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VEHICLE TO VEHICLE USING LI-FI TECHNOLOGY

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Abstract: Vehicle to Vehicle communication is one of the upcoming prominent technologies, which aims to provide more road safety measures by providing the important data and information of the vehicles. By introducing Li-Fi technology in the V2V communication enhances the overall performance of the system. The Li-Fi technology helps the V2V communication system to transmit data through a wireless medium at a higher data rate. In Li-Fi, signal is transmitted from a LED and the data is received by the photodetector. In this project, a prototype V2V communication Li-Fi system is designed to avoid road accidents and traffic congestion. The transmitter of the proposed system consists of Li-Fi transmitter module to convert the input data into modulated light signal. The receiver of the proposed system consists of Li-Fi receiver module which decodes the modulated light signal. The decode data is displayed in the LCD. The data shared between two vehicles are speed, temperature and steering angle. These parameters are important to avoid major accidents. Li-Fi technology is used over other transmission techniques, because it is suitable for real time applications.

Keywords: Li-Fi, V2V, Speed, Temperature, Arduino, Light, Transmitter, Receiver.

I. INTRODUCTION

Traditional V2V communication systems typically rely on radio frequency (RF) technologies such as Wi-Fi and cellular networks. While these technologies have been successful in providing basic communication capabilities, they suffer from limitations such as limited bandwidth, susceptibility to interference, and security vulnerabilities. To overcome these challenges and meet the growing demands of future transportation systems, alternative communication technologies are being explored.

The integration of Li-Fi (Light Fidelity) into Vehicle-to-Vehicle (V2V) communication systems represents a significant step forward in the quest to enhance road safety and optimize traffic management. However, thorough testing and assessment are necessary prior to using this cutting-edge technology in practical settings. At this point, simulation becomes important and plays a key part in determining whether Li-Fi-based V2V communication is feasible and performs well.

Designing and implementing this Li-Fi-based V2V communication system is a major focus of this project. Information gathered from simulated scenarios offers a thorough grasp of Li-Fi technology's performance in a dynamic and heterogeneous V2V communication ecosystem. with a focus on enabling real-time data exchange between vehicles on the road. Specifically, the system aims to facilitate the exchange of critical information such as vehicle speed and temperature, which are essential for ensuring safe and efficient operation on the road.

In the subsequent sections, we will delve deeper into the technical aspects of the proposed system, including the design and implementation of Li-Fi transmitters and receivers, data transmission protocols, and system integration considerations. Through this project, we aim to demonstrate the feasibility and effectiveness of using Li-Fi technology for V2V communication, paving the way for safer, smarter, and more connected transportation systems in the future.

II LITERATURE REVIEW

In the 1990s, the notion of vehicles communicating with each other marked the early stages of what is now known as vehicle-to-vehicle (V2V) communication. This concept emerged as a response to the growing need for enhanced safety and improved traffic efficiency on roadways. While the development of vehicle-to-vehicle (V2V) communication in the 1990s was a collaborative effort involving many researchers, one individual who made notable contributions during that time is Dr. Victor D. Menon. He conducted research on dedicated short-range communications (DSRC), an essential V2V communication technology. Research and development pertaining to vehicle-to-vehicle (V2V) communication has been greatly aided by the U.S. Department of Transportation's (USDOT) Intelligent Transportation Systems (ITS) program.

The primary goal of these early concepts was to leverage communication between vehicles as a means to enhance overall road safety. By enabling vehicles to exchange information with one another in real-time, it was envisioned that potential hazards and risks could be identified and addressed more effectively. The focus was on developing a communication framework that would allow vehicles to share key data such as speed, position, and direction of travel. The deployment of wireless technologies played a crucial role in these early concepts.

The creation of layer-2 protocols that enable a car to communicate with other cars in a safety manner. The goal is to deliver safety alerts to vehicles with minimal latency and high dependability. The communication is geo-significant, local, and one-to-many. The network of vehicular communication is ad hoc, highly mobile, and has many competing nodes. The messages must be received with a high probability, but they are very brief and have a limited useful lifetime. The Dedicated Short-Range Communications (DSRC) multi-channel architecture is compatible with the protocols. We derive analytical bounds on the performance of the suggested protocols. The protocol's performance sensitivity is assessed in a range of offered and vehicular traffic flows. The outcomes demonstrate the viability of our strategy for DSRC vehicle safety messaging.

