Li-Fi based Vehicular to Vehicular Communication for Smart Collision Avoidance

by Divya Royal

Li-Fi based Vehicular to Vehicular Communication for Smart Collision Avoidance

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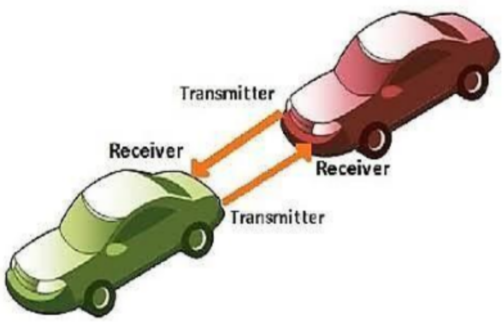
ABSTRACT: Around the world, collisions between cars cause a significant number of road accidents. Road accidents claimed the lives of more than 1.2 million people in 2018, according to the World Health Organization (WHO). Safety for people is crucial. The goal of the paper is to prevent car collisions and lessen the effects of accidents in daily life. There are many causes of this unfavorable situation that leaves people dead or disabled. This includes an abrupt lapse in driving focus, brake failure, and loss of stability. These risky situations can be avoided if all vehicles follow a communication system, and drivers control their vehicles according to where they are in relation to other vehicles. There are some drawbacks to the radio frequency (RF)-based communication system, including interface, crowded spectrum, and security. VLC can be used to get around these restrictions. It offers high data rates, security, and community on the interface. Visible light is used by the VLC data communication system to transmit and receive large amounts of data. Light Fidelity is the name of this technique (Li-Fi). This research introduces a novel approach to model front-and-rear vehicle collision. A low-cost option with high data rate capabilities is the planned Li-Fi based Vehicular to Vehicular (V2V) communication system.

KEYWORDS: Road accidents, Human Safety, Li-Fi, v2v Communication.

I. INTRODUCTION

Accidents have become a major global problem in recent years. Automobiles are including numerous human safety features. The primary purpose of the recommended method is to reduce the number of accidents, as that result to the huge loss of human life. According to studies, automotive crashes cause the vast majority of accidents. If the vehicle in front can communicate with the vehicle in back, an accident can be avoided. Science and technology are progressing at a have gone one step farther in wireless communication by inventing Li-Fi, or Light Fidelity technology in the year 2011 by Prof. Harald Haas of the university of Edinburgh who talked about the existing of Li-Fi technology in his TED talks [7]. The goal of implementing Li-Fi is to create a system that is both cost effective and has a high data transmission rate [11]. Because high intensity LED lights are already present in automobiles, they can be used as Li-Fi transmitters. The Li-Fi system transmits data via the visible light spectrum utilizing LED lights. LED lights are modulated at high frequencies, allowing them to transfer the data and to receive a capable of detecting charges in light intensity. The data is subsequently decoded and turned into useful information by the receiver. Collisions in vehicles employing Li-Fi technology can be avoided by adding simply inexpensive electronics. Data can be sent utilizing Li-Fi technology in a very secure and interference-free environment. Li-Fi enables real-time connection between vehicles by allowing for faster data transmission and bigger bandwidth [6]. Because of the use of light, Li-Fi is more secure because it is less likely to be intercepted by unauthorized outside parties. Using LED sources such as headlights and taillights, LiFi-based V2V communication may broadcast data at high speeds, up to several Gbps, to identify potential collisions and inform drivers. Because walls and other impediments cannot block visible light, LiFi-based V2V communication is less susceptible to hacking and eavesdropping.

Fig 1: Communication between the Vehicles



When compared to other wireless communication technologies, Li-Fi based V2V communication can handle more traffic and offers a faster and more accurate data transfer rate [3]. Several benefits exist between LiFi over WiFi technologies. One of the most significant advantages is speed. With the speeds of up to gigabits per second, Li-Fi has the potential to attain substantially greater data rates than WiFi. This is because visible light wavelength travel at a greater frequency than radio waves, which are employed in WiFi. LiFi is also more secure than WiFi since it employs visible light waves that cannot pass through barriers, making it more difficult for unauthorized people to access the network. Furthermore, because it operates on the visible light spectrum rather than radio frequencies, LiFi is less likely to interface with other wireless signals such as Bluetooth and WiFi. This technology assists in communication between the two vehicles and in turning in the proper direction by detecting the distance between the two vehicles using an ultrasonic sensor. Li-Fi based V2V communication may need to be linked with other wireless communication technologies in order to develop a strong and trustworthy smart collision avoidance system.

