International Journal for Research in Engineering Application & Management (IJREAM)
ISSN : 2454-9150 Vol-10, Issue-04, July 2024

Vehicle-to-Vehicle Li-Fi Communication: Enhancing Connectivity on the Road

Dushyant Sharma, EC Ajmer, India

Lalit Kumar Dusad, EC Ajmer, India

Deepesh Prajapat, EC Ajmer, India

Sarthak Bansal, EC Ajmer, India

Harsh Shukla, EC Ajmer, India

Abstract: In this article an experimental model based on Li-Fi communication technology has been developed which will enhance connectivity on road thereby decreasing the probability of deadly road accidents due to lack of communication among the vehicles running on the highways. This innovative approach utilizes visible light, positioning itself as a subset of visible light communication (VLC). Here we present a potential implementation of Li-Fi in communication systems, presenting a small-scale prototype that underscores its capabilities and scope.

Keywords — Visible Light Communication, Arduino, Light-emitting diode, Vehicle to Vehicle Communication, VANET

I. INTRODUCTION

Light Fidelity, also known as LiFi, is a technology based on communication using light as a medium. This technology is known as Visible Light Communication (VLC) which removes the complexity of cable communication. In a similar way another prominent technology Wi-Fi uses the radio waves and it is also a fully developed technology in the field of communication. Li-Fi on the other hand proves to be more useful technology as the speed of transmission is around 1Gbps. In India, road accidents in previous years were primarily caused by various traffic violations, with "over speeding" being the main culprit. Therefore, using the Li-Fi technology we have developed an experimental model which will enhance connectivity on road thereby decreasing the probability of deadly road accidents due to lack of communication among the vehicles running on the highways. Research indicates that accidents could potentially be prevented if drivers were given warning messages a few seconds in advance, enabling them to take alternate routes or exercise caution to avoid traffic congestion or accidents. Li-Fi is an emerging communication protocol that utilizes light intensity variations beyond the detection capability of the human eye.

Vehicular Ad-hoc Network (VANET) helps a group of vehicles to set up and maintain a communication network among them without using any central base station or any controller [3].

This paper explores the feasibility of implementing Li-Fi in communication systems. An experimental model has been developed for vehicle to vehicle communication.

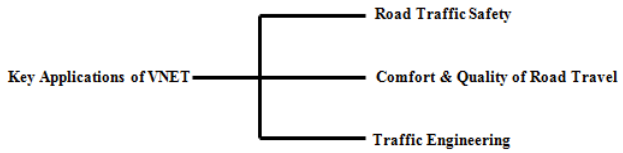

Fig 1: Key applications of VANET

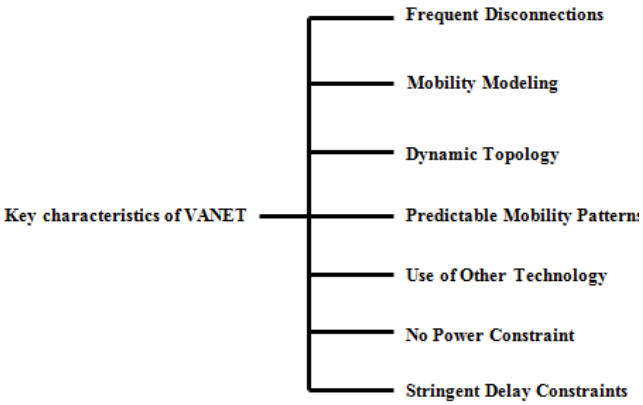

Fig 2: Key characteristics of VANET

The basic architecture of a Li-Fi system is depicted in Fig. 3. Here a pictorial view of the main blocks of a Li-Fi system has been presented. The main elements comprises of LED lamp, receiver dongle, lamp driver, internet network etc. One vehicle is fitted with transmitting LED & other with LDR sensor to develop a communication network.