Driving load reduction, traffic prevention, and safe driving are all expected to be addressed by driving assistant systems with cameras and sensors. Additionally, wireless technology-based vehicle-to-vehicle (V2V) communication systems have been suggested as an add-on to the current systems. A GPS module is used in place of the traditional speedometer in the proposed system, which eliminates many of the issues with the current setup. In order to prevent transmission collisions, this study develops an embedded communication system for a small autonomous electric car. The ability for vehicles to communicate with one another facilitates the successful design of a platooning control system that takes vehicle interruptions and separations into account.

Vehicles with internet connections might be an upgrade. In addition to the current IoT connected vehicles solution, this paper presents a novel concept of a vehicle to vehicle (V2V) connection via the internet. This system could guarantee data transfers between cars as they approach, sharing real-time road information and guaranteeing everyone drives in a safer and better environment. The IoT-based V2V communication system is built upon a foundation of sensor- equipped vehicles, capable of collecting and sharing data related to their speed, position, and status. These vehicles form a self-organizing network that facilitates seamless communication, allowing for the transmission of critical information such as traffic conditions, potential hazards, and road infrastructure updates.

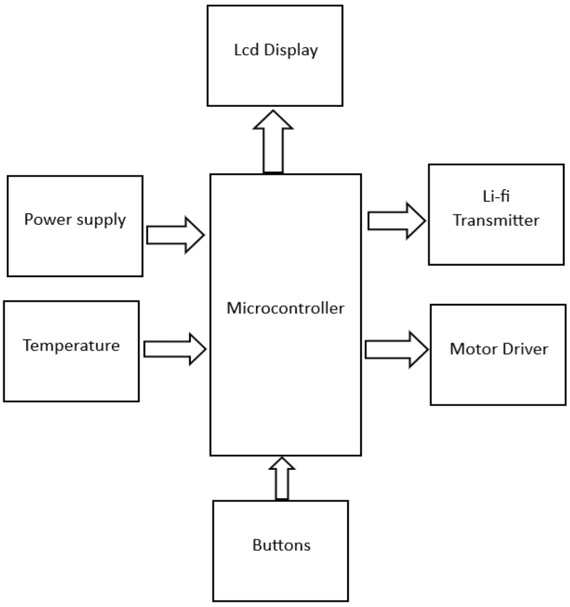
Using Light Fidelity (Li-Fi) technology, this paper presents a novel approach to Vehicle-to-Vehicle (V2V) communication, since road safety is still a top priority in the age of smart transportation. Li-Fi, a visible light-based wireless communication technology, has special benefits like high data rates, low latency, and immunity to electromagnetic interference. This paper explains the integration of Li-Fi for the transmission and reception of driver safety-related data among vehicles, contributing to an advanced and secure V2V communication system. The proposed system relies on vehicular Li- Fi transceivers installed in vehicles, enabling the transmission of critical safety-related information, including vehicle speed, acceleration, and position. Li-fi's inherent characteristics, such as the ability to provide high-bandwidth communication, facilitate real-time data exchange, enhancing the responsiveness of safety applications.

