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IOT-BASED V2V COMMUNICATION USING LI-FI FOR ENHANCED ROAD SAFETY AND ACCIDENT PREVENTION

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Abstract: Road accidents are a major cause of fatalities worldwide, often resulting from human errors like drunk driving, drowsiness, panic situations, or delayed responses to obstacles. To address this, a smart Vehicle-to-Vehicle (V2V) Communication System is proposed, utilizing Li-Fi technology and Arduino microcontrollers to prevent accidents and enhance driver safety. The system consists of a Transmitter Kit and a Receiver Kit installed in individual vehicles. The Transmitter Kit includes sensors to detect intoxicated driving, fire, drowsiness, panic situations, and obstacles. When an abnormal condition is detected, the Arduino processes the data and sends an alert signal through Li-Fi, a secure and interference-free communication method. The Receiver Kit in nearby vehicles receives the signal and triggers alerts or actions to prevent accidents. This system is low-cost, lightweight, and easy to deploy, making it suitable for both rural and urban areas without relying on internet connectivity. It promotes safer driving environments by enabling real-time communication between vehicles.

Index Terms **-**Li-Fi communication, Arduino, vehicle-to-vehicle (V2V), accident prevention, alcohol detection, fire detection, drowsiness monitoring, ultrasonic sensor, panic alert system, intelligent transport system (ITS), real-time safety alert.

1. INTRODUCTION

Road safety remains a concern due to increasing vehicle density and driver negligence. Vehicle-to-Vehicle (V2V) communication is an emerging technology that enhances safety by sharing real-time information. Traditional V2V communication uses RF-based technologies like Wi-Fi, Bluetooth, or DSRC, but these have limitations. This project explores Li-Fi technology, which provides high-speed, interference-free, and secure data transmission using visible light communication (VLC). The proposed system integrates multiple sensors, including ultrasonic, fire, alcohol, and drowsiness detection sensors, to monitor vehicle safety and driver conditions. Each vehicle is equipped with an Arduino-based sensor module and Li-Fi transmitter. When a critical condition is detected, the Arduino processes the sensor data and transmits it via Li-Fi to the receiver module in other vehicles. The receiver module triggers alerts, such as stopping the vehicle, displaying warnings, or activating emergency lights. Li-Fi technology offers higher security, no electromagnetic interference, and greater bandwidth efficiency. The system operates using an LED-based light source and photodiode receiver, ensuring fast and efficient data transmission. This project aims to improve road safety, accident prevention, and emergency response mechanisms. By implementing smart safety measures using V2V communication, the system enhances situational awareness for drivers, reducing accident risks. The implementation of sensor-based vehicle control and intelligent decision-making will contribute to a safer transportation system. Li-Fi technology provides a reliable and efficient solution for V2V communication. The system is designed to be low-cost and efficient. It uses embedded systems and Li-Fi communication to enhance road safety.

The proposed system has the potential to reduce accidents and save lives. Overall, the Li-Fi based V2V communication system is a promising solution for improving road safety.

II. LITERATURE REVIEW

The concept of Vehicle-to-Vehicle (V2V) communication began taking shape in the 1990s, driven by the need for improved road safety and traffic efficiency. Researchers, including Dr. Victor D. Menon, made notable contributions to the development of V2V technology, particularly in Dedicated Short-Range Communications (DSRC). The U.S. Department of Transportation's (USDOT) Intelligent Transportation Systems (ITS) program has also played a significant role in advancing V2V research and development, helping to shape the future of transportation safety and efficiency. The current vehicle communication and safety mechanisms face significant challenges. RF- based technologies like Wi-Fi, Bluetooth, and DSRC are plagued by signal interference, limited bandwidth, high latency, and security vulnerabilities. These issues compromise the effectiveness of safety systems, putting drivers and passengers at risk. Traditional safety measures, including collision avoidance systems, alcohol detection, and fire alarms, operate in isolation without real-time data sharing. Moreover, camera-based driver drowsiness detection systems can be expensive and less effective in low-light conditions. The lack of efficient communication between vehicles results in delayed accident prevention responses, increasing the risk of collisions and hazardous situations on the road. Furthermore, the absence of a robust and reliable communication system hinders the development of advanced safety features, such as real-time traffic updates and emergency response systems. To address these challenges, a more efficient, interference-free, and fast communication system is essential.

