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LI-FI : IOT BASED VEHICLE TO VEHICLE COMMUNICATION

Suresh Kallepalli, Vinod Babu Pusuluri, ,Hema Hareendra Dattu, Palavalasa Sai Raj,
Department of Electronics and Communications Engineering RGUKT Nuzvid-India.
Suresh.yuvva@rgutkn.ac.in
Konatham Raja Sekhar, Department of Mechanical Engineering RGUKT Nuzvid-India

Abstract:
Light Fidelity, also known as LiFi, is a technology based on communication using light which eliminates the hassle of wired communication. This approach ensures the comfort and safety on the road by preventing major accidents. This article proposes an Internet of Thing based idea on application of Light Fidelity without any additional infrastructure and protocols. This approach makes use of various sensors namely speed sensor, ultrasonic sensor, LCD screen, LDR sensor, etc and exchanges the real-time data collected from these sensors using Internet connectivity. Services such as alarm to prevent accidents, detecting alcohol levels, information about traffic and messages about any emergency can be shared easily. Additional features like Save Our Souls (**SOS**) alerts can also be generated in the International Morse Code format both for light and audio format to enable two-way flow of information using ESPN module. More over the main aspect in the proposed system is use of Light Fidelity **(**Li-Fi**)** to transmit the data to ensure safety. The real time V2V communication is established at various distances like 5cm, 10cm &15cm.
Keywords: ***Li-Fi, protocols, SOS alerts, transmission, Morse code, Internet of Things.***

I. Introduction:

In India on an average 1.5millin accidents occurs and 3.7 million people lost their lives in 2021 alone as per NCRB-2022. Annually, around 40,000 people die and 1.7 million are injured in road accidents across Europe, more than 16,000 crashes take place on U.S. highways every day. With the rapid growth of automobiles, the phenomenon of ‘‘urban traffic congestion’’ has seriously influenced the urban environment. Traffic congestion is a common problem in a city, which may be caused by various reasons such as traffic planning, traffic construction, etc. There are many reasons for traffic congestion. One is Dynamic congestion, also referred to as general traffic congestion. Because of the unreasonable commuting, loop holes in traffic management lead to unreasonable traffic congestion; the other is static congestion, which is caused by the congested parking areas. Countries around the world solve optimization problems mainly by adopting the following methods like Enhancing Public Transportation Infrastructure and Services, Implementing Land-Use planning and Traffic Management strategies. As road safety is a huge concern, many have spurred research into vehicular communication networks (VCNs). These networks allow users to share information [1-2]. There are various technologies evolved for road safety through different strategies [3-5]. One such attempt is the Fausto research, to improve the safety of road management systems and the stability of Motor density by sharing information. Vehicles accidentally approach each other to form and manage a locally autonomous, decentralized dynamic network. In order to improve the traditional time slot reservation method, Fausto proposed a reservation **ALOHA** protocol, the solution proposed by Fausto can improve communication efficiency [6]. Computer simulations verify the performance of the system in an environment. There are attempts to reduce the accidents by drowsiness detection using IoT [7]. The list of existing technologies for V2V is mentioned in the below table.

Table.1 Existing technologies for V2V communication.

Feature	WiFi [5 - 8]	LiFi	Bluetooth [5 - 5.3]	ZigBee [5]
Mode Of Operation	Using Radio Waves	Using Light Waves	Using short wavelength **UHF** radio waves	Using radio waves
Coverage distance	46m	10m	10m, 100m **(**Based on classes**)**	75 - 100m
Frequency of operation	2.4 GHz, 4.9 GHz and 5 GHz	10,000 times the radio waves	2.4 - 2.485 GHz	2.4 GHz
Data Speed	10 - 600 Mbps **(**Based on version**)**	1 Gbps	720 Kbps	250 Kbps
Security Protocol	WPA, WPA2, and WPA3	-	Secure simple pairing, SSP	128-bit AES
Maximum number of nodes	255	Hardware dependent	Eight devices, 8	256

II. V2V Architecture:

The V2X communication network comprises 3 layers, where the data is read, processed and sent by the Engine Control Unit (ECU). The ECU reads the real-time data from the sensors, analyzed by the ECU and transfers the analyzed data **(**using Li-Fi**)**, also feeds the analyzed data into the cloud **(**using ESP-8266**)**. The functions of each layer are described in detail below.