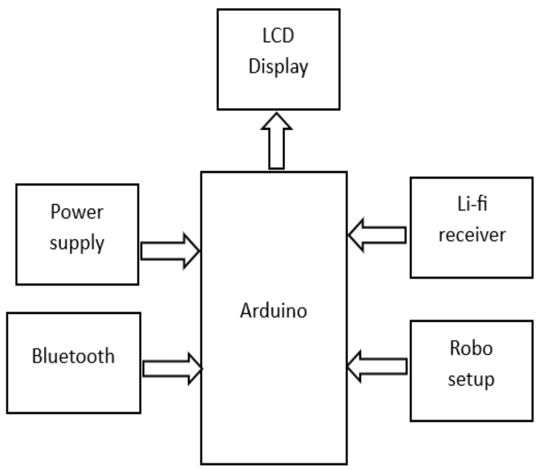
III METHODOLOGY

The project is structured to comprehensively address the research objectives of enhancing vehicular communication through the application of Li-Fi technology. The project begins with a clear problem definition and scope clarification, laying the foundation for the study of robust and efficient vehicle-to-vehicle communication using Li-Fi. Subsequently, a thorough literature review is conducted to delve into existing knowledge and insights related to Li-Fi technology, V2V communication, and the intersections between the two. This review will provide the necessary context and inform the research approach. Moving forward, the research design and approach are carefully selected, taking into account the defined scope and objectives. The methodology includes a data collection phase, where data sources and collection methods are determined, whether it involves Li-Fi hardware, simulation tools, or real-world vehicular networks. Performance metrics, such as data transfer rate, latency, signal strength, reliability, and network connectivity, are collected and rigorously assessed.

The heart of the project lies in the implementation of the Li-Fi system within a controlled environment or testbed, configuring Li-Fi transmitters and receivers in vehicles to establish V2V communication channels. Performance evaluation follows, involving a series of experiments and simulations to measure and analyze key parameters. These parameters include data transfer rate, latency under different conditions, signal quality, and network reliability. The methodology also encompasses a comparative analysis, where the performance of Li-Fi- based V2V communication is benchmarked against traditional wireless technologies such as Wi-Fi or cellular communication, shedding light on the strengths and limitations of Li-Fi in vehicular networks. In the pursuit of optimizing the Li-Fi system, the research delves into strategies to enhance its performance for vehicular environments. Adaptive modulation schemes, beamforming techniques, channel allocation strategies, and interference mitigation approaches are explored. Security and reliability represent critical aspects of the methodology, where the study investigates the protocols and measures required for secure V2V communication via Li-Fi and assesses the system's robustness under varying environmental conditions and potential sources of interference.

The suggested technology is functional. There are two components to it, the transmitter and the receiver. Visible LED light is used to transmit data between vehicles. Consequently, the recommended system has low environmental impact and low installation costs. Vehicle-to-vehicle communication has been shown to be the most successful strategy for lowering the daily total of reported accidents. Li-Fi technology uses LED light to transmit data from one vehicle to another. Li-Fi technology is not very complicated because the protocols that are used in it are being phased out. The design of this system aims to achieve maximum dependability while permitting any required data flow between the transmitter and receiver inside the vehicle.





Li-Fi Receiver

ARDUINO:

Arduino is an open-source electronics platform known for its user-friendly hardware and software. It makes use of microcontroller boards that can be programmed using a condensed form of C++. Arduino is widely utilized in robotics and home automation projects, and its extendable shields increase its flexibility even further. It's customary to share projects with the community via blogs and social media, and while publishing information, it's crucial to take your audience's degree of experience and license needs into account.

Figure 1: Arduino

MOTOR DRIVER (L298N):

The most versatile and basic variety is the brushed DC motor driver, which has several uses. This DC motor functions as a modulator-equipped power amplifier. To power DC motors, a DC inverter converts AC to DC. Increased motor speeds provide more voltage in the tachometer, which the inverter uses as a reference to make sure the motor is operating at the user-specified speed. This is mostly utilized for accurate reversing and braking.

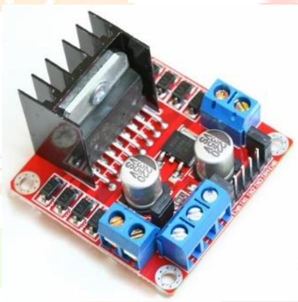


Figure 2: Motor Driver

MOSFET:

A MOSFET (Metal-Oxide-Semiconductor Field-Effect Transistor) is a type of transistor used in electronic circuits. It controls the flow of electrical current between source and drain terminals by applying a voltage to the gate terminal. MOSFETs play a crucial role in electronic devices, serving purposes like signal amplification, switching, and voltage regulation due to their efficiency, speed, and versatility. They come in various types, such as N-channel and P-channel, tailored for specific applications in modern electronics.

Figure 3: Mosfet

Li-Fi TRANSMITTER AND RECEIVER:

Data transmission using light is referred to as Li-Fi (i.e.) the data through a LED lamp whose intensity changes faster. The new Li-Fi receiver is equipped with a solar panel that receives light with data. Its baud rate is 9600. You can move up to 15 feet with no obstacles. Moderate exposure to sunlight affects opacity. The trim pot on the receiver board can be adjusted to increase the distance.

