Design of Precrash System for Smart Cars by using Li-Fi

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Abstract: In this paper we proposed a system to avoid collision between vehicles by using light fidelity (Li-Fi) technology. The data transmission from one vehicle to another is facilitate with the help of car to car communication (C2C). The model consists of Li-Fi circuit, Arduino UNO, Ultrasonic Range Sensor, Servo Motor. The transmitter section will be placed on the rear light of the leading car and the receiver section will be placed on the front of the following car. The transmitter section placed on the leading car will sent the calculated speed to the receiver section placed on the following car and according to the data received the speed of the following car will change such that it avoids collision. The system makes use of the visible light spectrum for communication between vehicles. Hence the collision detection system become cheaper.

Keywords: Collision, Detection, Li-Fi, Car to Car Communication, Visible Light Spectrum.

I. INTRODUCTION

There exist an expeditious increase in population, more and more peoples are move to the urban areas, which leads to faster urbanization. Green Internet of Things mainly aims to make a sustainable smart world. The Green IoT connects everything in the smart world to the internet with minimum amount of energy. The application of IoT improves the standard of living [1]. In present scenario, each person has his own private vehicle. This leads to adverse impact on environment due to the emission of various gases such as CO, CO2 etc [2]. At present, the cars completely depends on humans instead of software. The whole efficiency of the car is decided by the driving skills of the person driving the car. The application of digital technology [8]-[13] creates smart cars that works according to the software and which automatically do everything. The smart cars are developed to avoid the problems associated with the manual driving [3]. In present scenario, the smart car uses Light detection and ranging technology (LiDAR) to detect the objects in front of it and receive the data. In this technology, the LiDAR consists of transmitter and receiver section. The transmitter section which emit the laser pulse and receiver capture reflected waves so that we can measure the distance. The LiDAR can work only at clear environment so ultrasonic sensors are preferred over LiDAR. The cost LiDAR technology is high when compared to ultrasonic sensor, that's why the LiDAR is not industrially acceptable [4]. Light Fidelity technology used to transmit data from one vehicle to another to avoid collision. It also uses an ultrasonic range sensor to detect obstacles by sending ultrasonic waves and measure the distance between them, the further decisions carried out based on the distance measured. The Vehicle to Vehicle (V2V) communication is facilitate by using Li-Fi technology [5]. The real time data is transmitted by using Li-Fi technology. Basically the LED's act as Li-Fi transmitter. At ON time the logical state of LED will be '1' and otherwise it will be '0'. At the receiver end photodiode act as receiver which will convert the optical signal into an electrical signal [6]. The transmitter and receiver sections can be mounted on 'N' number of cars represented by C_n, where n.=1., 2., 3… N. In the proposed model N=2. The transmitter circuitry is placed on the rear lights of the leading car (C1) and receiver circuitry is placed on the front side of the following car (C2).The measured distance from C1 to C2 is transmitted via Li-Fi transmitter. The receiver circuitry is receive the information from C1. The distance between C1 and C2 is taken by using Ultrasonic range sensor. The variation in speed will show with help of servo meter. The system also comprises of LCD display, 12V DC supply and ARDUINO UNO. Safety distance calculation in order to avoid collision is based on the relative velocity and distance between the vehicles. The driver is warned, when the measured distance lower than the safety distance so that driver can take appropriate steps for collision avoidance. Safety distance or Threshold distance is the minimum distance to avoid collision [7].

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II. SYSTEM OVERVIEW

The proposed system consists of Li-Fi circuitry, Arduino UNO, Ultrasonic Range Sensor, Servo Motor, LCD display, 12 DC Power Supply.

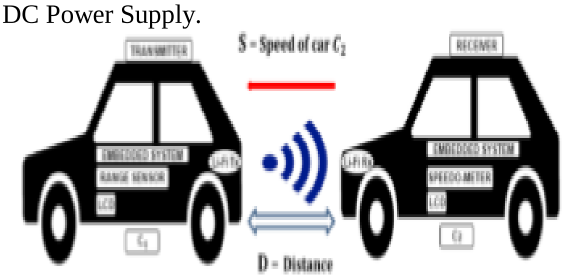

Fig. 1.Proposed System

The Li-Fi circuitry is classified into two sections, termed as “Transmitter” and “Receiver”. The Li-Fi transmitter circuitry is installed in car C1 which comprises of Ultrasonic range Sensor, Li-Fi transmitter, Power Supply, Arduino UNO. The Arduino UNO act as the brain of the system which process the real data. The proposed model measure the distance between vehicles with the help of ultrasonic Sensor. The distance between C1 and C2 is denoted as “D” shown in Fig. 1.The Ultrasonic Sensor has four pins, namely “VCC”, “Trig”, “Echo” and “GND” as shown in Fig. 2.

