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Driver Assistance System Using Li-Fi Technology Based Communication

V Subbulakshmi, G Prethija, B Keerthana, R Pavithra and S Sesha Kayathri

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SUBBULAKSHMI V
Information Technology
Velammal Engineering College
Chennai , India
vsubbulakshmi90@gmail.com

PRETHIJA G
Information Technology
Velammal Engineering College
Chennai , India
prethijafferson@gmail.com

KEERTHANA B
Information Technology
Velammal Engineering College
Chennai , India
keerthirishi897@gmail.com

PAVITHRA R
Information Technology
Velammal Engineering College
Chennai , India
pavithraramesh517@gmail.com

SESHA KAYATHRI S
Information Technology
Velammal Engineering College
Chennai , India
skayathri99@gmail.com

***Abstract*—Due to vehicle crashes, accident rates are increasing day by day. In 2018, about 1.2 million of the population had departed their lives in road accidents, which are surveyed by the World Health Organization (WHO). These accidents occur due to reasons like brake failure, loss of stability which leads to death or disabilities. To overcome these adverse accidents, communication was set up between vehicles to avoid collision between them. At present, an RF-based communication system has been established to avoid collision between vehicles. Even though RF-based communication has helped to avoid collision between vehicles, it has some shortcomings such as congested spectrum, interference and security. To overcome these drawbacks, we have used visible light communication. The Li-Fi based communication system provides interference immunity, high bandwidth, security and a high data rate. We have also used GPS and GSM to send an alert message if an accident occurs. The main purpose of this work is to avoid collision between vehicles and to send an emergency text to the concerned portable vehicle to avoid the death of human life. The proposed Li-Fi based V2V communication system is quite a cost effective and provide high rate capabilities.**

Keywords—Light Fidelity (LiFi), Light-emitting diode, Arduino, Ultrasonic Sensor, MEMS Sensor, Vehicular communication.

I. INTRODUCTION

There has been an increasing advancement in the field of science and technology. We human beings utilize these technologies for our own comfort and time utilization. The progression varies from wired to wireless type of communication system. The wireless type of communication has been moved one step forward by inventing Li-Fi based wireless communication system.

Herald Hass, father of Li-Fi technology, stated that the intensity of electric field and electric potential of light emitting diodes serve as the heart of this technology. This technology is a leading edge in near future since it uses visible light spectrum. This spectrum is used since the data transmission rate is ten thousand times greater than the bandwidth used in Wi-Fi technology. As there is a demand for Wi-Fi by users, thus RF based signals are constantly used .Hence, LiFi is the best solution for this issues. The main idea is to use the light bulbs. These light bulbs can be used as a source for transmitting data.

Road accidents occur due to collision between the vehicles. As a result, loss of human lives occurs. Predominance of road accidents occurs due to the rear vehicles which are unable to know the actions of the front vehicle. Therefore, if a communication is established between front and rear vehicles, collision can be avoided.A Dedicated Short-Range Communication (DSRS) communication system was habituated between vehicles which communicate at a frequency range of about 5.9 GHz. On the other hand, a Vehicular Ad-Hoc network, an application of MANET has been habituated in which two vehicles communicate using wireless fidelity. Li-Fi is used since it is frugality and has high data rate where as DSRS and Vehicular Ad-Hoc network lack frugal and has low data rate.

Already LED lights are available in the cars. These LED lights can be used as transmitters for Li-Fi. By attaching low cost circuits and by using Li-Fi technology, collision can be avoided between vehicles.

Fig. 1 Li-Fi technology communication

Fig. 2 V2V communication

This paper has been divided into five sections. Section II is about the literature review related to V2V communication system and Li-Fi based communication system. Section III illustrates the transmitters and receivers design for Li-Fi based V2V communication system. In Section IV implementation of V2V communication system is discussed. Section V illustrates the conclusion work.

II. RELATED WORK

In the literature, several works have addressed the working of Internet of Things smart devices. It explores control measures and safety of accidents in projects that are being built and to minimize the accidents that occur in the working industries.