a) Cognition layer: This layer is responsible for realizing the real-time data. The perception of road information is mainly realized through sensors and transmission networks, such as pressure sensors, temperature sensors, ultrasonic sensors, and by the 360-degree cameras. After reading the data from sensors, it is transmitted through the wireless network; the data aggregation is finally completed.

b) Processing layer: Onboard Microcontroller **(**at mega 328P**)** performs real-time sensor data analysis and applies pre-programmed decision-making algorithms to determine the appropriate course of action. Simultaneously, the processed data is logged into the cloud as data sets for future purposes, to understand the Motor density, weather elements, etc.

c) Network layer: This layer is responsible for data transmission. The data is transferred in 8-bits **(**typically, a byte**),** 1 bit is used for actuation. A bit value of 1 corresponds to the LED being switched on, transmitting a digital "1". Conversely, a bit value of 0 corresponds to the LED being off, representing either no data transmission or a digital "0". The LEDs can be switched on and off at higher rates. Hence, if signal processing technology is introduced in the LED circuits, data can be transferred using a train of light pulses. A series of 1s and 0s carry information that can be easily decoded and converted into an electric signal by the receiver. The received signal is converted back into its equivalent binary data. In case of any emergency, alert signals **(**Location, etc**)** are sent to the nearby Hospitals, etc.

III. Methodology:

The system we're developing aims to enable wireless communication between any two vehicles using Li-Fi technology, while preserving their identity and ensuring their safety. All the Data is transferred through light pulses and also it has an array of features, including continuous speed

monitoring, alcohol detection, Brake-assist system, Advanced Driver Assistance system (**ADAS**), and Physical controls for the disabled people to establish communication. Additionally, it incorporates an alarm system that emits **SOS** signals in international Morse code format **(**both in light and audio format**)**. All of this information is displayed on an LCD screen for easy accessibility and there are various modulation techniques to transfer the data and few of them are listed below. The outflow of the proposed work is as shown below in Figure.1

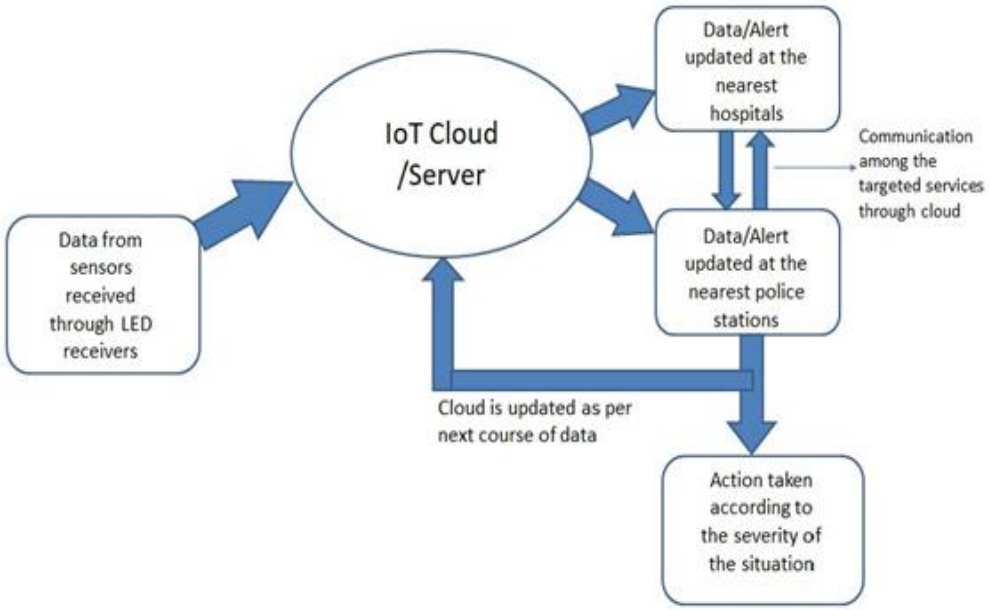

Figure.1 Outflow of the Proposed work

The proposed LIFI technology has the advantages in terms of data speed up to 10Gbps, further it is meritorious in high density coverage and security and larger spectrum availability, cost effectiveness. LIFI spectrum is almost 1000 times more than the RF spectrum. However, it has the challenges in term of data transmission in harsh atmospheric conditions, physical barrier for data transmission as light is absorbed by the physical objects and poor internet connectivity in the absence of light source.