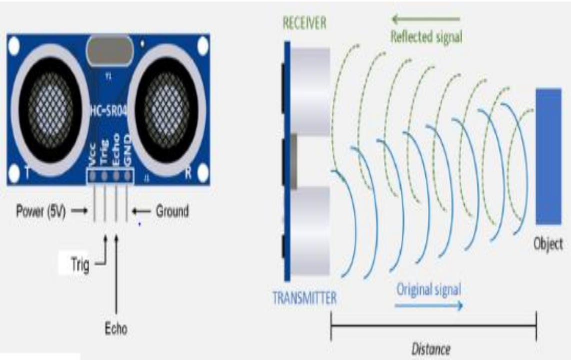

Fig. 2.Ultrasonic Sensor

Fig. 3. Servomotor

The servo motor will rotate clockwise or anti clockwise according to the speed received from the transmitter section. In this proposed model, the servo motor has a rotation from 25^0 to 160^0 and speed ranging from 0-90Km/hr. The system also used LCDs, 12 DC supply for the proper functioning of the entire system.

A. TRANSMITTER MODULE

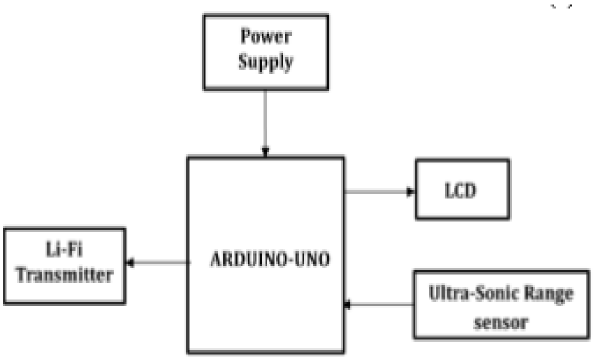

Fig. 3.Transmitter Block Diagram

The transmitter module consist of Li-Fi transmitter circuitry, Ultrasonic sonic sensor, LCD and power supply which is used to transmit information from leading car C1 to C2 in order to avoid back to back collision. When a following car C2 comes closer to leading car C1, the ultrasonic sensor placed on transmitter will be initialized and measure the distance between two vehicles, then it checks if the measured distance is less than the threshold distance (d_{th}), if it is true the LCD display attached with the transmitter section will show “WARNING” as indication otherwise the LCD display will show “SAFE ZONE”. The threshold distance is 100cm in the proposed model.ie; d_{th} =100cm.

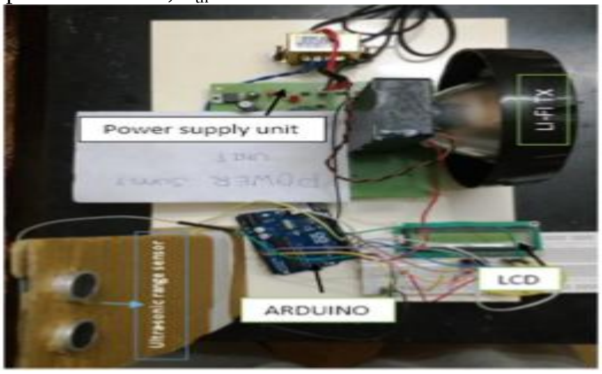

Fig. 4 Transmitter Module

The measured distance(D) is used to find out the velocity of the second car C2. The conversion of measured distance to speed is using following equations:

$$V_t = V_0\, e^{-aD} + C\,T \quad (1)$$

Where , “V_t“ is the Velocity of sound at temparature, “V_0” is the velocity of sound at 0 degree celsius, “a” is the Attenuation coefficient, “C” is the rate of change of velocity with per degree rise in Temparature, “T” is the Temparature.