Yang et al. stated that vehicle obstruction in V2V communication is a special scenario [1]. The path loss and spatial distributions including the channel characteristics are different from the vehicular communication system. The Global Navigation Satellite Systems (GNSS) found that it was difficult to identify vehicle obstruction. Therefore, it has been stated that it has been difficult for the V2V system to respond suddenly due to vehicle obstruction in the channel characteristics. The vehicle obstruction is identified correctly and an effective and reliable operating state is maintained for proper selection of propagation channel models in V2V communication. The measurements are used as training datasets in which the channel characteristics are extracted. The scenario identification model is obtained by training the back propagation neural network (BPNN) by using validation data and thus the identification accuracy has been verified. It has achieved an identification accuracy of about 97% in vehicle obstruction scenarios. Therefore, this survey indicates that the system shows a good performance for the identification of vehicle obstruction in the V2V communication system.

Zhipeng Di et al have made a research on Forward Collision Warning with Advanced Driver Assistance Systems (ADAS) which stood for the development of ADAS [2]. This has been done to develop autonomous vehicles and to increase road safety. The FCW depend on monocular vision and has two processes namely vehicle detection and vehicle tracking. The vertical, the horizontal edges, and the shadows are combined roughly to generate hypotheses of vehicles which are done in the case of the vehicle detection process. Also, to eliminate the non-vehicles, HOG transform and an improved classifier namely Adaboost are applied. Based on normalized cross-correlation and the Harris corner detector algorithm, feature point matching method is used for frame handling, in the case of tracking. The bottom line of new vehicles is checked by measuring the distance. The system is tested, verified, and implemented and the system has proved to achieve to have a good performance.

Bera et al. stated that WiFi technology is becoming a trend nowadays with an increase in the number of users [3]. The Wi-Fi has a standard of IEEE 802.11n and provides a speed of about 150Mbps. Though it has a speed of 150Mbps, it is incapable of providing the service to all the users. Therefore, to overcome these issues, the drawbacks of Wi-Fi have been focused to enhance the technology by introducing Li-Fi. Li-Fi was first proposed by Herald Hass, a German Physicist. Herald Hsss stated that Li-Fi has been used as a medium of communication. The LEDs blink at a very faster rate which cannot be identified by human eyes. The data rate speed is about 10megabit per second which is considered as much faster than an average broadband connection.

Pooja Chatelet et al. developed Li-Fi based smart vehicular communication system which avoids collision between vehicles. Li-Fi uses visible light spectrum which has been emerging as new technology [4]. They ensured safety by using LED headlight as transmitters and photo sensors as receivers. The LEDs used suits for limited range of communication. The system is economical since LEDs are inexpensive and algorithms used for signal generation and transmission process are very simple. The transceiver circuits that are considered basic are implemented.

Dhanush Varanasi worked on wireless communication and stated that these wireless communications have to be safe, fast, and reliable [5]. Li-Fi that is emerging as a technology has been designed to overcome these problems. The main aim of this system is to make a development in the field of Li-Fi an optical wireless technology, to enhance its current use in the communication field and also to achieve future scope.

Padmapriya et al. introduced an innovative product with a societal acceptance that aids comfort, convenience in everyday life. Nowadays, shopping at malls has become a daily activity [6]. We can see a huge rush on holidays and weekends. People purchase various items in the malls and they purchase them by using trolleys. They must find the product in the list, and then needs to stand in a queue to pay their bills at the billing session. This process consumes too much time. So, to avoid this 'LIFI Based Automated Smart Trolley Using RFID' has been introduced. Here, the system uses RFID tags. Every product consists of an RFID tag. When the customer puts their products inside their trolley, the RFID reader scans the products inside the trolley. The LCDs display the name and cost of the product. The system uses VLC to transfer data to the main computer. They deployed a Li-Fi for billing to receive the data from the transmitter section.

