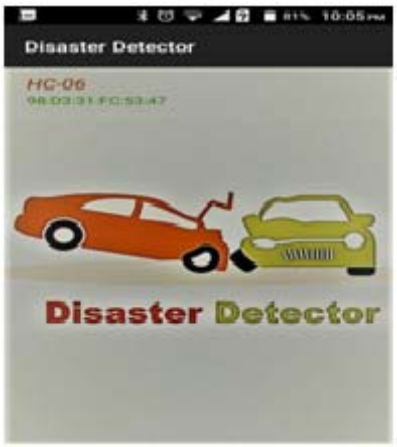

Figure 4. Bluetooth pairing with Smartphone

B. Configuration of Mobile Application

When the Bluetooth module is paired with the mobile phone, the configuration page of the mobile application

would appear. The driver name and contact number of person to whom alert will be transmitted in case of emergency are required to configure mobile application. The configuration page also shows the position of vehicle i.e. latitude and longitude in form of degree. The position of vehicle is acquired from Global Positioning System (GPS) of mobile phone. Fig. 5 shows the configuration page of mobile application.

Figure 5. Configuration of mobile application

C. Working

Fig. 6 depicts the working flow of the proposed system. As soon as Arduino got a signal from the vibration sensor as well as accelerometer within two seconds, Arduino transmitted a message to the mobile application through Bluetooth module. The application sent the alert SMS to the concerned person with the precise location of the crash. The concerned person or rescue service received a message having emergency note as well as accident location. Fig. 7 shows the sample SMS alert and crash location.

V. Advantages

The proposed automatic accident detection system can be a savior of life for those who are worried because of road crash. It can play a vital role to reduce the death rate in accidents. The proposed system is very user-friendly that even a non-technical person can use it easily. In short, the main benefits of this system are low cost, secure and easy to use.

VI. Conclusion

An automatic accident detection system is presented in this work to reduce the death casualties caused by the road accidents. The proposed system consists of hardware and software components. The hardware unit comprises of accident detection sensors that are controlled by Arduino board and is fitted in the vehicle. On the other hand, software

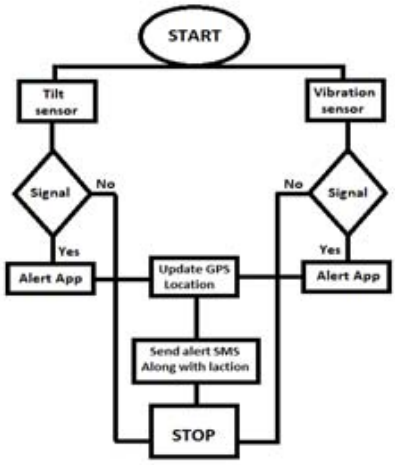

Figure 6. Working flow of proposed System

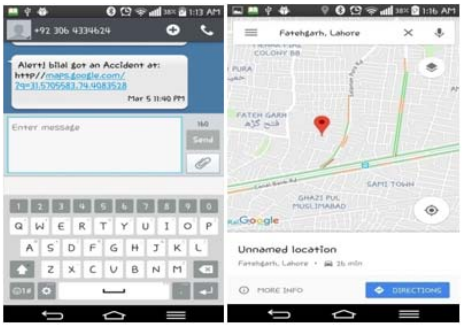

Figure 7. Alert SMS and crash locations

component is Android mobile application installed in drivers Smartphone. So, in case of an accident the notification along with precise location of accident is automatically send to concerned family member or rescue service within a few seconds.

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