$$D = V_t \times Time \div 2 \quad (2)$$

Where Time is the ping time from the sensor

$$S = (S_{max} \div d_{th}) \times D \quad (3)$$

In this proposed model S_{max} = 90Km/hr, D = 1m. The equation (3) becomes as follows:

$$S = 0.9 \times D \quad (4)$$

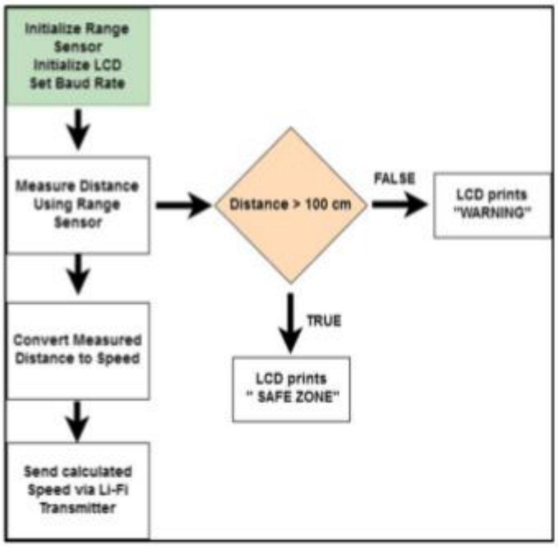

Fig. 5. Transmitter Workflow Diagram

Table- I Actual and Measured Distance

Actual Distance (cm)	Measured Distance (cm)	Accuracy (%)
10	11.23	89.04
20	21.04	95.05
30	30.96	96.89
40	40.77	98.11
50	50.65	98.71
60	60.51	99.15
70	70.36	99.48
80	80.19	99.76
90	90.14	99.84
100	100.11	99.89

From the above table it can be observed that, the system has good accuracy and it shows linearity.

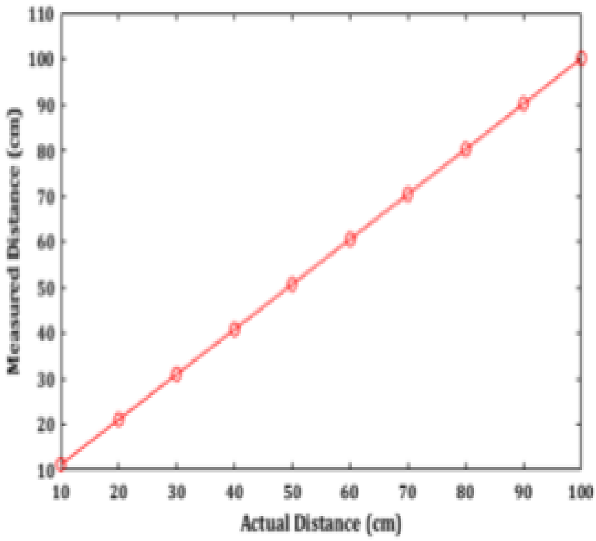

Fig. 6. Plot of Actual distance vs Measured Distance.

B. RECEIVER MODULE

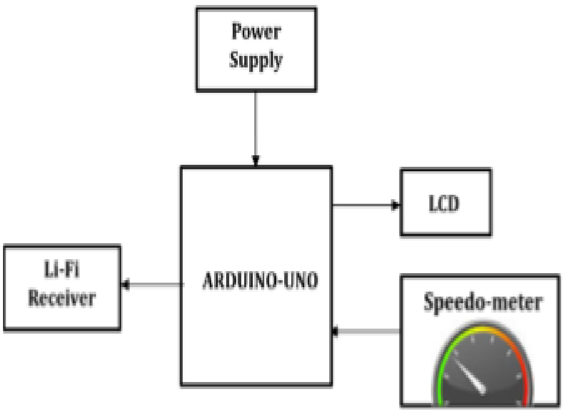

Fig. 6.Block Diagram of Receiver Module

The receiver section will get the calculated speed transmitted by the leading car via Li-Fi transmitter circuitry. At the receiver side, LCD display, servomotor will get initialized. The LCD display fixed to the receiver will output the speed received from the following car. The proposed model uses servomotor as speedometer, it can show the variation in speed by rotating the needle of servomotor either in clockwise or anti clockwise direction. The speed is transformed to degree of rotation by using set of equations given below,

$$DOR = DOR_{max} – (DOR_{max} – DOR_{min} / Smax) \times S \qquad (5)$$

Where, DOR- degree of rotation, DOR_{max} and is the maximum degree of rotation and DOR_{min} is the minimum degree of rotation. In this prototype, $DOR_{max}= 160^0$, $DOR_{min} = 25^0$ and S_{max} = 90 Km/hr, then the equation 5 becomes,