Irlon Silva Santos et al. proposed a study on V2V communication and have implemented using VLC [7]. It is possible to transmit event-based messages by modulating the vehicle tail lights. To achieve this, a model has been created which uses high bright LEDs and controls environmental conditions to avoid external interferences

Noof Al has presented an initial design and results from the V2V communication system using Li-Fi technology [8]. Therefore, V2V has been found as the most successful solution to reduce road accidents. The main advantage of using LED in Li-Fi technology is that it eliminates complex wireless networks. There have been many case studies that have researched the V2V communication system. The

experimental results have been presented and it has agreed quite well.

Isamu Takai et al. have introduced an optical wireless communication technology that is based on an optical V2V communication system with LED transmitter and a camera receiver [9]. They used an optical image sensor namely CMOS image sensor. The OCI responds to light intensity light source variations which have a communication pixel; the output consists of high intensity flag image. The LEDs are detected using a camera receiver in real-time. Various vehicle internal data and image data are transmitted successfully between the two vehicles. The image data reception archives a transmission rate of about 13.0 fps.

Deok-Rae Kim et al. implemented an outdoor Visible Light Communication that is based on Controller Area Network [10]. These are used in cars, planes, ships, and medical devices for establishing V2V communication. The system uses headlights and backlights. An application circuit has been made and the principles were explained effectively. The problem that is achieved in this system is the photo detector (PD) saturation problem. In the daytime, a total communication distance of about 20meters has been achieved and the experimental transmission performance has been presented.

III. PROPOSED APPROACH

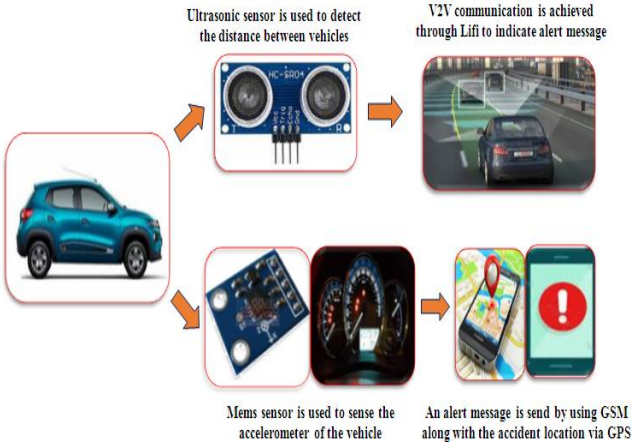


Fig.3 System Architecture Diagram

Fig.3 depicts the system architecture diagram of the proposed work. The system comprises 2 sections, namely transmitter and receiver.

The LED lights present in the vehicle are used as a transmitter, and they send the pulses as 0's and 1's. The LEDs transmit the data quickly in such a way that it is not visible to the human eye. The photodiode which is in front of the vehicle receives the transmitted data as current. This system is used in situations, when a vehicle applies a brake, it is sensed by an ultrasonic sensor and an alert message is transmitted by light to the rear vehicle. Once the brake is applied, the Arduino processes the data, and it triggers the LED which serves as a Li-Fi transmitter to alert the rear vehicle. The alert message is also displayed in the LCD of the rear vehicle. The data which is transmitted from the front vehicle's LED is received by the photo detector in the rear vehicle in the form of a current pulse. MEMS sensor senses the accelerometer (i.e. Speed) of the vehicle. When an accident occurs, the MEMS sensor informs it to the Arduino. Then the Arduino is now responsible to send the accident location and alert message using GPS and GSM.

The proposed system developed here is used to address the issues present in the literature works done in the past. The smart safety helmet works based on IoT and various sensors for collision avoidance. We have implemented various modules in the proposed system. These modules are defined below

