Vehicular Crash Signaling System

Sharmila K P, Renjitha V C, Rizwan Roshan

Abstract - The rise in demand for automobiles has resulted in a palpable increase in the traffic density, thereby giving way to more road accidents over time. Many a times, casualties of a road accident fail to live after they fall victim to poor emergency facilities and inadequate accident response time. It is not viable to anticipate road accidents but the repercussions can be minimized at the very least. If given immediate medical attention and care, the number of deaths caused as a result of road accidents could be reduced to a considerably low number. The primary hindrance in casualties receiving appropriate medical care is the fact that the rescue services do not receive any piece of information about the accident and sometimes, even when the information is passed on, it is usually received late. Hence to ensure that victims get adequate medical help on time, there is a need for an efficient automatic system. The Crash Signaling System uses a combination of technologies such as vibration sensor, Zigbee, GSM and GPS modules that detects the impact of the accident as well as the point of accident and conveys the information of the location to the nearby emergency care unit. It also sends information about the point of accident to the vehicles in the vicinity which then would help the drivers of oncoming vehicles to stay alert and drive cautiously. The ZigBee module assists in sending the alert message about the point of accident to the vehicles in the vicinity. The proposed system ensures that the emergency services are made accessible to accident victims in a timely manner and shares the information of the accident to the nearest hospital or rescue team via a GSM module. Besides it also sends a message to the victim's emergency contacts. This system can be used in all in all vehicles for accident detection and reporting. VANET is a similar wireless communication technology which employs V2V and V2I

Keywords – accident detection, Road accidents, VANET, ZigBee.

I. INTRODUCTION

In this revolutionary era, the innovative technologies and well-developed infrastructure has simplified our lives and made it more convenient. The steep rise in population in today's world has only resulted in an increased demand for vehicles, thereby giving way to massive vehicular density on highways. The vehicular density is on a rapid rise giving way to more road accidents [1, 11]. Reckless driving, driving when intoxicated, riding with no helmet protection and riding with inadequate sleep are some of the many factors that contribute to road accidents. In most cases of road accidents, the victim(s) fails to live due to lack of timely medical assistance.

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The critical time between the accident and the arrival of the rescue team could decide the survival rate of an accident victim. Hence, safety on road has become an issue that needs distinct attention. Our proposed solution of Crash Signaling System contains a vibration sensor used to detect the impact of force produced as a result of the accident. This design focuses on sharing vital information about the accident and the accident site to the close by hospital and police station, known as Vehicle to Infrastructure (V2I) communication. The Emergency Medical Services (EMS) can reach the accident spot without any delay with the implementation of the proposed system. The GPS tracking system is used for monitoring accidents. Once the accident is identified, GPS collects the accident position values which consists of latitude (N or S) and longitude (E or W) coordinates. The coordinate values are fed to the microcontroller. The microcontroller then supplies this information to the GSM module. The GSM module enables the system to send the message to family members. At the same time the alert message is also dispatched to the rescue squad. The sensors located within the vehicle are loaded with GPS modules to efficiently track the location of the vehicles. This module helps in identifying the location of the vehicle where the accident takes place and thereby ensuring medical attention arrives quickly. Group communication is a preferred mode by the drivers if they are heading to the same destination or traveling on the same route. They can adopt a few of the common features they would like to access, which has been made available for the communication process. The system not only helps to provide immediate assistance to the road accident victims, but also alerts the drivers of the oncoming vehicles within the vicinity about the accident. This is known as Vehicle-to-Vehicle communication (V2V) [8, 9]. This information can be passed from one vehicle to another vehicle with the aid of a ZigBee Module [2]. A similar network that makes use of both V2V and V2I is Vehicular ad hoc networks (VANET). VANETs which are a spontaneous formation of wireless networks of mobile devices in a vehicular domain was first revealed in 2001 under "car-to-car ad hoc mobile communication and networking" applications It was elucidated that vehicle-to-vehicle and vehicle-to-infrastructure communication architectures will exist simultaneously in VANETs to ensure traffic safety on road, navigation and other roadside solutions. VANETs plays an essential role in the framework of intelligent transportation systems (ITS). The communication domain varies with location, in a rural area, interference is at the least rate whereas in an urban region, owing to the presence of innumerable signals results in interference on a larger scale. The topology of the system should be designed in a way to

resist the environmental conditions. But the proposed solution does not use VANET and the reasons will be discussed later in this paper.

