Multipoint Collision Detection and Prevention System Using Li-Fi

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***Abstract*- In a country like India, where 20 million people are hospitalized every year due to road accidents, it is quite evident that there is something off with roads and drivers. Roads in the urban areas are highly congested. Moreover, accidents and deaths can also be caused by the intake of alcohol/drugs consumed by drivers, overloaded vehicles, defects in motor vehicles, bad infrastructure, faults of pedestrians. So, in this paper a multipoint collision detection and prevention system using Light Fidelty (Li-Fi) for smart cars is proposed that can be an effective way in preventing, but not completely eradicating, the number of accidents to a decent extent. Li-Fi uses LED to transmit burst of data to one or more receiver. The system uses Arduino Uno to make the system behave according to the algorithm used. Depending on the distance between the vehicles, the vehicles behind slow down or stop completely. In case of a collision alert message, the receiver also raises an alarm for the driver.**

***Index terms*- Light Fidelity(Li-Fi), Collision Detection, Cruise Control, LED, Smart Cars.**

I. INTRODUCTION

As our world is progressing towards the future, we see an increase in the demand for smart appliances and vehicles. These smart machines are highly autonomous, and require very little to none human intervention. Smart Cars, for example, comes with features such as self-driving, parking assistance, cruise control and is connected to the Internet. Visible light communication (VLC) has been a vast subject where the idea is to use visible light modulation for signal transmission and communication.

In a country like India, where population is 1.33 Billion, roads are usually crowded and traffic jams are very common. Also, the number of lives that are claimed due to road accidents is also very high [1]. This is because people usually over speed, turn without giving indicator and overtake from wrong side, indulge in drunken driving [2]. So, in our project we are using Li-Fi [3] to make a collision avoidance system so that collisions can be avoided. Li-Fi or Light Fidelity is a communication scheme based on VLC and it is a fast and inexpensive form of optical wireless communication system [4]. Besides, the light spectrum is free and unlicensed and hence inexpensive in terms of bandwidth [5]

Also the system has detection and prevention system in the form of cruise control where in the vehicle behind is stopped once it crosses a safe distance limit [6-7], leaving no choice to the driver and hence reducing human error and involvement in an accident. We have made sure that only one car stops in case only it is the one to cross the safe distance limit. The other car behind it doesn't get stopped even if it's in range of transmission. Hence, unnecessary braking of cars can be stopped so that behind that car don't get interfered. This way we ensure an almost smooth flow of traffic. This way, the driver can keep a check on the speed of his car and be alert, and thus avoid accident. The transmitter circuit attached to the front car also keeps calculating the distance between itself and the cars behind it using the ultrasonic sensor. Based on this calculation, it

transmits a message to the cars behind if the distance between them gets closer than a threshold value. This transmission of message is done using Li-Fi.

II. EXISTING SYSTEM

The paper has cruise control, alarm message generation and speed control. The new proposed design besides having the features as above can also raise a beeper alarm to alert the driver. Also, the system uses two ultrasonic sensors, as opposed to one used in [7], to make a multipoint collision detection and prevention system. It has also been taken care that incase either of the car crosses the safe distance threshold, only that particular vehicle can process the alert message; however both the vehicles receive the message. This can prevent any unnecessary breaking mechanism that can be onerous for a driver who is in safe limit of distance.

III. PROPOSED SYSTEM DESIGN

I. ALGORITHM OF THE TRANSMITTER:

The two ultrasonic sensors in the vehicle continuously detect the distance between itself and their corresponding vehicles. The LCD on the transmitter continuously displays the current speed of the vehicle. It continuously transmits its current speed if the vehicles are within the safe distance limit. The moment either of the vehicle cross the safe distance, a message is transmitted an alarm is raised and the vehicles are slowed down. In case only one vehicle crosses the safe distance limit only it get stopped. The other vehicle keeps on moving even if it's in the transmission range.

In the main paper [7], on which the proposed system works, has a point-point functionality.