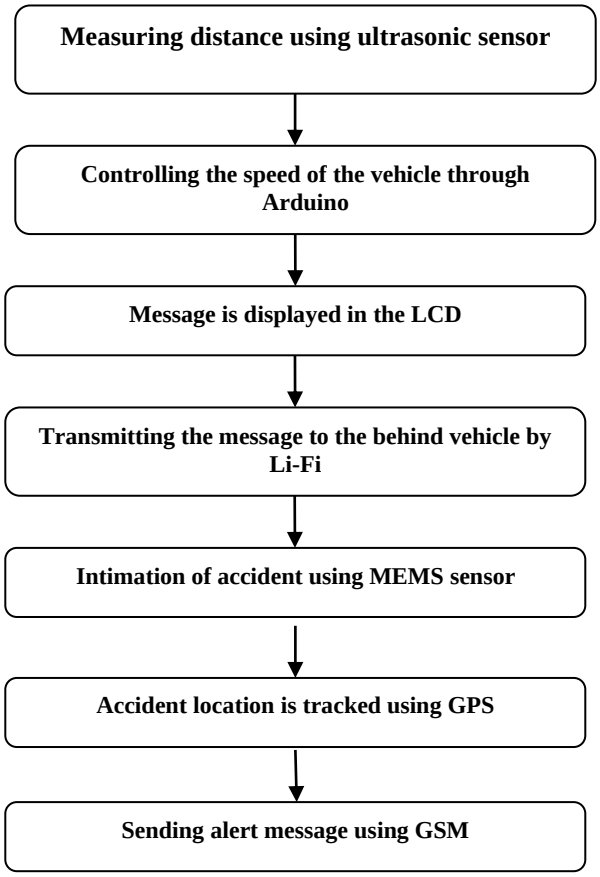


Fig.4 Flowchart of Proposed Work

A. Measuring the distance using Ultrasonic Sensor.

An ultrasonic sensor detects the vehicles within the provided range, using sound waves. The distance is measured by sending out an acoustic wave at a selected frequency and listening for that acoustic wave to recover from any obstacle. The space between the sonar sensor and the object is calculated by recording the time between the generated acoustic waves and bouncing back. The ultrasonic sensor in the transmitter is used to detect the obstacle in front of the vehicle. The distance between the vehicles is set as a threshold value and now the ultrasonic sensor detects if there is any obstacle within the threshold distance.

TABLE.1 ULTRASONIC SENSOR PIN CONFIGURATION

Pin No.	Pin Name	Description
1	VCC	Connects to 5V of positive voltage for power
2	Trigger	Trigger pin is an input pin. Start the transmission with 10µs high time
3	Echo	output pin
4	Ground	Pin connected to ground pin of the system

B. Controlling the speed of the vehicles through Arduino

If the ultrasonic sensor detects any obstacle, it informs it to the Arduino controller and now this controller is responsible for controlling. Arduino boards read inputs which are in the form of light which falls on a sensor, a finger touch on a button, or a message from twitter and turns it into an output like motor activation, switching on an LED, publishing some content online.

C. Transmitting the message to the behind vehicle by Li-Fi

The speed control information is sent to the rear vehicle. This information's are transmitted using Li-Fi Technology. Li-Fi is a technology which uses light that is capable of transmitting data at high speeds. In the proposed system, LED lights present in the vehicle are used for the transmission of visible light.

D. Message is displayed in the LCD

After receiving the message from the front vehicle, the Arduino in the receiver side of the behind vehicle controls the vehicle speed. The alert message is displayed in the LCD of the behind vehicle so that the driver is aware that the vehicle's speed will be slowed down. Anyhow, the control is with the driver, so if he wishes to move the vehicle further, he can perform such actions.

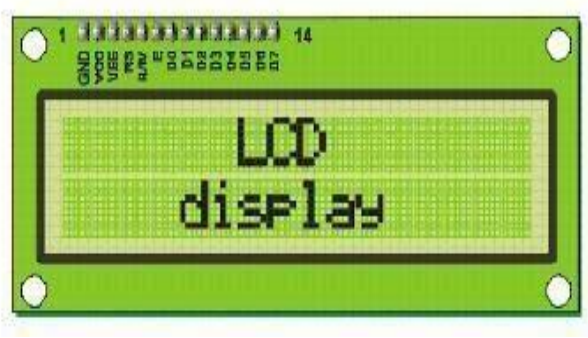


Fig.5 LCD Display

E. Intimation o accident using MEMS Sensor

Whenever the lean is applied to the MEMS sensor, then a balanced mass makes a difference within the electrical potential. This can be measured in sort of change within capacitance. Then those signals are often changed to make a stable output in digital. The MEMS sensor measures the force of acceleration. Thus, the MEMS sensor in the transmitter side is used to sense the accelerometer in order to detect the accident. Once the MEMS sensor detects the accident it sends the information to the Arduino controller.