II. LITERATURE SURVEY

A large amount of research has been undertaken in recent years on the use of Li-Fi for V2V communication in the context of smart collision avoidance. The goal of this literature review is to provide a comprehensive summary of the current state of the art in this area. It will begin by going over the fundamentals of Li-Fi communication and its possible applications in V2V communication. The existing research on Li-Fi-based V2V communication for smart collision avoidance will then be reviewed, including the various system designs, modulation schemes, and channel models that have been presented. Finally, the survey will end with a discussion of the problems and potential future research areas in this field.

G. Sekar [1], one of the authors of the "Vehicle Collision Avoidance System Using Li-Fi," presents an innovate approach to prevent vehicular collisions using Li-Fi technology. Li-Fi technology transmits data using visible light waves, resulting in a secure and reliable communication channel that is immune to electromagnetic interference. The system's effectiveness is proven through models and tests, which emphasize its high data transmission rates and collision avoidance capabilities, making it a better option to conventional wireless communication technologies.

Soni et al.'s [4] 2019 IC3I conference paper presents a concise case study on Li-Fi technology, which uses light waves for wireless data communication. The purpose of this paper is to provide a thorough understanding of the technical aspects, benefits, and limitations of Li-Fi. The writers use different use cases in healthcare, education, and transportation to demonstrate the promise of Li-Fi technology. The study emphasizes the importance of additional research and development in order to address current limitations and improve the efficiency of Li-Fi technology, ultimately unlocking its full potential in a variety of applications.

A. Lavric and V. Popa's [8] article "LoRaWAN: Long Range Wide Area Networks Study" investigates the efficacy of LoRa wireless networks for low-power wide area network (LPWAN) uses in the context of the Internet of Things. (IoT). The writers look at how Time on Air (ToA), bitrate, and Spreading Factor (SF) affect network efficiency. They discovered that raising the SF parameter improves network range while also lengthening signal transmission and increasing power usage. It is necessary to balance network coverage and battery usage when selecting suitable SF and bitrate settings. The writers also assess packet delivery rate and end-to-end delay, finding that LoRa technology can provide a dependable and cost-effective option for IoT apps that require extensive geographic coverage.

N. Chi [9] has stated that VLC is a new area of optical communications that concentrates on the visible portion of the electromagnetic spectrum. There is a lot of current work in optical communications, mostly optimized for capacity and transmission efficiency in fiber and open space, with a leaning towards spectrum that minimizes attenuation in the medium. However, because of its abundance and the simplicity with which it can be modulated using light emitting diodes, the visible spectrum has acquired popularity. (LEDs). This interest is also being driven by recent demand factors such as the burgeoning mobile industry and the rapid evolution of LED-based lighting. We outline the context of VLC, its unique benefits, and the assembled papers' state-of-the-art research contributions here and in this special issue.

X. Yang, L. Liu, N. H. Vaidya, and F. Zhao [12] describes a vehicle-to-vehicle communication protocol for cooperative collision warning in their paper named "A vehicle-to-vehicle communication protocol for cooperative collision warning." To identify the position and pace of adjacent cars, the protocol employs a directional antenna and a cooperative awareness algorithm. The suggested procedure gets high detection accuracy while reducing false alerts. The authors also conduct models and tests to assess the protocol's performance, showing its ability to provide prompt and accurate impact alerts. The suggested protocol can be used to create useful vehicle-to-vehicle transmission systems targeted at reducing traffic accidents.

