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Airbag ECU coupled Vehicle Accident SMS Alert System

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***Abstract*—In the current evergrowing traffic, security is one of the biggest concerns during travel. From airbags and ABS to EBD and automatic braking, work is on to make road travel more secure by the day. This project describes a design and implementation of an effective alert system to monitor an automobile's condition during travel. It is designed to send out an alert in case the vehicle has met with an accident. Our design of the system uses the in-built vibration sensor in the Airbag Electronic Control Unit to detect the abrupt vibrations from the occurrence of an accident. This detection and messaging system is composed of a GPS receiver, a microcontroller and a GSM modem. This enables the monitoring of the vehicle and in the event of an accident; it can immediately be intimated to the emergency services.**

Keywords—GPS, GSM, Vibration Sensor, Arduino, SMS, GPRS.

ACRONYMS

ARAI	Automotive Research Association of India.
ECU	Electronic Control Unit.
GPRS	General Packet Radio Service.
GPS	Global Positioning System.
GSM	Global System for Mobile communication.
NHTSA	National Highway Traffic Safety Administration.
SAE	Society of Automotive Engineers.
SMS	Short Message Service.

I. INTRODUCTION

A. Motivation and Need

The motivation for the system was after witnessing and reading about numerous cases of delayed arrival of the concerned authorities on the accident site plainly due to the delay in conveying the news of the accident. This delay has often been the cause of disastrous consequences. The main motivation and significance of the system: saving lives. Road accidents have been one of the most important issues that need to be addressed in our country. India has the unwanted top spot of being the most deadly country worldwide in terms of road accident fatalities. Statistically, there is one death every 3.5 minutes [8] due to a road accident in India. 5 lives end on Delhi's roads every day. Over 150k people [8] were killed in road accidents in 2016 alone. A figure that is greater than the number of people killed in all our wars put together. If we analyze deep into the aftermath of the accidents we find that there can be three types of deaths arising from a road accident.

- 10% of the deaths occur almost instantly or in a few moments from the actual incident.
- 15% of the deaths take place days, weeks or months after the incident due to complications from the same.
- But the far majority of the deaths (about 75%) actually can be saved in the first 60 minutes after the accident. The so called, "Golden Hour". If the victims can get sufficient support at this time, their lives can be saved.

So from the total deaths, the majority of the losses of life are due to a delay in addressing the

victims of the accident rather than the impact of the accident itself.

While this is often blamed to an inefficient emergency services system, there is an additional problem that the mass public has at times not seen. There are numerous accounts of incidents which narrate to us the delay in the arrival of the said emergency services, but if we delve deeper into the reasons of these delays we will learn that there were countless occasions where the delay was due to the plain and simple fact that they did not receive the accurate location information for the accidents on time. This is sometimes a result of the accident victims or co-travelers being unaware of the exact location of the accidents on the highways of the country. Especially in places where they do not have any buildings or landmarks or even entire towns for reference.

B. Aim of the proposed Work

The aim of the project is to provide a communication link between the vehicle passengers and someone might be able to provide help to the victims in case of an untoward incident. The main aim is to provide a particular individual with the location information of the vehicle once it meets an accident. By doing so, we would enable a faster emergency response from the necessary authorities, which might have a significant impact on the number of death tolls in road accidents.

Our primary problem statement is clear: to develop a system which reliably and consistently delivers an alert and the location information of the occurrence of any sort of an accident in an automobile in the least possible time. The problems right now include:

- Getting an accurate location of the accident. Such as in the cases of accidents on highways.
- In cases of major accidents, the availability of a person in the condition to contact the concerned authorities or any person who could send help there.
- In some cases even with people available, it is necessary to prioritize other tasks on the accident site (such as survivor retrieval) and this causes a further delay in the arrival of important life-saving forces.
- In cases of accidents of government vehicles (such as buses) where the driver and/or conductor is left incapacitated and /or is unaware, there maybe a problem for the passengers to contact the necessary responsible authorities with information of the location of the accident.

Our solution to all of the above mentioned problems is singular and fairly simple. We automate the alerting process by deploying a hardware device in the automobiles which will record the location of the crashed vehicle and send the location details to an appropriate contact person. This will be done by using the combined usage of GPS, GSM and sensing modules which will all be centrally managed by a microcontroller (An Intel Arduino board).

II. LITERATURE SURVEY

A. Survey of the Existing Models/Work

1) "Accident detection and reporting system using GPS, GPRS and GSM technology," [1]: In this paper, the authors have proposed a system that monitors the speed of the vehicle using a GPS sensor. The system monitors the speed of the vehicle based on its location and compares it with the previous speed in every second through a micro-controller. This comparison is to detect accidents based on the monitored speed.