F. Accident location is tracked using GPS

Once the accident is detected, the location where the accident has occurred is tracked using the GPS. A constellation of satellites and ground stations are used by GPS receiver to calculate accurate location. These GPS satellites transmit information signal to the receiver over frequency (1.1 to 1.5 GHz). Using this information, GPS module or a ground station can compute its location.

Distance=Speed * Time

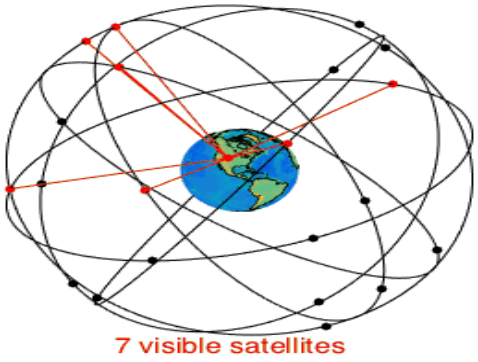


Fig.6GPS 7 visible satellites

G. Sending an alert message using GSM

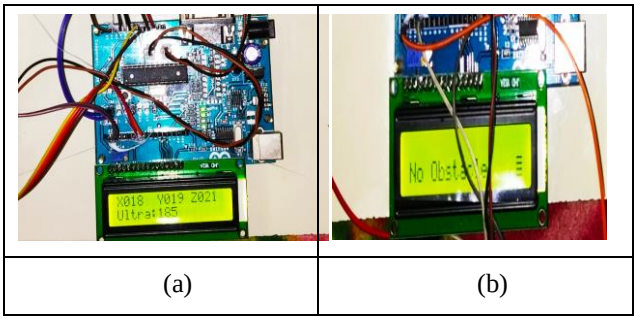
The GSM will be loaded with few emergency contact numbers for the purpose of sending alert messages. In case of any accidents, the alert message as well as GPS tracked location is sent to all the loaded emergency contact.

IV. RESULT AND DISCUSSION

The accuracy of the output of any device is determined by its flawless functioning. In other words, a guaranteed result must be provided by the equipment under any circumstances. Therefore, different values are used for testing the prototype. For the ultrasonic sensor, the range of object detection is set as 1m to 4.5m. These numeric values are displayed in the LCD. Once these values exceed their limit, the buzzer is alarmed in the case of the ultrasonic sensor and the message is sent via GSM in the case of the MEMS sensor. The feasible values of the sensors are provided in Table2 given below.

TABLE.2 FEASIBLE VALUES

Component	Working range	Test value	Result
Ultrasonic sensor	Less than 1m	104(in cms)	Buzzer alarm
MEMS sensor	Greater than 120km/hr.	130km/hr.	Message sentvia GSM



(a) (b)

Fig. 7 (a) Feasible value of ultrasonic sensor in LCD display (b) Feasible output of ultrasonic sensor in LCD display.

V. CONCLUSION AND FUTUREWORK

Using this system, vehicle-to-vehicle (V2V) communication is proposed to monitor the motion of distant vehicles. By using this system, vehicle collisions can be detected and thus road accidents will be reduced. In case of emergency, we can contact emergency numbers (i.e. Fire service, ambulance, family members, etc…).This work has been efficiently implemented for V2V communication by using Li-Fi-based communication. It tracks the location of drivers using GPS and sends an alert message to those numbers stored in the database through GSM. This system used Arduino as a mode of input and output for implementation. In the future, it would be more effective if RaspberryPi is used along with a camera to monitor the vehicles moving ahead.

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