II. VANET VS ZIGBEE

Vehicle ad-hoc network (VANET) is very different from the proposed system when it comes to the applications. VANET which is a sub division of Mobile ad-hoc network (MANET) is a model structured by moving vehicles and fixed roadside stations that has recently come to light. It supports both vehicle-to-vehicle and vehicle-to-infrastructure wireless communication. The most significant implementation of VANET is to enhance safety for driving, using the combination of mobile vehicles and roadside stations [10]. Since VANET involves a group of moving vehicles, the factors such as swiftness and density of the vehicular network differs occasionally which may not assure steady wireless connectivity when the network density is low. Hence, VANET alone may not provide well-timed detection or information about dangerous road conditions. Boosting the efficiency of the network while minimizing contention is challenging for VANET, particularly when numerous devices are situated in a small region and each of the device has massive data message to be transmitted. Two of the most prominent technologies are used in VANET for simple and effective communication:

- IEEE 802.16 (Wireless MAN/WiMAX):

A set of Wireless broadband standards for MAN, designed to enable multimedia application over wireless connections ranging up to 30 miles.

- IEEE 802.11p (WAVE):

Used specifically for wireless access in vehicular domain. This standard allows V2V and V2I communication in the licensed Intelligent Transportation System (ITS) band of 5.9 GHz. ZigBee is a rapidly evolving wireless communication standard which was established by the IEEE 802.15.4 standard [6]. They are designed for applications which require very low rate of data and consumes least power. They are highly secure and reliable as they support several network topologies which includes point-to-point, point-to-multipoint connections and mesh networks [1]. ZigBee consists of a large number of nodes (65,000) in a single network which is mostly used for data transmission. ZigBee interfaces can be used to collaborate different communication activities for the reduction of contention and interference which is one of the drawbacks of VANET [5,10]. ZigBee standard is used as a wireless communication protocol in V2V and V2I as well. It uses license free 2.4ghz band transfer data at the rate of 250 Kbps up to 70 meters.

III. RELATED WORK

This section discusses solutions related to existing technologies and examines their advantages and disadvantages.

As per the previous works by Prasun Shrivastava,Vikram Lodhi and Shubham Vijay Vargiya [1] describes about an electronic system that was designed to be embedded in the vehicle to drive safely with functions such as alcohol detection, car lock system and GPS for finding the exact location of the car if lost. The work carried by Dr.S.S.Riaz Ahamed in "the role of ZigBee technology in future data communication system" as explained in [2] summarizes that Zigbee can achieve better results with respect to features if Zigbee technology is embedded in systems. His work also discusses how Zigbee is a better wireless technology due to its reduced costs of development and growing requirement in the industry. The Remote Monitoring and Controlling Systems concept Based on ZigBee Networks is explained by Soyoung Hwang and Donghui Yu in [3] which explores the vast applications and implementations of ZigBee Network. A smart and reliable system solution using Internet of Things (IoT) was described by Elie Nasr, Elie Kfoury and David Khoury in [4] which sends notifications immediately to the Public Safety Organizations (PSO) headquarter whenever an accident occurs and locates the geographic coordinates on the map. Whereas Rashmi Mishra, Akhilesh Singh and Rakesh Kumar in [5] briefs about security issues and challenges faced in VANET along with suitable solutions. In this paper, the fundamental difference is that the proposed system is a combination of most of these mentioned technologies on-board with the help of LPC2148. The LPC2148 makes it possible to combine all technologies with less expenditure and also benefits the mankind with an advanced device for their vehicle which can provide safety and reduces casualties.

IV. THE PROPOSED SYSTEM

Road accidents over time have given rise to massive death numbers. According to a recent survey, over 1, 46,133 people were killed in road accidents in the year 2015 alone which exceeds the number of people killed in all the historical wars put together [1]. There is one death every four minutes due to a road accident in India. The primary reason for the death of accident victims is lack of timely medical assistance.

Fig. 1.The proposed System

We developed a Crash signaling System that would reduce the human death to accident ratio. This system helps in providing quick assistance to the accident victims. The design focuses on Vehicle-to-Vehicle communication [8] and Vehicle-to-Infrastructure communication that provides the location of the accident to the hospital and police station and also alerts the drivers in the vicinity. The design detects accidents immediately and sends this information to the required authorities. The system contains a microcontroller [7] attached with vibration sensors. The methodology can be explained as follows:

1. In the event of an accident, the vibration sensor will detect the pressure involved and confirms the occurrence of the accident.
2. The microcontroller then detects the location of the accident that has taken place using a GPS module.
3. The alert message containing the location of the accident is sent to the nearest police station and a rescue squad via a GSM module.
4. Once the authorities receive the details of the location, they can instantly track down the accident spot with the help of the GPS module.
5. Furthermore, the message alerting the drivers in the vicinity about the accident is sent using the Zigbee Module [3,9].