2) "Black Box Resembling System for Vehicle Accident Detection and Post-Crash Analysis,"[2]: In this paper, the authors have proposed a system to detect some basic parameters such as the alcohol consumption levels of the driver, the seat-belt status etc and incapacitate the car engine ignition based on these parameters. Then the system will continuously monitor the vehicle(s) and over time, it will enable reporting on the statistics and locations of accidents on the roads. For accident detection, it involves the analysis of data points such as the body temperature, heart-rate of the driver among other variables.

3) "Car Accident Detection and Notification System Using Smartphone"[3] : In this paper, the authors have proposed the creation of a smartphone app that can be downloaded by the driver. This app will use the smartphone's underlying hardware capabilities to detect accidents, capture information and send appropriate notifications.

4) "A Public Safety Application of GPS-Enabled smart phones and the Android Operating System,"[4]: In the above paper the authors have explored the Android OS and constructed an application which collected speed and location information from GPS receiver using Google Maps API. They used this to determine the schools nearby and sound an alarm if the person drives over the speed limit in a school zone.

5) "Vehicle Collision Recognition and Monitoring System Based on AVR Platform,"[5]: In this system, the authors have proposed a system based on the ATMEGA AVR platform and uses an ADXL335 accelerometer to detect accidents based on the reading in the range of ±3Gs.

B. Summary/Gaps identified in the Survey

The above mentioned systems all have a similar target but there are a few shortcomings in each of those stated above. While by no means is the system mentioned here perfect, but there are a few gaps identified in each of the survey papers that the system proposed here attempts to address. The paper (1) is using continuous speed comparison as an accident detection mechanism that cannot be an accurate method. There can be various scenarios where a driver might be forced to reduce their vehicle's speed, but the accident might be avoided. It is a 'false positive' and it may not be beneficial to report such incidents to the emergency services. This may, on the contrary, prove detrimental to the ability of the emergency services personnel to provide support due to the sheer number of such reports that may not, in reality, need attention. The paper (2) does have a more accurate accident detection mechanism but it uses far too complex data points to be readily available on a large scale. The system's method of monitoring and calculation of heart rates, body temperatures and such data accurately will be too complex for everyday and widespread use. The model in paper (3) is that of the creation of a smartphone application that will continuously monitor the vehicular ecosystem using it's inbuilt accelerometer, GPS and communicate in the event of an accident with the use of it's GSM. While a fantastic idea, I would like to point out that the usage of such an application cannot be enforced while there is still a large percent of population without the financial means to afford a smartphone, this idea cannot be widespread. Additionally, the usage of a smartphone to continuously monitor the vehicle will cause a rapid drain in the phone's battery levels, leaving the app inaccessible and redundant during long highway journeys - one of the most important usecases of this project. The paper (4) also presents a similar idea to (3) in using a smartphone as the base infrastructure. It's model involves using an Android phone and accessing Google Maps APIs to calibrate the vehicle speed and location. This will have similar pitfalls to (3) in addition to the problem of insufficient 3G/4G infrastructure in the country to support this effectively. The paper (5) is closest in idea to the system proposed in this paper. But this involves the usage of an ADXL335 accelerometer, which has a full scale range of ±3Gs. While this paper does provide an insight over an easy and accurate way to detect an accident, the implementation could be redundant due to the hardware in use. This is because, as mentioned in various documents of standards by the Society of Automotive Engineers (SAE), Automotive Research Association of India (ARAI) and the other automotive industry standardizing agencies and institutions, 3G is not the accurate value of the force experienced by the vehicle passengers during an accident.

The ARAI standards for India for instance, the AIS-098 [6,7], require the airbag deployment to limit the forces experienced by the passengers at 80Gs. Similarly, in the United States of America, regulations by the National Highway Traffic Safety Administration (NHTSA) limit the forces for the passengers at ±60G. These figures show the magnitude of forces actually experienced by the passengers in a vehicle. Thus, like proposed in this paper, it would be beneficial to couple the accident detection with the Airbag ECU, which has undergone years of international level R&D to fine-tune it with realistic situations as opposed to theoretical estimations.

III. PROPOSED SYSTEM

The system will, on a high level, detect the incidence of an accident and notify about the event and it's location to a set of phone numbers including, but not limited to, emergency services.

