



Accident detection system: survey and analysis

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ABSTRACT

Now-a-days, the vehicles are becoming more sophisticated with features like GPS navigation and airbags for safety. In spite of this the victims of the accidents which occur at remote locations do not get prompt medical service. There are several cases where the accident victims lose their lives due to lack of medical assistance. In such situations the advancements in technology does not seem to be useful. This paper specifies the system that would automatically detects an accident and notifies the nearest rescue service which will enable the accident victim to receive instant medical help and assistance.

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Introduction

Every year the lives of almost 1.24 million people are lost due to accident. Road accidents are the leading cause of death among young people, aged 15–29 years. Over 37,000 people die due to accident and over 1,600 children less than 15 years of age die each year. Unless any action is taken on such accident happening in the world or otherwise it is predicted to become the fifth leading cause of death by 2030.

The Global status report on road safety 2013 indicates that world-wide the total number of accident deaths is unacceptably high at 1.24million per year.

In today's day, vehicles with smart assistance systems are heavily in demand due to different reasons like Dense Traffic and Fatal Accidents.

Now-a-days, GPS has become an integral part of vehicle system. So, the systems like WreckWatch would be a smart choice as they would be cheap, efficient and also maintainable as they could just be updated centrally i.e. no maintenance dates or period limits. These systems propose to use the already present elements of the vehicle as well as the smartphones and develop an accident detection system for the vehicle.

Related Work

Accident Detection using Android Smart Phones

This is an innovative solution for the problem of accident suffering victims by developing an Accident detection system using android smart phone. This system has been developed and implemented using the heart beat sensor technology integrated with android smart phone. The application for accident detection using heart beat sensor measures heart rate of the driver. The background noise is filtered from the signal by the system to detect only the sound of the pulse. The microphone has to be held closer to the heart or any other place on the body where the heartbeat is felt intense enough to detect audio signal processing. The pulse rate is determined by considering the time between each pulse in order to get the pulse rate. In case of a variation from normal heart rate of a human being (60 to 100 Beats per Minute) the system immediately transmits the GPS location to the contacts of the driver using SMS (Short Message

Service). When an accident is detected the driver is prompted for a response via voice or touch to nullify false detection.

Accident Detection

This system is used to identify the occurrence of an accident and determine the condition of the driver. The accident location, heart rate, body temperature at accident occurrence spot is transmitted to software for analysis of the victim's physiological status. A copy of this data is also forwarded to mobile phones of the emergency care center.

Heart Rate Measuring Module

The Infrared sensor is used to detect the heart rate while the heart beats are identified using the diaphragm and microphone assembly which is installed at the seat belt. The Infrared Sensor produces less ambient light as compared to normal optical wavelength. This light is produced on current passing through it in forward direction and block current in reverse direction. A Plethysmography sensor is used to detect changes in blood flow form the driver's finger.

Module for Accident Identification

In this module the vibration sensor and the concomitant circuit is used to identify the occurrence of accident. If an accident is detected then the potential difference is transmitted to the micro-computer module for further processing.

Seat belt Sensor Module

The seat belt system is provided with a device that has a microphone and elastic diaphragm to record the sound of the heartbeat which it transmits to the brain of the system.

GPS and GSM Module

The Global Positioning System (G.P.S.) provides location and time information in all weather conditions anywhere on or near the Earth where there is an unobstructed line of sight to four or more GPS satellites using a space-based satellite navigation system. It is freely accessible to anyone with a GPS receiver. The system will transmit the longitude latitude, using this information the GSM service will be used to determine the actual location.

Working

The heart rate of the driver is measured by the IR transmitter and receiver. The IR transmitter is a transmitter like an LED which transmits infrared light; this is combined along with the IR receiver. For monitoring the pulse rate the pulse rate sensor has to be clipped to the finger of the driver. In order to detect the heartbeat the IR transmitter and receiver should be placed in a straight line. The IR rays are interrupted according to the blood flow which is detected by the IR receiver. This signal is then passed through a series of capacitors and amplifiers for processing the signal. The processed signal (final square wave output) is provided to the microcontroller in order to monitor the heart rate.

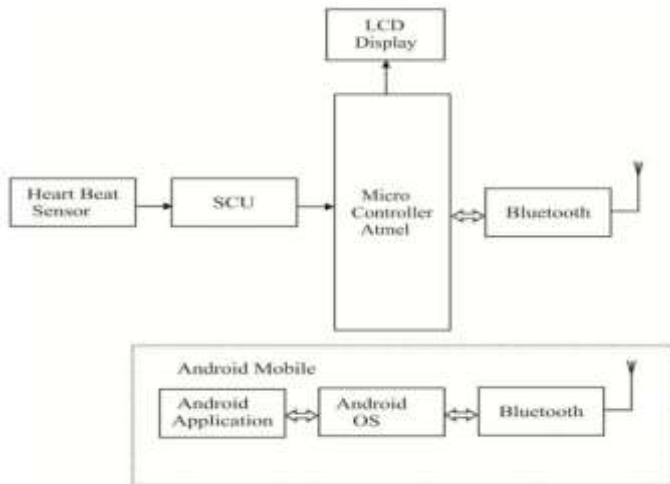


Figure 1. Accident Detection System using Android Smartphone

If a variation in the heart rate is detected then the user is prompted to respond using speech or touch. If the accident is confirmed then the Longitude and Latitude are captured and sent to the contacts of the driver. The details of the user are registered in order to be sent to the contacts of the user. The related contacts of the user are also registered prior to using the system.