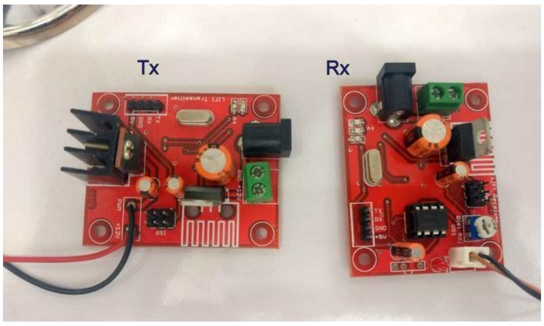


Figure 4: Li-Fi Tx and Rx Module

TEMPERATURE SENSOR (DS18B20):

The DS18B20 is a digital temperature sensor widely used in electronics projects. It operates on the 1-Wire protocol, allowing multiple sensors to share a single digital pin. Known for accuracy and a broad temperature range, the DS18B20 has a unique address for easy identification in a sensor network. Its digital output makes it popular for applications like weather stations and thermostats, simplifying integration into various electronic projects.

Figure 5: Temperature Sensor

BLUETOOTH TRANS-RECEIVER (HC-05):

A flexible Bluetooth module for wireless communication is the HC-05. It supports Master and Slave modes and may act as a transmitter as well as a receiver. It uses the Bluetooth Serial Port Profile (SPP) to enable serial communication between devices while operating within a voltage range of 3.6V to 6V. The module may be customized with AT instructions, and it is frequently used with microcontrollers such as Arduino and Raspberry Pi. With features like LED indications, pairing, and security, the HC-05 is a well-liked option for setting up wireless connections in a variety of electrical applications.

Figure 6: Hc-05

DC MOTOR:

A DC motor converts electrical energy into motion and is comparable to a miniature power plant. It consists of a moving portion (rotor) and a stationary part (stator). The motor's rotor rotates because of magnets that conduct electricity. These motors are useful because they are widely used in electric automobiles, fans, and toys, and they are simple to use. They are powered by direct current (DC) batteries or power supply.

Figure 7: Dc Motor

IV RESULTS AND DISCUSSION

The circuit has been built as discussed, codes have been uploaded into the Arduino then the project is ready for testing. The different parameters discussed in this project are Speed and Temperature. Speed parameter is calculated in the form of RPM (Revolution Per Minute). And Temperature is calculated in Degree Celsius (°C). The Li-Fi-based communication system successfully detected the speed of vehicles with high accuracy and effectively monitored the temperature of vehicle engines in real time.