This would enable the seamless exchange of data between vehicles, infrastructure, and emergency services, ultimately enhancing road safety and reducing the risk of accidents. By leveraging advanced technologies, such as Li- Fi or other alternatives, the automotive industry can create a safer and more efficient transportation ecosystem. The development of such a system would require collaboration between industry stakeholders, researchers, and policymakers to ensure the creation of a comprehensive and effective solution. By working together, we can create a safer and more connected transportation system for everyone. Overall, the need for a more efficient and reliable communication system is crucial for enhancing road safety and reducing the risk of accidents. By addressing these challenges, we can create a safer and more efficient transportation ecosystem for everyone.

III. METHODOLOGY

1. Li-Fi Based V2V Communication System

The proposed system introduces a Vehicle-to-Vehicle (V2V) communication system using Li-Fi technology and Arduino-based embedded systems. It integrates ultrasonic, fire, alcohol, and drowsiness sensors to monitor the vehicle's surroundings and driver condition. Key features include obstacle detection, fire alert system, alcohol detection, drowsiness monitoring, Li-Fi-based data transmission, automated vehicle control, and real-time alerts.The system ensures faster, more secure, and interference-free data transfer, improving road safety, accident prevention, and emergency response. Unlike existing RF-based systems, Li-Fi technology provides a reliable and efficient solution for V2V communication. The system automatically stops the vehicle and alerts surrounding vehicles in critical conditions, enhancing situational awareness and reducing accident risks. The Li-Fi-based V2V communication system offers several advantages, including higher security, no electromagnetic interference, and greater bandwidth efficiency. The system operates using an LED-based light source and a photodiode receiver, ensuring fast and efficient data transmission in real-time. This system has the potential to significantly improve road safety, reducing the number of accidents and saving lives. By implementing smart safety measures using V2V communication, the system enhances situational awareness for drivers, reducing accident risks and ensuring timely alerts in critical situations. The integration of multiple sensors and Li-Fi technology enables the system to detect and respond to various hazards, including obstacles, fires, and driver fatigue. The system's automated vehicle control and real-time alerts ensure that drivers are notified promptly, reducing the risk of accidents and improving overall road safety. Overall, the Li-Fi- based V2V communication system is a promising solution for improving road safety, offering a reliable, efficient, and secure way to enhance situational awareness and prevent accidents.