WreckWatch- Accident Detection System

Wreckwatch is an application that shows how smart mobile phones, such as the iOS phones and Google Android platform phones, can be used to automatically detect the road accidents with the help of accelerometers and acoustic data and immediately notify an emergency helpline server after an accident occurs and provide on-site information through GPS location, images of the accident, VOIP communication channels and accident data recording.

This section provides the following contributions of Wreckwatch to the study of determining the traffic accidents using smartphones: (1) A formal model for accident detection that combines the used sensors and data contents, (2) Describes how sensors in the smartphone, various network connections and internet services can be used to provide situational awareness about the accident to the first responders and (3) Some results demonstrating the efficiency of different approaches employed by Wreckwatch to prevent all possible false positives.

Wreckwatch displays an effective approach for reducing accident fatalities. So, it attempts to reduce the time between when an accident occurs and medical personnel are dispatched to the scene of the accident. Automatic collision notification systems use the sensors embedded in the vehicle to determine when an accident has occurred. These systems immediately notify the emergency medical personnel about the accidents.

Conventional vehicular sensors for the accident detection systems, such as BMW's Automatic Crash Notification System or GM's OnStar, notify emergency responders immediately after the accident by utilizing the built-in cellular radios and detect car accidents with accident detection sensors, such as an accelerometer and airbag deployment monitors. Figure 2 shows how traditional accident detection systems operate

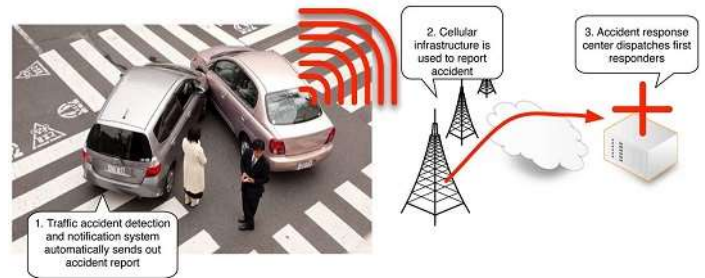


Figure 2. WreckWatch- Vehicle based Accident Detection & Notification System

The cost of smartphones now-a-days compared to other traffic analysis and accident prediction systems is low and hence makes them an appealing alternative for in-vehicle accident detection and notifying systems. Smartphones always travel with their owners, providing efficient accident detection regardless of whether the vehicle is equipped with an accident detection and notification system or not. Furthermore, because most of the smartphones are associated with their owners, automatic notification systems built on these smartphones can aid in the identification of victims in the accident and determining what medical history to be obtained before victims arrive at the hospital. The ability to detect traffic accidents using smartphones has only recently become possible because of the advances in the processing power and sensors deployed on the phones which make them as the Smartphones.

Moreover, smartphones now possess significant sensor data processing power that can support the real-time execution of sensor data noise filtering and analysis algorithms. Another key attribute in the smartphones for accident notification is that they provide numerous network interfaces for sending information back to centralized emergency-response service centers, such as 911 call centers. Smartphones also include Bluetooth interfaces that can directly communicate with the onboard computers in many newer cars. Building an accident detection system based-smartphone is hard, however, because phones can be dropped accidentally (and generates false positives) and the phone is not directly connected to the vehicle. Also, conventional built-in vehicle accident detection systems rarely generate false positives because they rely on sensors, such as airbag sensors and accelerometers that directly detect damage to the vehicle only.

The Wreck Watch Formal Accident Detection Model:

The first scenario in accident detection is triggered when the phone is traveling above a actual threshold speed associated with being inside the vehicle. In this situation, an accident is detected if the smartphone experiences a violent acceleration event, probably indicating a collision, followed by a high-decibel sound, such as air bag get deployed, a loud horn, or even an impact sound. It may also be possible to detect an accident just from an acceleration event, without any sound event, where the acceleration value alone is so large enough that it exceeds the actual accident detection threshold value.

For the accident detection, second scenario occurs when the phone is traveling inside the vehicle that stops at an intersection, traffic light, or any other location. In this case, the algorithm attempts to detect if the user has left the vehicle or is he just waiting for some reason or traffic condition to change.

The WreckWatch formal model also uses built-in microphones on the smartphones to detect high-decibel acoustic events which are indicative of an accident. Using a secondary sensor in combination with acceleration attempts to decrease the probability of false positives.

In case of emergency, WreckWatch allows bystanders, pedestrians and uninjured victims to help as “citizen scientists” and report about the critical situational data to the first responders (Here, Emergency services). In particular, it allows bystanders, pedestrians and uninjured victims to take pictures using their smartphones and share them with first responders, as shown in Figure 3.