IV. Proposed Design & Results

In the Proposed design two prototypic vehicles were designed using Arduino-Uno with DC motors for each wheel. Each vehicle is connected with LDR-photo resistor which detects the light and measures. LEDs for the light source, ultrasonic sensor measures the distance and speed of the vehicle. The LCD displays on both vehicles displays the required data for the uses and it also useful for signaling. Node MCU and ESP device helps to connect the device to internet and cloud. GSM is used for the locating the device. The basic block diagram of the design is shown in Figure.2. The modeled-on board vehicle images are shown in Figure.3.

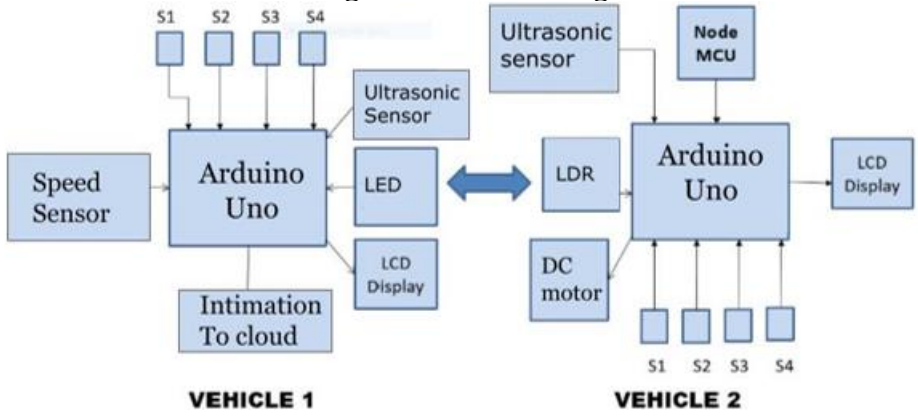

Figure.2 Basic Block diagram of the design

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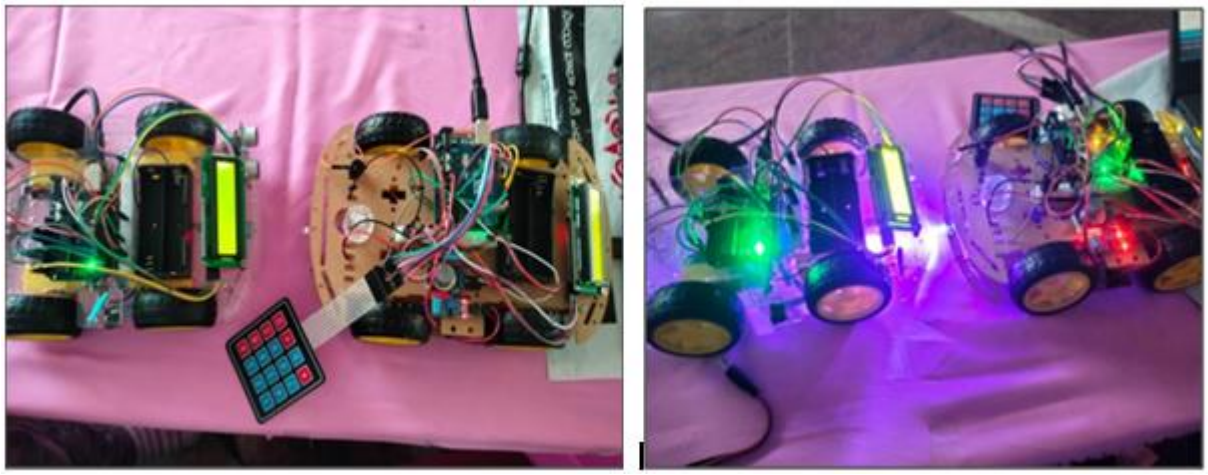

Figure.3 Designed on board model

The designed model is tested for V2V communication using all the sensors on board for various distances using light source. The Node MCU and ESP8266 connected the design to internet through cloud platform. The light source measurements at 5cm,10cm ,15cm and the cloud base received emergency alert message is shown in Figure .4