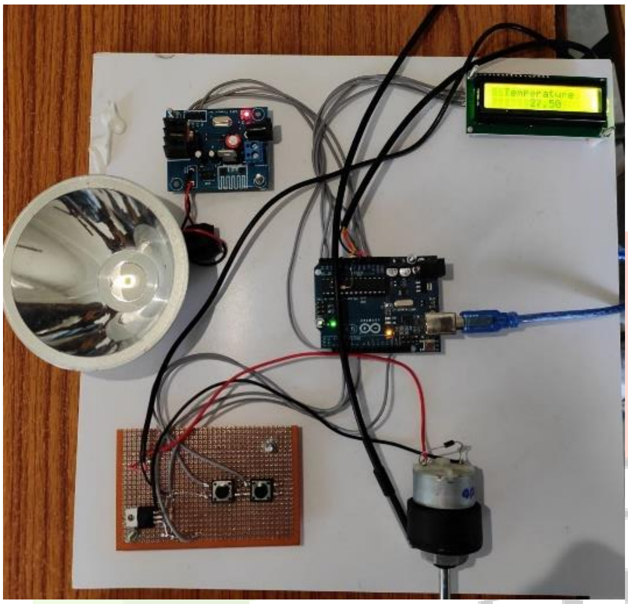


Figure 8: Li-Fi Transmitter

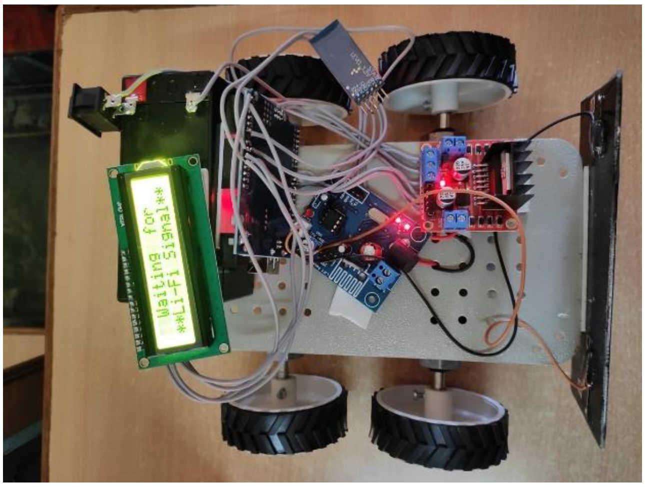


Figure 9: Li-Fi Receiver

Table 1: Speed and its range

SI.No	Description	Speed (in Percentage)	Speed (in RPM)
1.	Avg Speed	85%-91%	0-500
2.	High Speed	51%-100%	501 & above

Table 2: Temperature and its range

SI.No	Description	Temperature (in percentage)	Temperature (in °C)
1.	Normal Temperature	1% - 88%	1°C - 44°C
2.	High Temperature	89% - 100%	45°C & above

This proposed system may enable both intra- and inter-vehicle sensory data exchange in automobiles. The data exchange can be used to identify the abrupt changes in vehicles that gives a risk and alert the driver. Better vehicular conditions are made possible by an intelligent transportation system that are made possible by the use of V2V communication. The results of the performance evaluation of Li-Fi technology in V2V communication is carried out in simulated environment in which the result of inputs (Temperature, Speed, and Steering Angle) of the vehicles are obtained in LCD Module.

APPLICATIONS

Collision Avoidance: Li-Fi V2V communication enables automobiles to communicate real- time position, speed, and direction data, which can assist in the detection and prevention of potential collisions. This can significantly reduce the number of accidents and increase traffic safety.

Traffic Management: Vehicles can communicate information about traffic conditions, congestion and road closures through Li-Fi V2V communication, which is effective in traffic management. Vehicle rerouting and traffic flow optimization are made by using this data.

Emergency Vehicle Alerts: When an emergency vehicle, like an ambulance or fire truck, is coming, adjacent vehicles can receive instant alerts via Li-Fi V2V communication. This expedites response times and makes room for the emergency vehicle.

CHALLENGES AND FUTURE IMPROVEMENTS

1. Despite its advantages, Li-Fi technology may face challenges such as limited range and line-of-sight requirements between communicating vehicles.
2. Future improvements could focus on enhancing Li-Fi transceiver designs for longer-range communication and developing algorithms to mitigate line-of-sight issues.
3. Integration with advanced vehicle control systems and artificial intelligence algorithms could further enhance the capabilities of Li-Fi-based vehicle communication systems.

V CONCLUSION

In this project, a prototype V2V communication Li-Fi system has been designed to avoid road accidents and traffic congestion. In the proposed system, light emitting diode (LED) has been used to transmit data and photodiode has been used to receive the data from one vehicle to another vehicle. The parameters such as speed, temperature and steering angle of the Vehicle have been measured and transferred to one vehicle to another vehicle. The vehicle monitoring section of the Li-Fi system has been designed using Arduino, temperature sensor, speed sensor, motor and LCD display. The measured values of speed, temperature and steering angle are compared with the threshold of average and over speed conditions, normal and high temperature conditions, right and left movement conditions respectively. The measured data provides the important information of one vehicle. The measured data is exchanged at a higher data rate from one vehicle to another vehicle. The proposed system can send data up to 15 feet system without any interference. So, the Li-Fi technology incorporated with V2V communication has numerous advantages which improves the road safety.

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Mr. Kishore Kumar G K, Mr. Nithish S and Mr. Srinithivasan A are UG scholars in Department of Electronics and Communication Engineering at Sri Ramakrishna Institute of Technology, Coimbatore, Tamilnadu, India.

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