K.T. Swami and A.A. Moghe's [14] article "A Review of LiFi Technology" provides a summary of LiFi technology. The writers address the fundamentals, applications, benefits, and drawbacks of LiFi technology. The article emphasizes LiFi technology's promise for high-speed wireless communication as well as its suitability for specific uses such as interior communication, medical and military communication, and vehicular communication. The writers also discuss some of the barriers to LiFi technology acceptance, such as signal interference, line-of-sight restrictions, and restricted coverage area. Overall, the paper offers a thorough and informative overview of current LiFi technology.

III. Block Diagram

Fig 2: Transmitter Unit

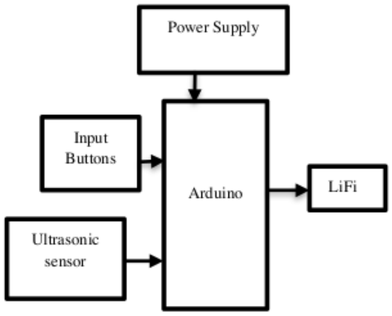
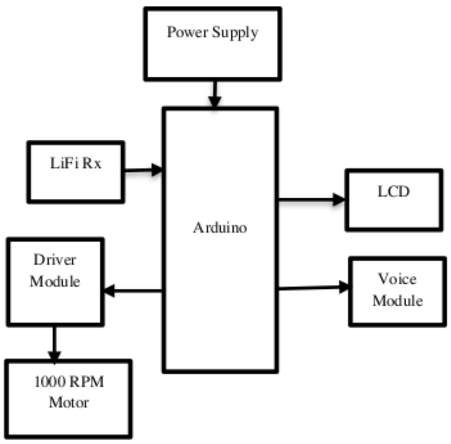


Fig 3: Receiver Unit

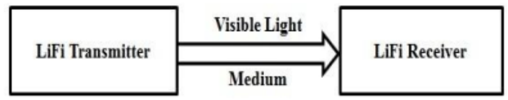


IV. PROPOSED METHOD

Li-Fi (Light Fidelity) is a wireless transmission device that transmits data using light waves. In recent years, it has drawn interest as a potential remedy for smart collision prevention in automobiles. The safety of drivers and passengers is improved in this manner by using Li-Fi based V2V (Vehicle-to-Vehicle) communication.

The Arduino UNO microcontroller serves as the system's brain in this system. As a result, the complete system’s program is stored in it. We have two devices here: the transmitter and the receiver [3]. Based on the premise, both components serve as transceivers.

Fig 4: Block Diagram of Transceivers

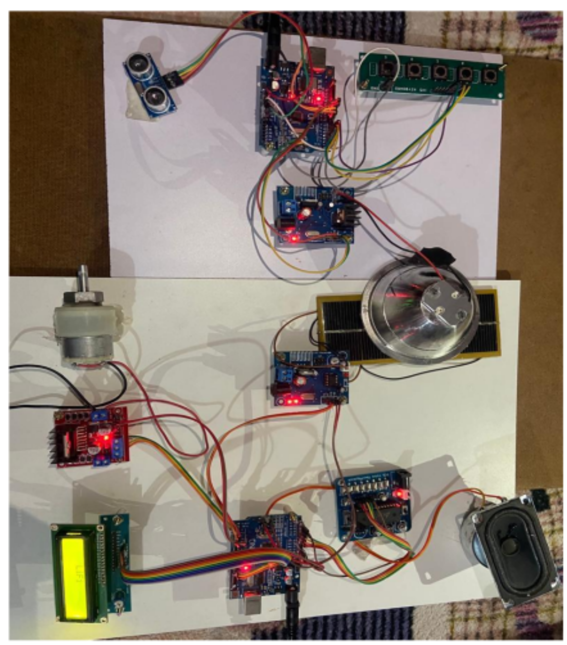


A Components in Transmitter and Receiver section:

The Arduino ATMEGA 328 microcontroller, Li-Fi transmitter amplifier board, Li-Fi transmitter module, Ultrasonic sensor, and Key Performer are all found in the transmitter section Fig [2]. The Arduino ATMEGA 328 microcontroller, Speaker, Voice module, Photo Detector, Li-Fi receiver amplifier board, 16 plus LCD module, 1000 RPM motor, Motor drive are all found in the receiver section Fig [4].