A. Component description

- Vibration Sensor: Whenever an accident occurs, a vibration takes place. This sudden 'impulse' would be monitored by the sensor which would set off the buzzer and activate the GPS module.
- GPS Module: This module is responsible for retrieving the current position of the car by communicating with satellites. This information would be in the form of a continuous stream of data values which will be sent to the Arduino board for processing.
- GSM Module: GSM module is responsible for the transmission of the information from the car to the predefined mobile number. It transmits the information received from the Arduino board to the specified mobile number.
- Buzzer: An optional accessory, it would act as an alert to notify that an accident has taken place.
- Arduino Board: This is the control unit of the complete setup which would be responsible for activation of the buzzer and the GPS module during the time of accident. The arduino board has the logic and is responsible for all the processing behind extracting the actual coordinates from the continuous stream of data which comes in from the GPS module. It would then initiate the transmission of the information received from the GPS module to the predefined mobile number via the GSM module.

B. Conceptual Design of the System

Our proposed design contains a vibration sensor which is part of the Airbag ECU and not externally installed, a GPS module, a GSM module and an Arduino Board. Optionally, a buzzer can be installed which can be used to alert the nearby public for assistance.

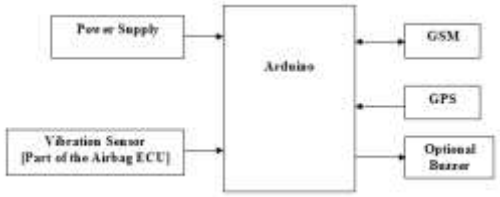

Fig. 1. Conceptual Design of the System

C. Flow Diagram of the System

The vibration sensor senses the vibration generated due to an accident and deploys the airbags. It also sends a signal to the Arduino Board, which in turn activates the GPS module. GPS module then retrieves the latitude and longitude of automobile and sends it to the Arduino board. This detail is forwarded by the Arduino board to the predefined mobile number(s) through the GSM module. Thus the location of the accident site has been shared with the predefined user(s).

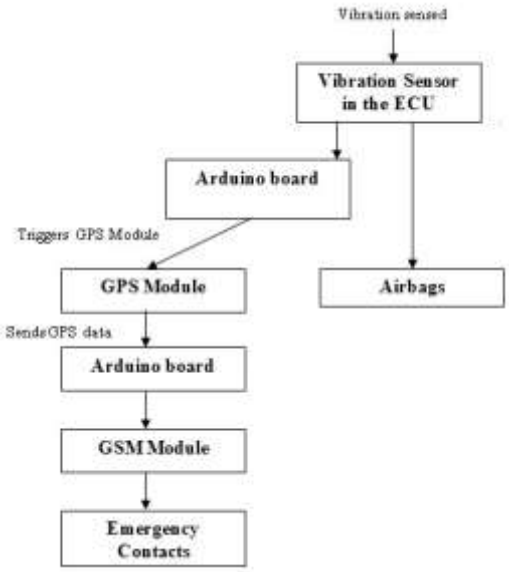

Fig. 2. Flow Diagram of the System

IV. IMPLEMENTATION

After successful coding, implementation and testing of the prototype, we obtained great results.

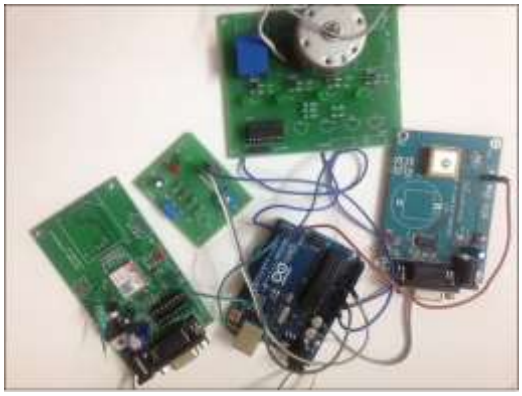

Fig. 3. The Prototype

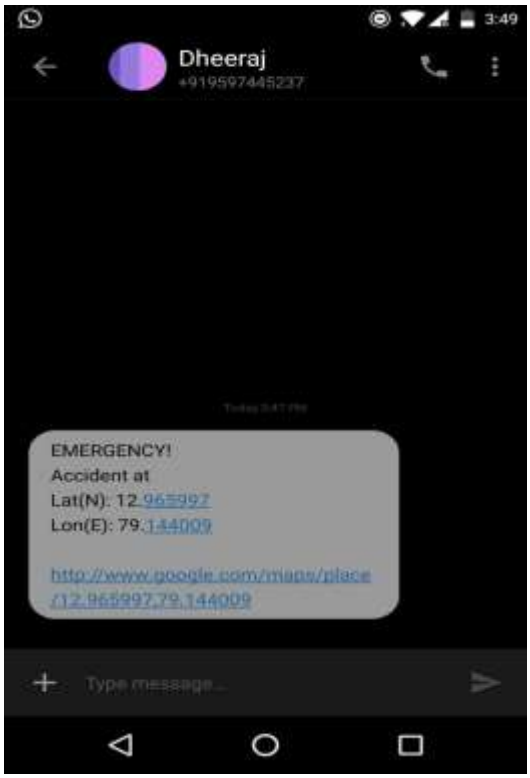

Fig. 4. The SMS

We were able to send out the SMS and also in the SMS was the hyperlink directly allowing users to access the location on Google Maps.