V. HARDWARE DESIGN

Like every other system, Crash Signaling System also has a design cycle. The flow chart of the system is illustrated in Fig.3. The implementation steps would remain the same for any system's design cycle. The analysis of the design is applicable to software and hardware components, sensors, input and output from the primary stage of the design to the final production. The electronic devices commonly use either a microprocessor or a microcontroller. The LPC2148 is the controller of the system. When a major accident takes place, the vibration sensor is triggered on by the impact of the accident. Once the microcontroller registers that the vibration sensor is active, the GPS module tracks the accident spot and extracts this location. The extracted location is sent to appropriate authorities and the victim's emergency contacts via a GSM module.

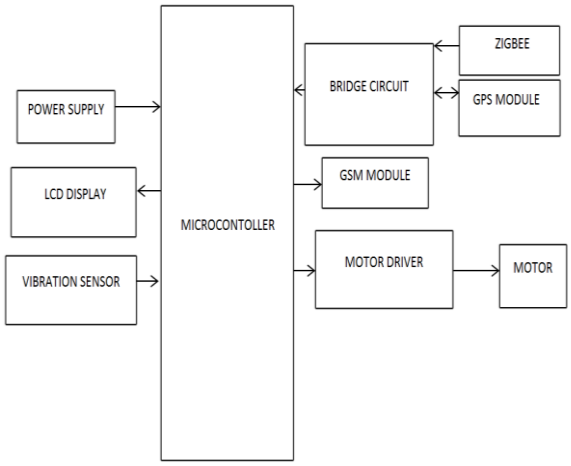

Fig. 2. Block Diagram

Along with this operation, the information of the accident is also sent to the vehicles surrounding the spot via ZigBee module alerting the drivers in the vicinity to drive carefully. This feature helps the drivers to choose an alternative route which lessens the traffic density around the accident spot. Group communication is another feature that has to be specified here. The drivers on the same route can communicate with each other and share common features for communicating. This feature will be a value-added service since the group of drivers can communicate about the accident that has occurred. The operational flow is given below.

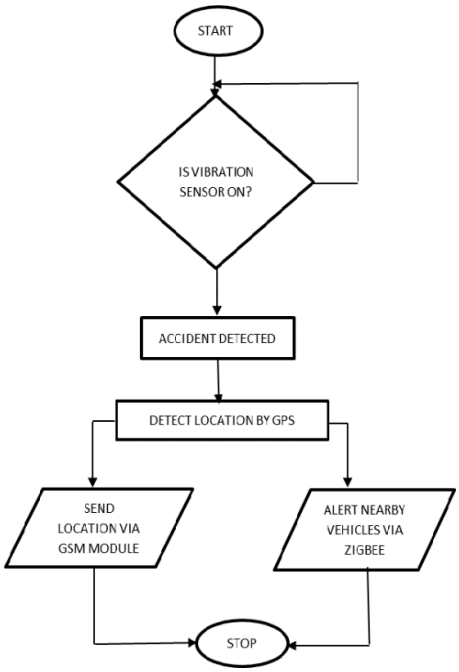

Fig. 3. Flow Chart

VI. IMPLEMENTATION

HARDWARE MODULES

For the implementation of our design, we have used an integrated device consisting of various components and communication protocols. The major components of this device are:

1. MICROCONTROLLER – LPC2148

The LPC2148 is a high performance 32-bit ARM7TDMI-S microcontroller which consists of a CPU with real-time emulation and On-chip crystal oscillator.
It supports In-System Programming (ISP) and In-Application Programming (IAP). As it consumes low power and is tiny in size, LPC2148 microcontrollers are becoming highly popular in the industry due to the demand for small-scaled products which are ideal for applications such as access control and embedded soft modem.

2. GSM MODULE- SIM900a

GSM which stands for Global System for Mobile Communication is a telecommunication standard used for the transmission of mobile voice and data services. Sim900a is an ultra-compact GSM module which works on dual frequencies (900/1800MHz). This wireless module is highly reliable which easily fits in user applications due to the small dimensions and provide cost-effective solutions.

3. GPS MODULE- SIM28m

The government of United States owns the well-established space-based radio navigation system called The Global Positioning System (GPS), initially named NAVSTAR GPS, which is controlled by the United States Air Force. This navigation satellite system is

used globally and this system shares the geographic location and time information to a GPS receiver anywhere at any point on Earth given that there are no obstructions in the line of sight to consecutive four or more satellites. SIM28M is a stand-alone or A-GPS receiver with a built-in LNA. Due to this feature SIM28M does not require an external LNA. SIM28M can trace the lowest of signals (-165dBm) even when there is low network coverage. The SIM28M has an extremely low power consumption feature.