2. Block diagram and Components

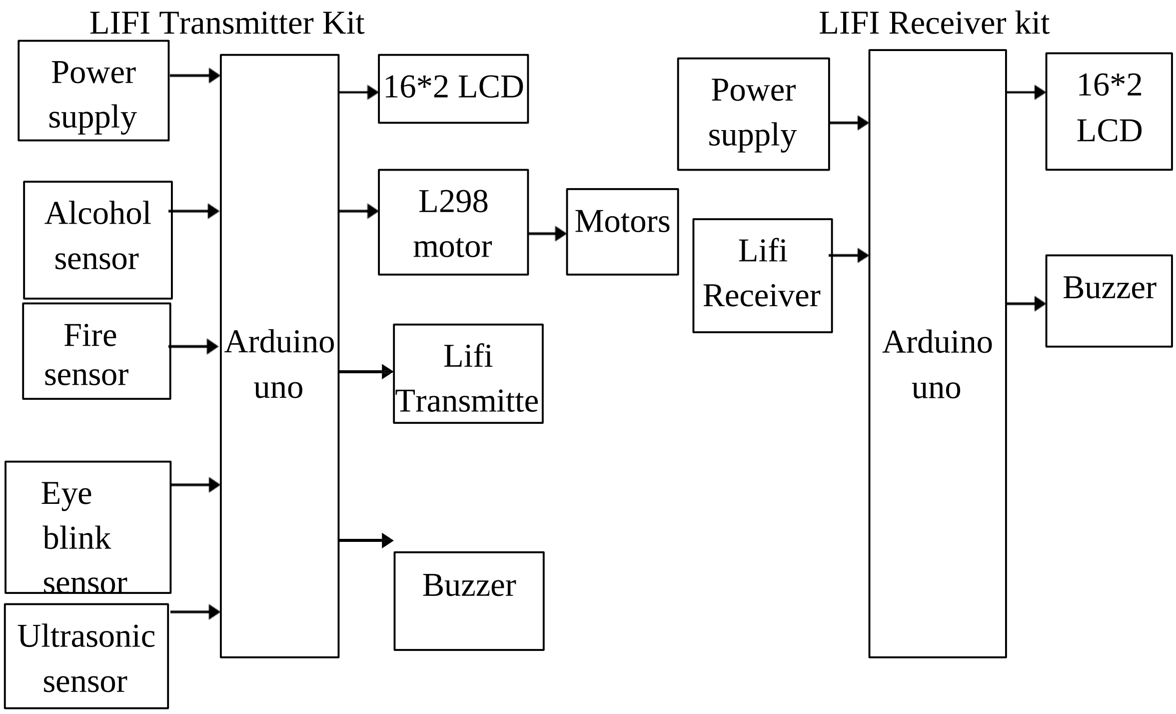

Figure 1: Block Diagram

ARDUINO UNO: The Arduino Uno is a microcontroller board based on the ATmega328 (datasheet). It has 14 digital input/output pins (of which 6 can be used as PWM outputs), 6 analog inputs, a 16 MHz crystal oscillator, a USB connection, a power jack, an ICSP header, and a reset button. It contains everything needed to support the microcontroller; simply connect it to a computer with a USB cable or power it with a AC-to-DC adapter or battery to get started. The Uno differs from all preceding boards in that it does not use the FTDI USB-to-serial driver chip. Instead, it features the Atmega8U2 programmed as a USB-to-serial converter. "Uno" means one in Italian and is named to mark the upcoming release of Arduino 1.0. The Uno and version 1.0 will be the reference versions of Arduino, moving forward. The Uno is the latest in a series of USB Arduino boards, and the reference model for the Arduino platform.

Figure 2: Arduino

DC Motor: A DC motor is designed to run on DC electric power. Two examples of pure DC designs are Michael Faraday's homopolar motor (which is uncommon), and the ball bearinmotor, which is (so far) a novelty. By far the most common DC motor types are the brushed and brushless types, which use internal and external commutation respectively to create an oscillating AC current from the DC source -- so they are not purely DC machines in a strict sense.

Figure 3: Dc Motor

Alcohol Sensor: Detects the presence of alcohol in the driver's breath to prevent drunk driving.
Working: The alcohol sensor measures the alcohol concentration in the vehicle's cabin.If alcohol is detected above a threshold, the system can alert the driver, disable the ignition, or send a warning signal to nearby vehicles via Li- Fi.Nearby vehicles receive the warning and can take preventive actions, such as maintaining a safe distance.

Figure 4: Alcohol Sensor

Panic Sensor: Detects emergency situations, such as sudden braking or collision, and alerts nearby vehicles. **Working:**The panic sensor is triggered during emergencies, such as hard braking or airbag deployment.The vehicle's Li-Fi system transmits an emergency signal to nearby vehicles.Nearby vehicles receive the signal and can automatically slow down or change lanes to avoid a collision.

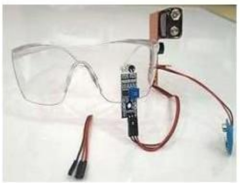

Figure 5: Panic Sensor

Fire Sensor: Detects fire in the vehicle and alerts nearby vehicles and emergency services.
Working: The fire sensor monitors temperature and smoke levels in the vehicle.If a fire is detected, the system sends an alert via Li-Fi to nearby vehicles and emergency services. Nearby vehicles can take evasive actions, and emergency services can be dispatched to the location.