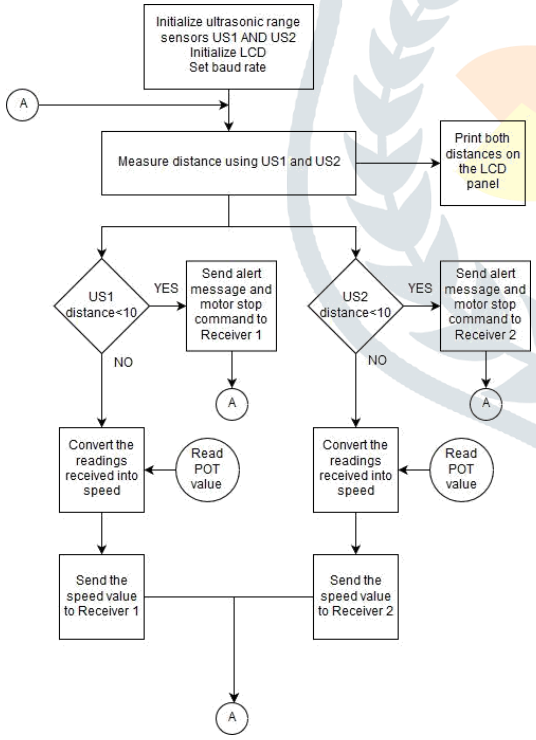


Fig.1 Transmitter flowchart

II. ALGORITHM OF THE RECEIVER:

When the vehicles are within the safety limit distance only the speed is received and the wheels of the vehicles behind rotates according to a duty cycle determined by the current speed of the front vehicle. Whenever the distance between the vehicles is less than 10 cm, an alarm is raised. In addition to this the message of collision alert is displayed on LCD screen and the car is stopped in case the driver is not conscious. Only when the distance is greater than 10 cm the receiving vehicles stop displaying the message and raising the alarm. Hence depending on the front vehicle, the speed of vehicles behind can be controlled.

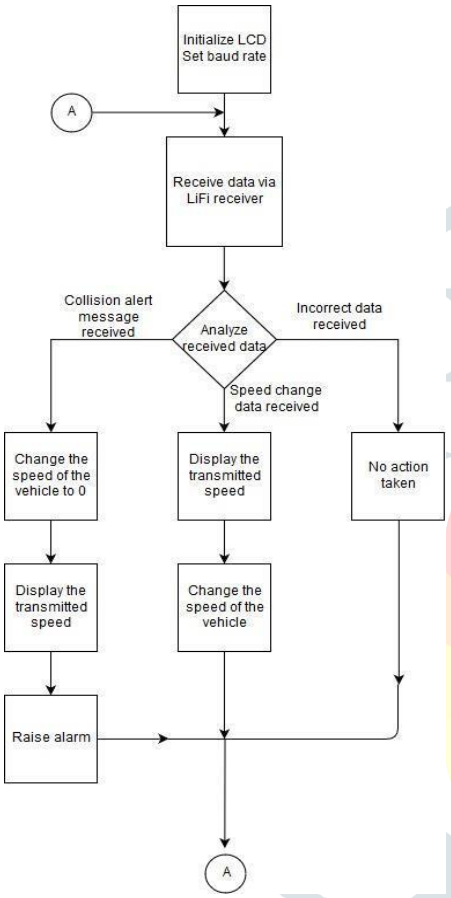


Fig.2 Receiver flowchart

III. SYSTEM MODEL AND DESIGN

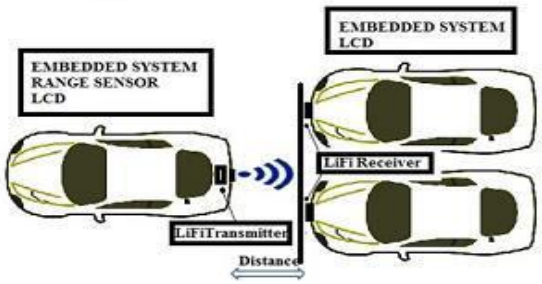
The proposed system is divided into two sub sections, viz- “Transmitter” and “Receiver”. The former deals with the circuitry related to the transmitter side while the latter deals with that related to the receiver side. The elaborated explanations of both the sections are described below. There are one Transmitter (front vehicle) and two receivers (behind). There are two ultrasonic sensors here continuously senses the distance between it and the two vehicles. The LCD on the transmitter displays the distance between both the sensors and the corresponding individual vehicles for the reference of the driver. Also in the next line of the LCD, the speed of the vehicle is displayed which is being varied by rotating the potentiometer. Fig.5 shows the transmitter system. When the safe distance between either of the vehicles and the front vehicle is less than the safe distance limit (10 cm in this model design), a message in the form of plain text is transmitted to both the cars.