$$DOR = 160 - 1.5 \times S \qquad (6)$$

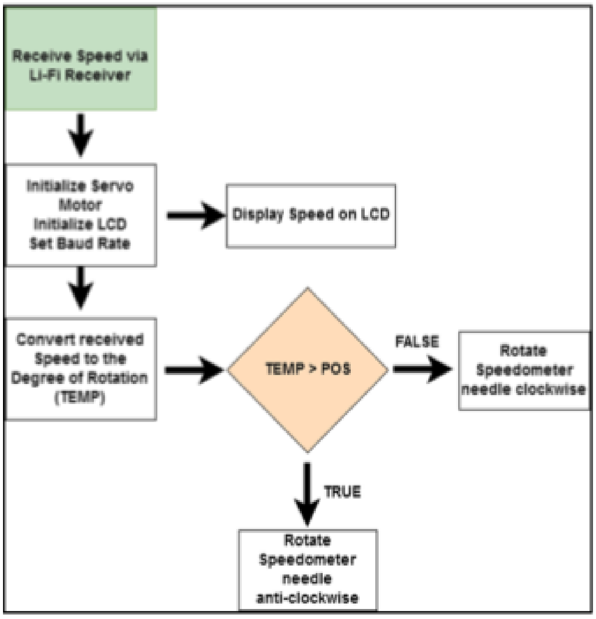

Fig. 8. Receiver Work Flow Diagram

The speed of the following car is controlled by using the work flow diagram as shown in Fig. 8. After the conversion of degree of rotation (DOR), then it check for the $C_{pos}> L_{pos,}$ if it is true the needle will rotate to anti clockwise direction, which means speed of the car C2 is decreased to avoid collision between C1 and C2. Otherwise, it will rotate in clockwise direction, which means speed of the car C2 is increased because the probability of collision is less. Where C_{pos} current position of the needle and L_{pos} is the last position of the needle.

Table-II Distance and Calculated speed

Distance (D) in cm	Speed (S) in km/Hr. S = 0.9×D
10	9
20	18
30	27
40	36
50	45
60	54
70	63
80	72
90	81
100	90

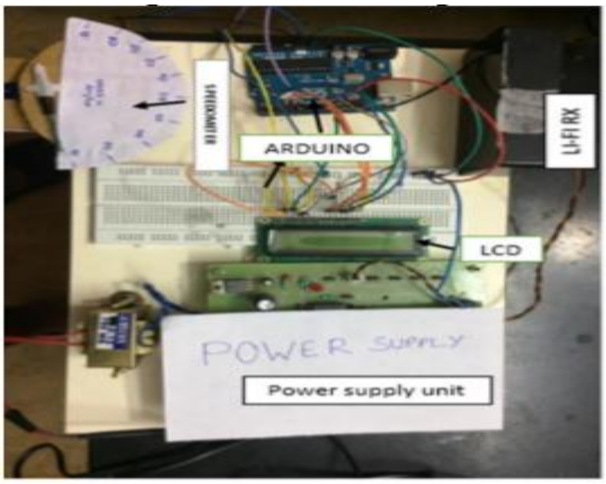

Fig. 9. Receiver Module

II. GRAPHICAL ANALYSIS

The performance of the designed prototype is tested and analyzed with the help of speed vs distance plot and angle of rotation vs speed plot. The speed and distance are directly related.

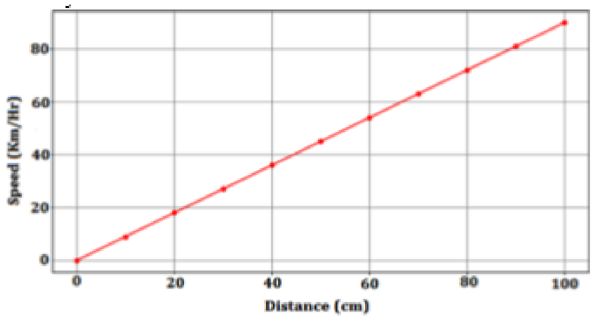

Fig. 10.Plot of Distance vs Speed

The relationship between speed versus angle of rotation as shown in Fig.11.It can be plotted by using equation 5.From the graph it can be observed that, the speed and angle of rotation are inversely related.