4. VIBRATION SENSOR

The vibration sensor is a device that is used for measuring the effect of collision. It has high-level sensitivity for detecting the vibration and the environment to supress sound signals. It also has a strong ability to engage in interference. The sensor consists of piezoelectric element, spring oscillator, sensitivity adjustment knob, and LED. We can adjust the sensitivity of the sensor by regulating the knob.

5. ZIGBEE – CC2500 RF MODULE

Texas Instruments developed a wireles s transmitter receiver which is based on ZigBee communication protocol, an IEEE 802.15.4-based specification called CC2500 RF Module [1]. CC2500 is a transceiver module which provides effective RF communication at the frequency of 2.4Ghz. It is fundamentally used to transmit and receive data at 9600 baud rates from any standard integrated circuits (CMOS/TTL). Zigbee is a set of high-level communication protocols designed for very low power wireless applications and used to create private area networks with small and low-power digital radios.

VII. RESULT

Once the traffic accident occurs, the GPS module immediately tracks the location and sends this location embedded in a Google Map hyperlink to the nearest rescue team, police station and also to the members of the emergency contact list belonging to the accident victim.

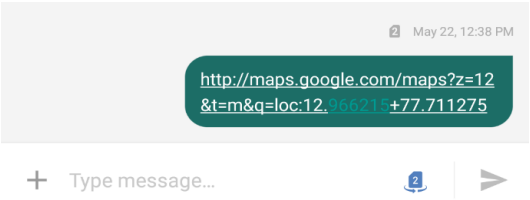

Fig. 4. Message showing the accident location

This information helps the rescue squad to arrive at the spot of accident soon enough to save the victim's life. Once the authorities access the link, they will be redirected to Google Maps which shows the exact location. The red pin points to the spot of accident. The proposed system provides safety compared to the existing system by informing the medical services about the traffic accident as soon as it occurs and the accident victim gets immediate medical attention which can save a life. This system also informs the drivers close to the location about the accident so that they can drive carefully around the spot or assist the victim.

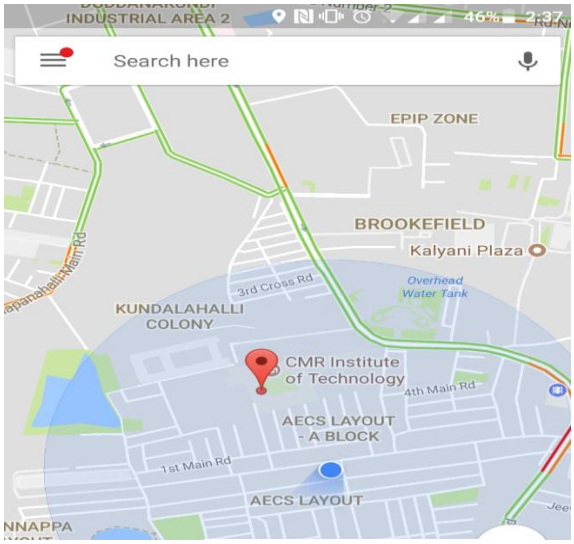

Fig. 5. Accident location

VIII. CONCLUSION

An innovative wireless system using ZigBee, GSM and GPS modules has been developed for vehicle accident detection and reporting. This paper proposes a design which is cost effective and portable due to its small size. This system can surpass the problems that the present-day vehicles have due to the absence of an automatic equipment which can detect the location of an accident. Hence, at the time of an accident, the implementation of this system on all vehicles can ensure that the victims can get immediate medical attention as well the victim's close relatives can be well informed about the victim's whereabouts. This system was verified at each stage by programming the microcontroller and receiving the location details to the respective contact numbers. The Vehicular Crash Signaling System can broaden the application prospects and play a significant role in our daily life in the future.

APPLICATIONS AND FUTURE SCOPE

SAFETY: Alerting the close by health center about the occurrence of accident and warning about road conditions contribute to the security of the passengers. The overhauling of traffic accidental conditions can be eliminated via vehicle to vehicle communication. At the event of a car failure, this warning message can be broadcast to the set up wireless network zone which can prevent accidents.

FUTURE ADVANCEMENT: As the vehicle to vehicle communication is advancing rapidly, the application will find more uses in our daily lives. Some of the advancements are use of Wi-Fi modules instead of ZigBee module. Wi-Fi module can be used because everyone has access to the internet via Wi-Fi and it's also easy for cloud computing. Another possible improvement would be finding the distance between the accident spot and the surrounding vehicles so that the drivers will have an idea of how far or near the accident has taken place. With the evolution of technology, the communication between one automobile and many numbers of automobiles simultaneously

could be achieved in the near future.

COLLABERATION: The combination of VANET and the Crash Signaling System can go a long way to prevent accidents from occurring and if there is an occurrence of accident then the Crash signaling System can help reduce the casualties.

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