Synchronously, a buzzer on the receiver vehicle starts giving a beep sound and displaying collision alert message on the corresponding LCD screen of the receiver. Also, the motor of the vehicle is stopped. Fig.6 shows the receiver systems. The alarm and the message continue to be raised until the distance becomes more than the specified safe distance limit [8-10]. This is beneficial for the other car even if it is in safe distance limit. It will receive the message of collision alert, but not react to it even if it is in the line of sight of the light beam. This can prevent unnecessary braking which might be onerous for the driver to handle.

Fig.3 System Model

IV. WORKING OF THE PROPOSED SYSTEM DESIGN

In the proposed prototype Fig.4, the transmitter has a 100k potentiometer which is used as an accelerator to change speed in four



slots namely 0 kmph, 40kmph, 60kmph and 80 kmph. This can be increased to many level but for sake of demonstration and simplicity and conciseness we have restricted ourselves to only four distinct speed points mentioned above.

Trigger pin transmits the ultrasonic waves toward the obstacles and the echo pin receives the ultrasonic waves reflected back by the obstacle. Then the Arduino Uno we can read data from the sensor and write the data to the LCD. Fig.6 shows the displayed data in the actual system. Also we have connected the potentiometer to control the analog value of the voltage to a particular value of speed of front vehicle. There are two cases in receiver side. First, the distance is greater than 10 cm. In this case, the vehicle behind adjust its speed automatically according to the speed of the front vehicle.Fig.7 shows the case. More the speed of the front vehicle more is the duty cycle of the motor on the receiver side. Second, when the distance is less than 10 cm, the LCD screen is cleared and a collision alert

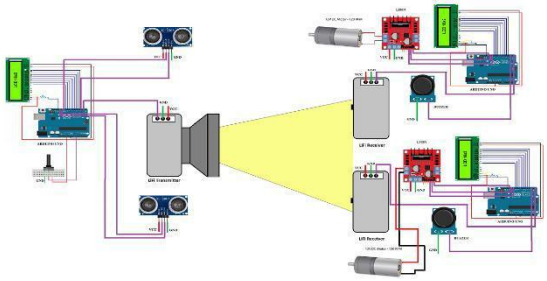


Fig 4 The proposed design

message, Fig.8, is displayed which is synchronous with a beep sound.

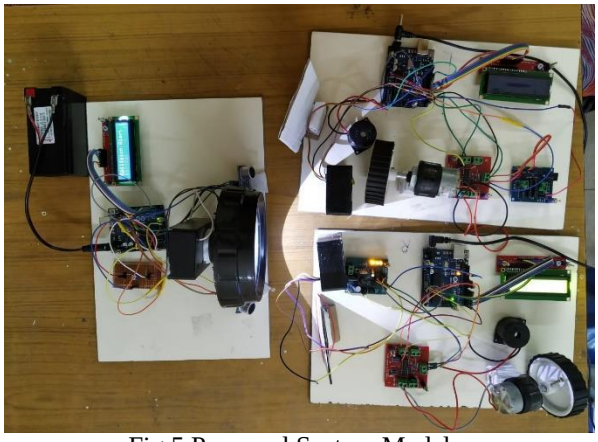


Fig.5 Proposed System Model

V. RESULTS AND TESTING

The proposed system works the way predicted. There are however some delays in the system in the case of collision. But the safe distance can be increased depending on relative speed and traffic conditions. The disparity in the actual and measured distance by the ultrasonic sensor almost follows a linear characteristics. The accuracy of the ultrasonic sensor is depicted using table I. The graph is almost linear. So, the ultrasonic sensor is highly reliable.

But in the actual system there will be additional processing delays as the Arduino performs more functionality and is overloaded with functions. The delays are measured for both the left and right sensors. The tabulations of the delay in the system are shown in table II.

