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Design of Collision Detection System for Smart Car Using Li-Fi and Ultrasonic Sensor

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Abstract

The 21st century is defined as the era of technological development. With drastic increase in population and in order to make life more comfortable and easy automation is becoming the need of the hour. Due to the advancement and development in the field of automation and embedded system the notion of smart car has become very popular. Smart cars are modernizing the trends in traditional automobile industry.

Every technological development needs to overcome certain obstacles and hence, in this work, I have proposed a design of collision detection system for smart car using LiFi and ultrasonic sensor on the Arduino platform. This design consists of ultrasonic sensor, Arduino processor, and Li-Fi circuit. In this paper, a system which can detect and thus avoid collision between vehicles and prevent the accidents is proposed.

Keywords- Automation, LiFi, Ultrasonic Sensor, Arduino Board.

INTRODUCTION

There has been a rapid growth in Automobile industry across the globe. With ever rising population, more and more people move to the cities, leading to faster urbanization. With rise in automation and Internet of Things (IoT), technology has increased the standard of living. Every year there is an increase in automobile sales of about 25% and the major reason is private transportation is becoming cheaper and affordable. One can conclude that in today's lifestyle each individual has its own private vehicle. Sole ownership of vehicles leads to certain disadvantages in terms of the harmful effects on the environment due to emission of CO2, CO, etc. Not only does the environment get affected by vehicles but one also cannot deny the fact that with increase in vehicular population across cities there has been an extreme rise in traffic and as traffic raises the roads, the highways, etc., start becoming unsafe for the citizens. Road accidents have become very common over the past few years and it is predicted to increase by 2% every passing year. The cars are totally dependent on human assisted driving rather than the pre-defined software of driving.

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MATERIAL AND METHODOLOGY

The hardware used in this system are Arduino, Ultrasonic sensor, LiFi Transmitter and Receiver circuit. Their uses are :The Li-Fi transmitter circuitry and receiver circuitry are installed in the Car represented by C_i where *i=1, 2,...,N*, for *N* cars. In the proposed system which will be investigated in this work, I consider the case with *N*=2. The tail light of C_1 is equipped with Li-Fi transmitter and the front side of C_2 is equipped with Li-Fi receiver. The devices and sensors which are used in the Li-Fi transmitter and receiver sections are described as follows.

1. **Li-Fi transmitter module:** To transmit the calculated information from C_1 to C_2
2. **Li-Fi receiver module:** To receive the information from C_1
3. **Ultrasound range Sensor:** To measure the distance between C_1 and C_2
4. **Servo motor:** To act as a speedometer, this will show the variation in speed.

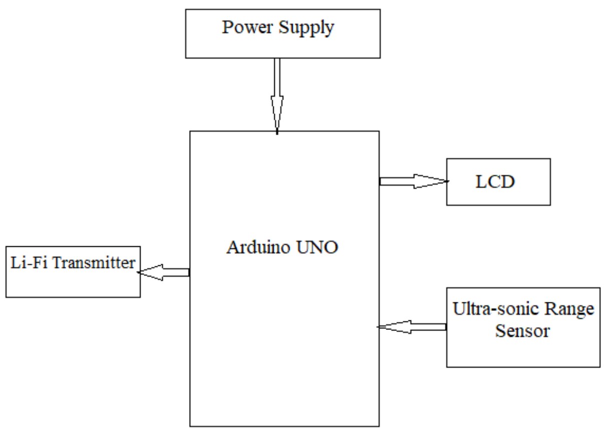

Figure 1: Transmitter Block Diagram

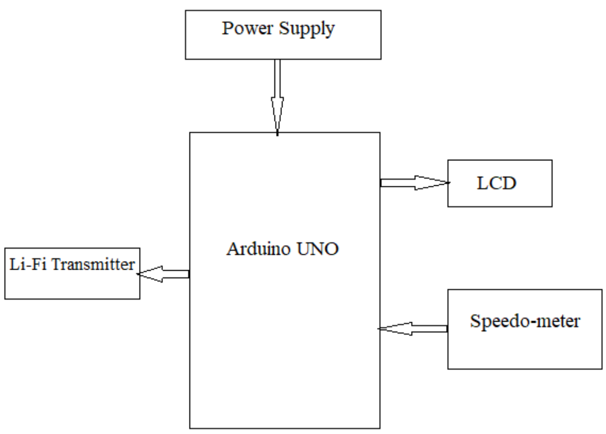

Figure 2: Receiver Block Diagram

This module is equipped with Li-Fi Transmitter module, Ultra-Sonic Range sensor and Arduino-Uno Board which in turn helps the leading car C_1 to transmit the information to following car C_2 to detect and avoid collision. The block diagram of transmitter section and its real time module is shown in Figures 1 and 2. When a following car C_2 approaches the leading carC_1, the range sensor installed in Car C_1 gets initialized and measure the distance between two cars. If the measured distance between two cars is less than the threshold distance (d_{th}) then the LCD display attached to the transmitter section will appear the indication "WARNING" otherwise the LCD display will inform "SAFE ZONE". Threshold depends on several different parameters like the relative velocity between two cars and distance between two vehicles, braking safety distance, "two seconds" rule. In this work has been considered one meter as the threshold distance or safety margin between two cars due to limitation of measuring range of an ultrasonic range sensor. In this prototype, the ultrasonic sensors used to measure distance in range of 10 cm-100 meters. It can be observed that the accuracy of measured distance is good as compared to the actual distance and it is almost linear.