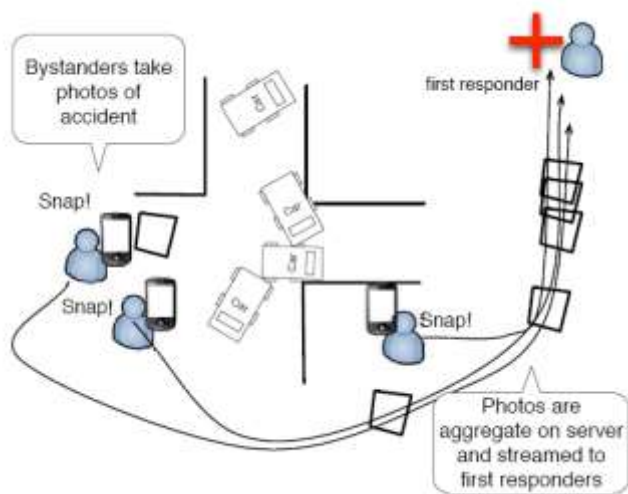


Figure 3. Citizen Scientist- Accident Image Upload

Emergency responders can access the images uploaded by the citizen-scientists via mobile devices en-route or a standard web browser at the central emergency response center. The WreckWatch application provides mapping functionality through the Google Maps on the smartphones to ensure that the emergency responders keep on receiving continuous information about the situation of the accident to prepare them for whatever they encounter at the site.

Potential Advantages of Smartphone-based Accident Detection Systems:

1. Smartphone sensors may measure forces almost similar to those experienced by the victims. In the event of a collision of vehicles, if the smartphone is in a user’s pocket, the smartphone will experience almost similar to the forces and accelerations experienced by the occupants of the vehicle. Even if the smartphone remains stationary relative to the vehicle during the collision, it could be possible to analyze the gathered data from the smartphone to recreate and demonstrate the forces it experienced during the collision.

2. The Iniquitousness of smartphones and their relatively low price, as compared an actual accident detection system, may help to improve the use of accident detection and notification system. Many existing accident detection and traffic monitoring systems require an in-and-out of vehicle, i.e. communication with the internal and external environment of the vehicle, infrastructure to operate efficiently. While some already implemented accident detection systems utilize the existing cellular networks, they have solely focused on voice recognition capabilities and were not implemented as expected. Smartphones allow use of the existing voice and data infrastructure, without any need for the additional in-vehicle hardware system. As the customers and developers do not have to purchase any new hardware, it is possible that the

smartphone-based accident detection systems would be highly recommended than non-smartphone options.

3. Reduce the complexity of software maintenance via. upgrade mechanisms. One most common problem in traffic monitoring systems as well as accident detection systems is that they need to be upgraded to fix the bugs and improve their user-friendliness over a period of time. With thousands or millions of built-in accident detection systems in vehicles, the maintenance may sometimes become very expensive. It may sometimes be impossible to upgrade some out-dated systems and continue servicing them. Hence, upgrading is a better option for the maintenance.

Potential Disadvantages of Smartphone-based Accident Detection Systems:

1. Accident detection systems would consume a remarkable amount of battery power. GPS receivers consume the largest amount of power and sorting them at the rate necessary to determine speed of the vehicle accurately reduces the battery life of the device from a day to several hours. To overcome this limitation, users may plug smartphones into vehicle-chargers and USB slots in their vehicles to provide them with continuous power.

2. Built-in safety systems of the vehicle reduce the impact forces. In-vehicle accelerometers are physically mounted to the chassis of the car, so their motion may directly mirror the vehicle’s motion and will experience most forces the vehicle experiences, even more that the smartphones. Smartphones, however, are likely to be held in a pocket or holster. Car safety systems are designed to reduce the force on the occupants of the car during an accident and because of this; the forces experienced by the phone may be significantly very less than the forces experienced by the accelerometers on the chassis of the car.

3. Destruction of the smartphone in the accident may prevent accident notification delivery. To maximize the probability of an accident to be reported, it is important to prioritize data transmission of the smartphone. Wreck Watch uses a two-staged process to report accidents. First, the initial accident report is sent through the smartphone to the server using a small message that can be delivered over UDP or even through HTTP. Any additional information recorded, such as forces of acceleration during the collision, is then transmitted immediately following the transmission of critical data. However, this two-staged protocol does not totally guarantee that the smartphone will be able to transmit any information if it is destroyed during the crash.

Conclusion

The existing systems for the accident detection use latest technology including smartphones, accelerometers, GPS, etc. but they lack a systematic approach. The technologies used by these systems can be utilized in a better manner. The WreckWatch appeals to have an appropriate but yet risky assistance as the damage to the smartphone may make the whole application non-functional. The Accident Detection Using Android Smartphone uses tools like heart-rate monitoring which can prove to be tedious for a user to continuously wear while driving. Hence, we can say that these systems provide a useful framework but they lack in proper utilization of the technology.

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