Figure 6: Fire Sensor

Obstacle Sensor: Detects obstacles on the road and shares this information with nearby vehicles.

Working: The obstacle sensor (e.g., ultrasonic, LiDAR, or camera-based) detects objects or hazards on the road.The sensor data is transmitted via Li-Fi to nearby vehicles, warning them ofthe obstacle Nearby vehicles can adjust their speed or trajectory to avoid the obstacle.

Figure 7: Obstacle Sensor

Software Tools:

Arduino IDE: Initial Setup where you can start programming immediately.First, we should configure the board and port settings to allow us .This is the Arduino IDE once it's been opened. It opens into a blank sketch upload code. Connect your Arduino board to the PC via the USB cable.

1. **IDE Arduino Setup:**You have to tell the Arduino IDE what board you are uploadingto Select the Tools pulldown menu and go to Board.This list is populated by default with the currently available Arduino Boards that are developed by Arduino. If you are using an Uno or an Uno-Compatible Clone (ex. Funduino, SainSmart, IEIK, etc.), select Arduino Uno.
2. **Ide: Board Setup** You have to tell the Arduino IDE what board you are uploading to. Select the Tools pulldown menu and go to Board.This list is populated by default with the currently available Arduino Boards that are developed by Arduino. If you are using an Uno or an Uno-Compatible Clone (ex. Funduino, SainSmart, IEIK, etc.), select Arduino Uno. If you are using another board/clone, select that board.
3. **Ide:** Com Port Setup If you downloaded the Arduino IDE before plugging in your Arduino board, when you plugged in the board, the USB drivers should have installed automatically. The most recent Arduino IDE should recognize connected boards and label them with which COM port they are using. Select the Tools pulldown menu and then Port.Here it should list all open COM ports, and if there is a recognized Arduino Board, it will also give it's name. Select the Arduino board that you have connected to the PC. If the setup was successful, in the bottom right of the Arduino IDE, you should see the board type and COM number of the board you plan to program. Note: the Arduino Uno occupies the next available COM port; it will not always be COM3.

IV. RESULT

Vehicle-to-Vehicle (V2V) communication using Li-Fi technology enables vehicles to exchange critical information in real-time. Each vehicle is equipped with Li-Fi transmitters (LED lights) and receivers (photodetectors) that transmit and receive data by modulating light intensity at high speeds. The transmitted data includes speed, direction, location, and sensor information, which is decoded by the receiving vehicle. Li-Fi requires a direct line of sight, achievable through headlights, taillights, or dedicated modules. Integrated sensors collect and transmit data, enhancing situational awareness and safety. This technology enables rapid and secure communication betweenvehicles, reducing the risk of accidents and improving overall road safety.

Vehicles are equipped with Li-Fi transmitters (LED lights) and receivers (photodetectors) that transmit and receive data through modulated light intensity. This technology allows vehicles to share speed, direction, location, and sensor data, enabling rapid and secure communication. With a direct line of sight required, Li-Fi can be achieved through headlights, taillights, or dedicated modules. By leveraging Li-Fi, V2V communication can significantly reduce accidents, improve situational awareness, and enhance overall road safety, paving the way for smarter transportation systems.