The measured distance between two cars (D) is used to calculate the speed of second car $C_2(S)$ by which it should move in order to avoid the collision. The calculated speed of car C_2 is transmitted to it using Li-Fi transmitter. The calculation involving the conversion of distance measured to the speed of car C_2 is shown below:

Vt=V0e pow-(aD)+CT (1)

D=Vt(Time/2)*(2)

Where, "Time" is the ping time from sensor

*S=(Smax/dth)*D*(3)

The equation which relates the conversion of distance measure to the speed depends on certain factors like the maximum speed of the car allowed

(In this paper it is 90 Km/hr), the safety margin between the cars C_1 and C_2 (In this paper it is 1m or 100cm), the precision and exactness of range sensor used. So, the equation becomes as follows:

*S=0.9*D*(4)

The receiver section receives the information transmitted from leading car C_1 and is installed in C_2, it is equipped with Li-Fi receiver module, LCD display, Arduino-Uno Board and Servomotor which acts as a speedometer. The block diagram of receiver section and real its real time module is shown below. The receiver module willreceive the speed transmitted by car with the help of Li-Fi receiver. The servomotor, LCD display will be initialized. The received speed will be displayed on the LCD display. The speed will be converted to the degrees of rotation of servo motor using set of equations. If the speed received is greater than the current speed of car then needle is rotated clockwise and vice-versa. The speed of the car is converted to degree of rotation (DOR) using Eq. (5). DOR is obtained from the maximum and minimum of its values.

*DOR=DORmax-((DORmax-DORmin/Smax)*S)*
(5)

The degree of rotation depends upon the design of speedometer and servomotor. In this work, I have designed the speedometer with its speed ranging from 0-90 Km/hr. The servomotor has degree of rotation from 250 to 1600. The equation can be modified as per the need of the user. There are certain factors on which the equation depends like the maximum speed of the car (in this paper its 90 Km/hr), the quality and precision of servomotor used to design the speedometer. So, the equation becomes as follows:

*DOR=160-(1.5*S)*(6)

RESULTS

The developed prototype is tested and analyzed with respect to speed versus distance and the angle of rotation versus speed. The speed of the car is decreases as the distance between the cars is decreasing. With respect to the developed prototype, the threshold distance between the cars is 40 cm means that the second car can maintain the speed of 35 km. That is, if the distance is equal or greater than the threshold distance then the speed changes to the maximum speed (i.e. 90km/hr) and if the distance is less than the threshold distance then the speed will decrease linearly. In the proposed and developed prototype, the speed of the second car is controlled with the help of stepper motor angle of rotation.

CONCLUSION

This paper presents a new and innovative collision detection of cars, thereby reducing the probability of fatal car accidents. The proposed method relies on Li-Fi transmitter and receiver systems. This paper would encourage and motivate others to further explore the notion of Smart Cars and the use of Li-Fi Technology and hence, develop more efficient strategy to enhance the transmitting range of the Li-Fi system and propose innovative solutions to overcome the challenges due to line of sight (LOS) communication and white light interference i.e. associated with the Li-Fi. Apart from that, the ultrasonic range sensor can be modified to increase its detection range. The proposed system can be extended to detect the Side impact collision, Lane-Change assistance or Blind-Spot detection. With proper assistance from the concerned authorities it is highly possible to implement the proposed system in the Smart Cars of the future.

REFERENCES

1. Chunsheng Zhu, Victor C. M. Leung, Lei Shu and Edith C.-H. Ngai, " Green Internet of Things for Smart World", 2015 IEEE Access, Special Section On Challenges For Smart Worlds
2. Mahadevappa Harish, "A Study on air pollution by automobiles in Bangalore city", Management Research and Practice, vol. 4 issue 3 (2012) pp: 25-36, 2012
3. P. Shruthi, et al. , Analysis of Fatal Road Traffic Accidents in a Metropolitan City of South India", J

Indian Acad Forensic Med. October-December 2013, Vol. 35, No. 4, 2013
4. Tao Jiang, Uma Ayyer, Anand Tolani, Sajid Hussain, “Self-driving Cars: disruptive or incremental?”, Applied Innovation Review, Issue 1, June 2015
5. Haas, Harald, Liang Yin, Yunlu Wang, and Cheng Chen. "What is lifi?." Journal of Lightwave Technology 34, no. 6 (2016): 1533-1544.
6. Shivaji Kulkarni, Amogh Darekar andPavan Joshi, “A survey on Li-Fitechnology”, 2016 International Conference on Wireless Communications, Signal Processing and Networking (WiSPNET), 201
7. Chunsheng Zhu, Victor C. M. Leung, Lei Shu and Edith C.-H. Ngai, “ Green Internet of Things for Smart World”, 2015 IEEE Access, Special Section On Challenges For Smart Worlds
8. Shivaji Kulkarni, Amogh Darekar andPavan Joshi, “A survey on Li-Fi technology”, 2016 International Conference on Wireless Communications, Signal Processing and Networking (WiSPNET), 2016
9. Harald Haas, “LiFi: Conceptions, misconceptions and opportunities”, 2016 IEEE Photonics Conference (IPC), 2016 [8] Harald Haas, Liang Yin, Yunlu Wang and
10. Cheng Chen, “What is LiFi?”, Journal of Lightwave Technology, Volume: 34, Issue: 6, pp. 1533 – 1544, March 2016

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