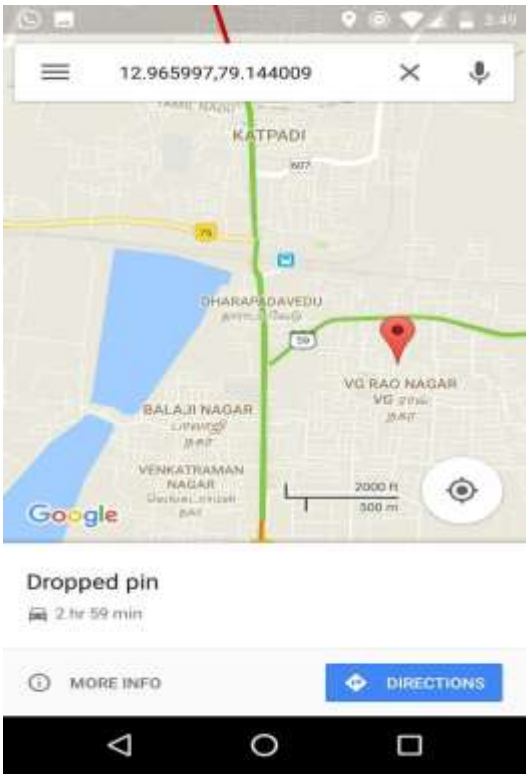

Fig. 5. Map location

V. CONCLUSION, LIMITATIONS AND SCOPE FOR FUTURE WORK

The project was successfully implemented. Thus by having this prototype in place we can address an unexplored area of security and safety and thereby contribute towards reducing the death toll numbers which are caused due to road accidents. Our prototype would help accelerate the response from the concerned team thereby resulting in a quicker addressing to the victims of the accidents. This experiment still will require real-life scenario validation. There is a lot of work to be done to see if the presence of such a system can be made a norm in all the vehicles sold and all the commercial vehicles such as buses/trucks plying on our roads. In addition, there is a vast scope for future developments in this field. This system can be expanded to have a high population density warning system for areas such as schools, colleges etc. It could be used to develop a speed limit warning system as well.

Through the use of tracking (GPS) and communication (GSM), the system can be expanded as a Stolen Vehicle tracking system by expanding it's software capabilities, without needing any new hardware.

If the system becomes an enforced standard, it can prove to be vital in saving precious lives. Potentially, a whole emergency services infrastructure such as call-centers for tracking accidents in the country and emergency response teams to respond to such episodes can be created and help in creating a better transport ecosystem.

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REFERENCES

[1] Md. Syedul Amin, Jubayer Jalil and M. B. I. Reaz , *Accident detection and reporting system using GPS, GPRS and GSM technology*, International Conference on Informatics,
Electronics & Vision (ICIEV), 2012

[2] M. Mounika, Gella Ravikanth, M. Srinivasulu , *Black Box Resembling System for Vehicle Accident Detection and Post-Crash Analysis*, International Journal of Scientific Engineering and Technology Research, 4(26):4931-4934, July 2015

[3] Hamid M. Ali, Zainab S. Alwan , *Car Accident Detection and Notification System Using Smartphone*, International Journal of Computer Science and Mobile Computing, 4(4):620-635, April 2015

[4] J. Whipple, W. Arensman and M.S Boler , *A Public Safety Application of GPS-Enabled smart phones and the Android Operating System*, IEEE Int. Conf. on System, Man and Cybernetics, San Antonio: 2059-2061, 2009

[5] Apurva Mane, Jaideep Rana , *Vehicle Collision Recognition and Monitoring System Based on AVR Platform*, International Journal of Engineering Research and General Science,2(6):540-545, 2014

[6] USA DEPT OF TRANSPORTATION - NHTSA, *Federal Motor Vehicle Safety Standards*, Docket No. NHTSA 99-6407;Notice 1

[7] ARAI, India, *AIS - 098 Requirements for the Protection of the Occupants in the event of an Offset Frontal Collision*, Automotive Industry Standards Committee, 2008.

[8] The Times of India, *410 people died on Indian roads every day last year*, 2017.