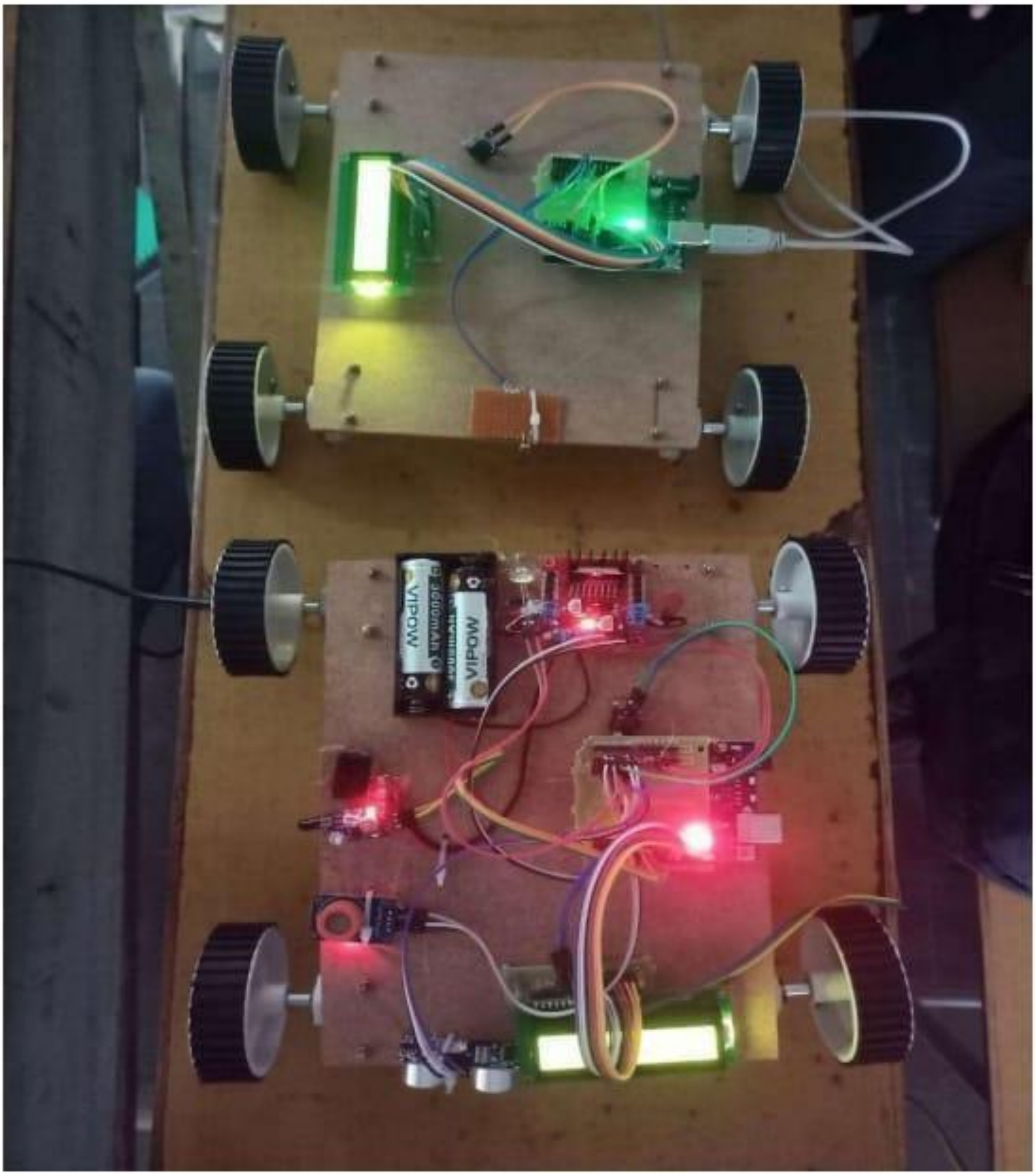

Figure 7: Li-Fi Transmitter and Reciever

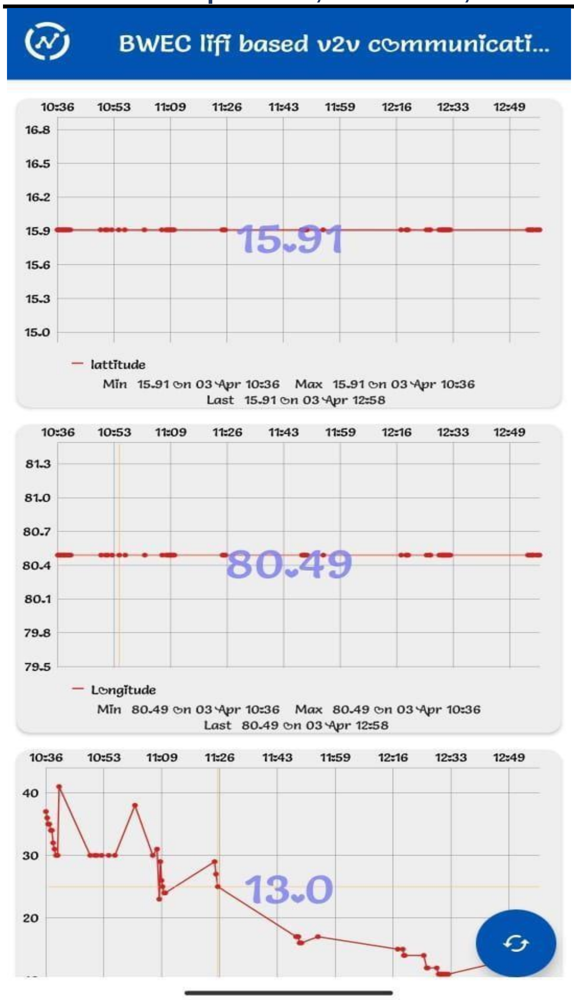

Figure 8: Lattitude and Longitude

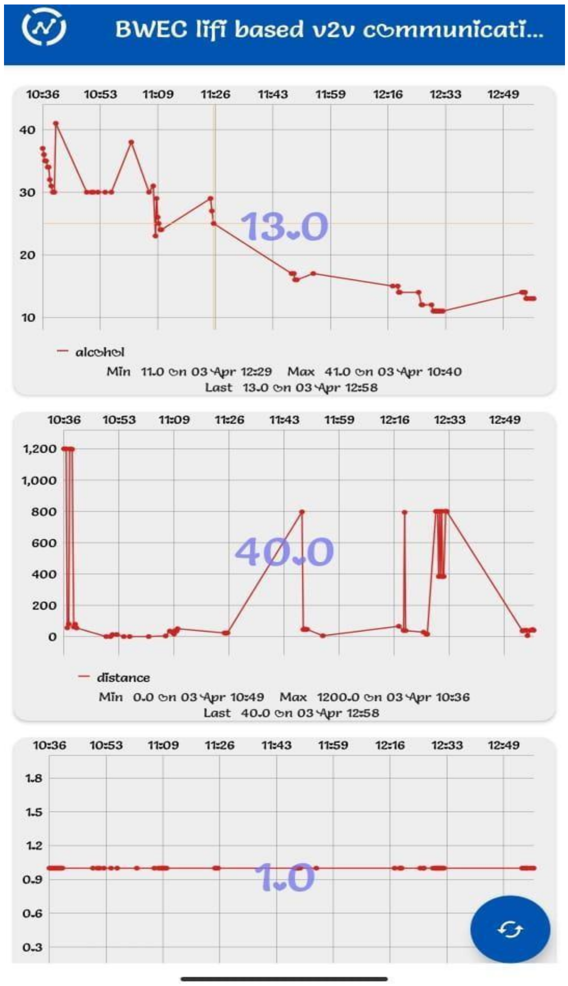

Figure 9: Alcohol,Distance,Panic Button

VI. CONCLUSION AND FUTURE SCOPE

This project successfully implements a Vehicle-to-Vehicle (V2V) communication system using Li-Fi technology, enhancing road safety and accident prevention. The system integrates various sensors for real-time safety monitoring, including ultrasonic, fire, alcohol, and drowsiness detection. Li-Fi enables fast, secure, and interference- free communication between vehicles, improving situational awareness and reducing accident risks. The system's automation of vehicle control and alert system minimizes road accidents, and its use of low-cost embedded systems makes it an affordable solution for future implementation in smart vehicles and connected transportation networks. Overall, the project demonstrates the effectiveness of Li-Fi technology in intelligent transportation systems, offering a promising solution for improving road safety.