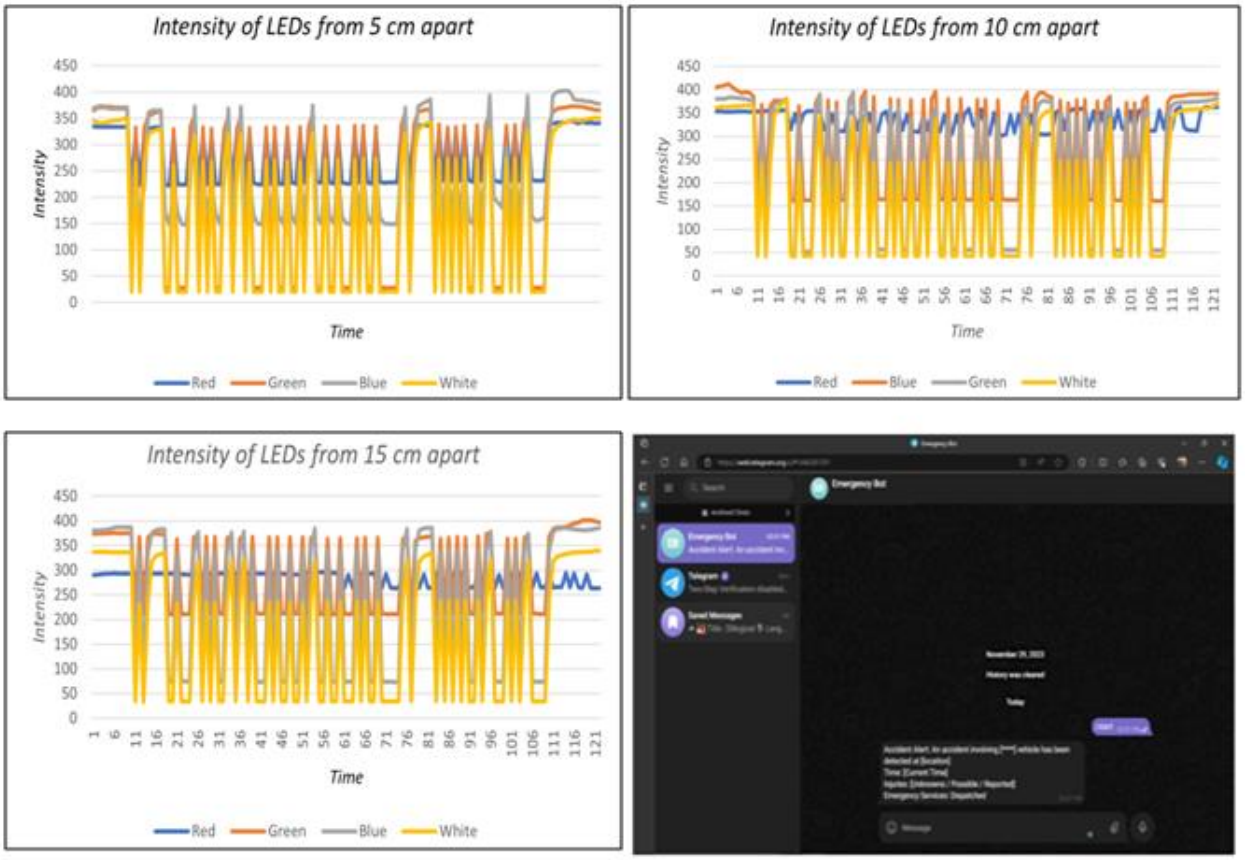

Figure.4 Light Source at various distances and Cloud based alert message.

V. Conclusion:

In this article, IoT based Li-Fi technology is introduced as medium communication between two vehicles. In addition, to avoid the accident alcohol detection sensor is integrated in the vehicle. The audio and color display are developed for the illiterate and physically unable people. The use ESP8266 helps to establish the communication to the nearby hospital, police station and schools' alertness in case of unforeseen events through cloud data base. Additionally, the implementation of

master save concept helps to avoid the collisions and giving proper alert alarms in required moments. The implementation of Li-Fi is as an application to V2V Communication, in which the speed of two motors is controlled using light source. Light source data is transmitted from one control unit to the other and it controls the speed of the motor. Use Li-Fi as a communication tool is applicable at airport, hospitals, shopping complex and school zones.

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