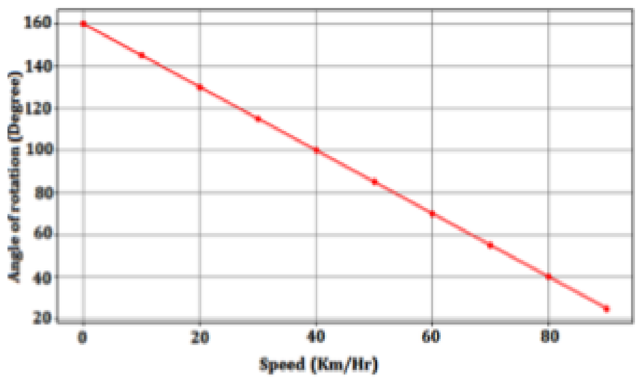

Fig. 12. Plot of Speed vs Angle of rotation.

III. CONCLUSION

The number of people dying due to car accidents has been drastically increasing day by day. The proposed system is a new and innovative solution to reduce the collision of cars to an extent and can reduce road accidents. This paper also motivate others to do further exploration on Li-Fi Technology. Which in turn helps to develop a more efficient way to enhance the range of transmission of Li-Fi system and enables to overcome the problems associated with the of line of sight (LOS) of communication.

REFERENCES

1. Chnusheng Zhu., Victor C.M. Leung, Lei Shu Edith C.-H. Ngai., "Green Internet of Things for Smart World.", *IEEE. Access, Special Section On Challenges for Smart Worlds*.", vol.3, pp.2151-2162., November .2015.
2. Mahadevappa Harish., "A study on air pollution by automobiles in Bangalore city", *Management Research and practice*, vol.4., issue 3, pp.25-36., 2012.
3. Tao Jiang., Uma Ayyer., Anand Tolani,, Sajid Hussain., "Self-driving Cars: disruptive or incremental.*?", Applied Innovation Review*., Issue 1., June 2015.
4. Harald Haas, Liang Yin., Yunlu Wang and Cheng Chen, "What is Li-Fi*?", Journal of Lightwave Technology*.", vol.34, Issue. 6, pp. 1533-1544, 2016.
5. Pooja Bhately and Ratul Mohindra., "Smart vehicular communication system using Li Fi Technology.", *in proc. International Conference on Computation of Power, Energy Information and Communication(ICCPEIC.)*,.2016.
6. Rahul Sharma, Raunak and Akshay Sanganal, "Li-Fi Technology Transmission of data through light,*", Int.J.Computer Technology.& Applications*, vol.5,pp. 150-154, 2014.
7. M.A Berlin and S. Muthusundari, "Safety Distance Calculation for Collision Avoidance in Vehicular ad hoc-Networks.*", .Scholars Journal of Engineering and Technology.(SJET*)., Volume 4,Issue. 1,pp.63-69,2016.
8. Kuruvilla John, Vinod Kumar R.S., and Kumar S.S., "A Novel Design of Synchronous Counter for Low Power and High-Speed Applications," *International Journal of Engineering and Advanced Technology*, vol. 8, issue. 4, pp. 779-783, 2019.
9. Kuruvilla John, Vinod Kumar R.S., and Kumar S.S., "Effect of clock gating in conditional pulse enhancement flip-flop for low power applications," International *Journal of Electrical Engineering and Informatics,* vol. 7. No. 2, pp. 357-365, 2019.
10. Kuruvilla John, Vinod Kumar R.S., and Kumar S.S., " Design of conditional pulse enhancement flip-flop embedded with clock gating and signal feed-through mechanism," *Journal of Engineering Science and Technology*, vol. 14, no. 4, pp. 2000-2012, 2019.
11. Kuruvilla John, Vinod Kumar R.S., and Kumar S.S., "Impact of Pulse-Triggered Flip-Flops in Low Power Applications," *Journal of Advance Research in Dynamical and Control Systems*, vol. 10, issue. 1, pp. 298-306, 2018.
12. Kuruvilla John, Vinod Kumar R.S., and Kumar S.S., "Design of low power and high speed implicit pulse flip-flop and its application," *International Journal of Engineering and Technology*, vol. 7, no. 3, pp. 1893-1898, 2018.
13. Kuruvilla John, Vinod Kumar R.S., and Kumar S.S., "Performance Comparison of Explicit Pulsed Flip-Flops in Low Power and High-Speed Application," *Proceedings of International Conference on Circuits and Systems in Digital Enterprise Technology, Kerala, India, Dec.* 2018.

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