The future scope of this project includes several potential enhancements, such as integrating the system with IoT and cloud technology to store and analyze real-time vehicle data, improving decision-making and predictive analytics for road safety. Additionally, AI-based driver monitoring can be implemented to enhance drowsiness and intoxication detection. Improvements in Li-Fi technology can extend its range and efficiency, enabling long-distance V2V and V2I communication. The system can also be integrated with smart traffic management, mobile app interfaces, GPS-based emergency response, and automatic emergency braking mechanisms. Furthermore, multi- vehicle network communication can be developed to enable a cooperative driving experience, ultimately leading to improved road safety and reduced accidents. These advancements can make the system more comprehensive, efficient, and effective in preventing accidents and enhancing road safety.

REFERENCES

[1] Quick Daren, "10 Gbps Li-Fi System Shows Wireless Data Transfer in New Light", International Journal of Advance Research in Computer Science and Management Studies, .

[2] J.-M. Wun, C.-W. Lin, W. Chen, J. K. Sheu, C.-L. Lin, Y.-L. Li,J. Bowers, et al., "GaN-Based Miniaturized Cyan Light-Emitting Diodes on a Patterned Sapphire Substrate With Improved Fiber Coupling for Very High-Speed Plastic Optical Fiber Communication", Photonics Journal IEEE, vol. 4, no. 5, pp. 1520- 1529, .

[3] Nancy Owano, "Li-Fi: Edinburgh Prof Seeds LEDs for Communication", International Journal Of Scientific Research And Education, .

[4] Neil Savage, "Li-Fi Gets Ready to Compete with Wi-Fi", IEEE Photonics Conference, .

[5] R. R. Sharma and Sanganal A Raunak, "Li-Fi Technology: Transmission of Data Through Light", International Journal of Computer Technology & Applications, vol. 5.6.3 REFERENCES

[6] C. Sridharan, P. Srikanth and J. R. Thresphine, "Intelligence with Li-Fi Technology", International Journal of Computer Engineering & Science (IJCES), January 2020.

[7] MOSAIF RAKRAK said “An Indoor Wireless Visual Sensor Network basing on Light -Fidelity Communications”,2017 International Conference on Wireless Networks and Mobile Communications

(WINCOM).

[8] Niharika Mishra, Monika Rai , Riya Mandal Harjeet Kaur. “Navigation System using Light Fidelity “2018 2nd International Conference on Trends in Electronics and Informatics (ICOEI)

[9] Kumar Ranjan “The Lattice-An intelligent grid for connected car Industry”.2017 IEEE Transportation Electrification Conference(ITEC-India) Asis Kumar Tripathy, Kumar Mishra, Tapan Kumar Das,” Smart Lighting: Intelligent and Weather adaptive Lighting in Street Lights using IOT”, 2017 International Conference on Intelligent Computing, Instrumentation and control technologies.

[10] Quick Daren, "10 Gbps Li-Fi System Shows Wireless Data Transfer in New Light", International Journal of Advance Research in Computer Science and Management Studies.

[11] R. Lavanya, B.Tulasi Bai, B.Durgasri, A.Priyanka, “IoT -Enabled Industry Monitoring and Controlling System”, journal of Emerging technologies and Innovative Research (JETIR)”, volume 11, Issue 3, march 2024, pp:j236-j242.

[12] J.-M. Wun, C.-W. Lin, W. Chen, J. K. Sheu, C.-L. Lin, Y.-L. Li,J. Bowers, et al., "GaN-Based Miniaturized Cyan Light-Emitting Diodes on a Patterned Sapphire Substrate With Improved Fiber Coupling for Very High-Speed Plastic Optical Fiber Communication", Photonics Journal IEEE, vol. 4, no. 5, pp. 1520- 1529.

[13] Nancy Owano, "Li-Fi: Edinburgh Prof Seeds LEDs for Communication", International Journal Of Scientific Research And Education.

[14] Neil Savage, "Li-Fi Gets Ready to Compete with Wi-Fi", IEEE Photonics Conference.