TABLE I
MEASURED VS ACTUAL DISTANCE
FOR ULTRASONIC SENSOR

Measured distance (cm)	**Actual distance (cm)**
10	10
20	20
30	29
40	39
50	49
60	59
70	69
80	79
90	88
100	100

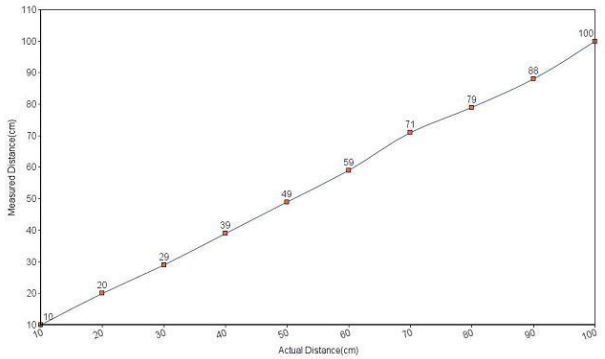


Fig. 4: Accuracy of Ultrasonic sensorTABLE II

DISTANCE VS DELAY:

Distance (cm)	Delay in seconds (left sensor)	Delay in seconds (rightsensor)
10	3.08	3.14
20	3.11	3.43
30	3.78	3.35
40	3.39	4.56
50	5.21	5.61
60	5.09	4.98
70	4.98	5.43
80	5.19	5.38
90	5.76	5.82
100	5.93	6.01
120	5.71	5.98
140	6.13	6.34
180	6.87	6.65
200	6.21	6.98

Fig.6 The LCD screen on the transmitter module displaying the distance between itself and the subsequent cars

Fig.7 The LCD screen on the receiver end displaying the same speed as transmitted by the vehicle

Fig.8 Collision alert on transmitter and receiver when the distance gets less than the threshold value

Fig.9 Distance shown after collision alert message shows that vehicle on left is near to the front more than the allowed safe limit

VI. CONCLUSIONS

As discussed throughout the literature, our proposed design would best work in a country like India where the roads are usually narrow and where people have less traffic awareness. Due to increased components and driver circuit, the delay can be significant (on an average 3 to 4 seconds). But it's an efficient way to reduce the role of drivers in the given scenario. This reduced human involvement doesn't ensure complete averting of an accident but it reduces the risk of an accident in a scenario where only the driver has all the controls.

The algorithm used in our system is not only precautionary but also preventive. Also unrealistic constraints such as sudden falling of trees or collapse of a bridge are not considered because they don't make a case for vehicle to vehicle collision detection and prevention system. Moreover most of these mishaps are purely coincidental and cannot be averted by any possible means. It is simply based on a fact that even science has uncertainties.

REFERENCES

[1] https://sites.ndtv.com/roadsafety/1-3-million-road-accident-deaths-decade-indias-killer-roads-1640/

[2] https://synergiafoundation.in/news-analysis/accidents-due-over-speeding-india

[3] What is Li-Fi**?** - *Harald Haas*, Journal of Light Wave Technology (2015)

[4] S. Kulkarni, A. Darekar, and P. Joshi, "A survey on Li-Fi technology,"in Proc. Int. Conf. Wireless Commun., Signal Process. Netw., 2016,pp. 1624– 1625

[5] H. Haas, "LiFi: Conceptions, misconceptions and opportunities," in Proc.IEEE Photon. Conf., 2016, pp. 680–681.

[6] H.Haas, L.Yin,Y.Wang, and C.Chen, "What is LiFi?" J. Lightw. Technol.,vol. 34, no. 6, pp. 1533–1544, Mar. 2016.

[7] Design of Collision Detection System For Smart Cars using Li-Fi and Ultrasonic Sensors- *Prabhu Krishnan*, IEEE Transactions on Vehicular Technology, Volume 67,No.12 (2018)

[8] M. A. Berlin and S. Muthusundari, "Safety distance calculation for collision avoidance in vehicular ad hoc networks," Scholars J. Eng. Technol.,vol. 4, no. 1, pp. 63–69, 2016.

[9] G. Breyer et al., "Safe distance between vehicles," in Proc. Conf. Eur.Director Roads, Paris, France, Apr. 2010, pp. 1– 9.

[10] Y.-L. Chen and C.-A. Wang, "Vehicle safety distance warning system: A novel algorithm for vehicle safety distance calculating between moving cars," in Proc. IEEE 65th Veh. Technol. Conf., 2007, pp. 2570–2574.

[11] https://www.researchgate.net/publication/279530585_LiFi_Technology_Data_Transmission_through_Visible_Light

[12] https://en.wikipedia.org/wiki/Li-Fi