V. IMPLEMENTATION ARCHITECTURE

Fig 5: Implementation Diagram



B Methodology:

The transmitter and receiver sections should first be turned on. When the distance between the vehicles is less which is measured by the Ultrasonic sensor, the LCD will show that there is an obstacle and the engine speed of the vehicle will also slow down. The speed of the engine will automatically increase as the vehicle goes away. Photo detector in the receiver section acts as a receiver. Some of the operations carried out by the Key Performer in the transmitter section, such as Left turn, Right turn, School zone, and Speed breaker, and that will be shown on the LCD and stated by the speaker in the receiver section as well respectively. All these processes will be communicated by the Li-Fi transmitter and receiver between two vehicles. Li-Fi-based V2V communication is a potential approach for intelligent collision avoidance in vehicles, to sum up. It has the ability to dramatically improve the safety of drivers and passengers on the road and prevent enormous human loss with the proper installation and testing.

C Li-Fi:

LiFi, or Light Fidelity, is a new technology that claims to revolutionize wireless communication by transmitting data using light waves. It is a wireless communication technique that employs light waves to transport data between devices and is based on the visible light spectrum. This technology has the potential to be quicker, more secure, and more dependable than ordinary Wi-Fi [6]. LiFi technology may offer provide more secure connectivity than standard Wi-Fi. Because LiFi transmits data via light waves, it is extremely impossible to intercept or hijack the data being delivered. Because light waves do not penetrate barriers, it is extremely difficult for someone to listen in on the data being transferred [11]. As a result, LiFi is an excellent solution for Military communications or financial transactions are examples of secure communication applications.

D Arduino:

Since Arduino is the system's brain, let's learn more about it. The Arduino ATMEGA-328 microcontroller has 14 analogue and digital input and output pins (of which 6 are designated PWM pins), 6 analogue inputs, and the remainder digital inputs. The power jack wire connects the Arduino board to the PC. For power supply, an external battery is attached to the arduino microcontroller [9]. The Arduino microcontroller is an open-source microcontroller that does not have any feedback. This arduino board has an I2C bus for transferring data from the arduino board to the output devices. These arduino boards are configured with AT Mega arduino microcontrollers using RS232 serial interface connectors. The operational voltage starts at 5 volts. The recommended input voltage for an Arduino microcontroller is 7v with a maximum of 12v. The DC input current to the Arduino board is in the 40mA region. Controlling actuators and sensors are two examples of using the Arduino in industrial applications.

V. RESULTS ANALYSIS

In this paper, we looked into how LiFi-based V2V communication may be used for intelligent collision avoidance. We performed tests to assess the performance of the LiFi-based V2V communication system, and we analyzed the results to make judgements on the effectiveness of the system. Our findings demonstrated that smart collision avoidance may be successfully supported in a variety of traffic circumstances using LiFi-based V2V communication. In order to help the driver, make prompt and safe decisions, the technology was able to accurately identify the presence of other vehicles and pedestrians in real-time.

Overall, our results point to the significant potential of LiFi-based V2V communication for enabling secure and effective transportation systems in smart cities. To increase the system's performance, dependability, and suitability for deployment in the actual world, more research is required. The outcomes of our study show that LiFi-based V2V communication is a promising technology for smart collision avoidance and has the potential to significantly advance the design of secure and effective transportation systems.

Some of the outputs that we will be displayed on LCD:

Fig 6: Li-Fi Collision Avoidance Display on LCD

VI. CONCLUSION

This paper described a practical way to use LiFi technology to prevent collisions between two moving vehicles, such as front and rear vehicles. The idea of the emergence of LiFi technology has been successfully introduced along with the V2V communication approach. In this, a straightforward module for future vehicles to implement visible light communication (VLC) between vehicles is presented. It is economical to use basic LED lights as the transmitter, photodiodes as the receiver, and straightforward electronics. A speed sensor is employed at the transmitter to process the vehicle's speed and brake state in order to send over the vehicle's brake and rear lights. Photo diode on the receiver side notices this and notifies the user in which direction to proceed. Real-time transmitter and receiver circuit prototypes are displayed.

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