II. OTHER TECHNOLOGIES

Tremendous research has already been conducted on vehicle-to-vehicle communication. Vehicles are outfitted with a variety of on-board sensors, as well as cellular technology. A comparison of different wireless communication technologies is presented in Table I [1].

 DOI : 10.35291/2454-9150.2024.0311

Table I: Comparison of different technologies [1]

Feature	Wi-Fi	Li-Fi	Bluetooth
Mode of Operation	Using radio waves	Using light waves	Using short wavelength UHF radio waves
Coverage distance	32m	10m	10m, 100m, Based on classes
Frequency of operation	2.4GHz, 4.9GHz and 5GHz	10000 times radio waves	2.4 – 2.485 GHz
Speed of transmission	150Mbps	1 Gbps	25Mbps

It is evident from the above table that the speed of transmission in case of Li-Fi is more than that of Wi-Fi technology. Moreover Li-Fi utilizes light waves unlike Bluetooth that uses short wavelength UHF radio waves.

III. Working Principle Of Li-Fi

Light emitting diodes (LEDs) possess the capability to switch on and off at a speed faster than human perception, with an operating speed of less than 1 µs. Consequently, this rapid switching creates an illusion of continuous light emission. Leveraging this imperceptible on-off activity allows for data transmission using binary codes, where switching on an LED represents binary '1' and switching it off represents binary '0'. By adjusting the rate at which LEDs flicker, different sequences of 1s and 0s can be encoded into light.

This modulation occurs at such high speeds that it goes unnoticed by humans. Subsequently, a light-sensitive device, known as a photo detector, receives the encoded signal and converts it back into its original data form [7].

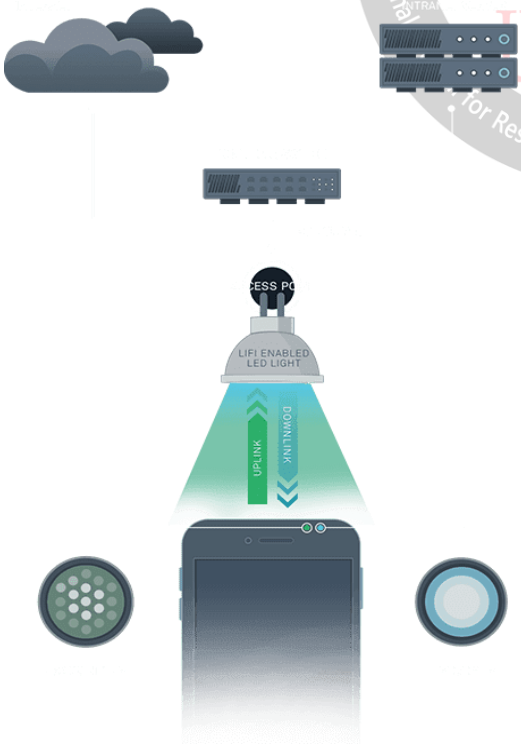

Fig 3: A Li-Fi System

Li-Fi diverges from VLC in its approach to wireless data transmission. While VLC employs LEDs for data transmission through intensity modulation (IM) and direct detection by a photodiode (PD), typically for point-to-point communication resembling a cable replacement, Li-Fi constitutes a comprehensive wireless networking system. This encompasses bidirectional multiuser communication, facilitating both point-to-multipoint and multipoint-to-point communication. Li-Fi also integrates multiple access points to create a wireless network comprising very small optical attocells with seamless handover capabilities [8].

IV. Experimental Work

Based on the study of research paper [2,4,5,6], an experimental model has been developed as shown in figure 4. Table II

Table II: Main Equipment Used

S. No.	Equipment
1	Two Arduino Uno boards
2	One 12V, 1A power adapter
3	16x2 LCD display
4	USB to TTL converter
5	LED
6	4x1 keypad
7	Dummy Cars
8	Connection wires
9	Fire Sensors
10	LDR Sensor
11	Bread board

Shows the main equipment used in developing the experimental model.

 DOI : 10.35291/2454-9150.2024.0311

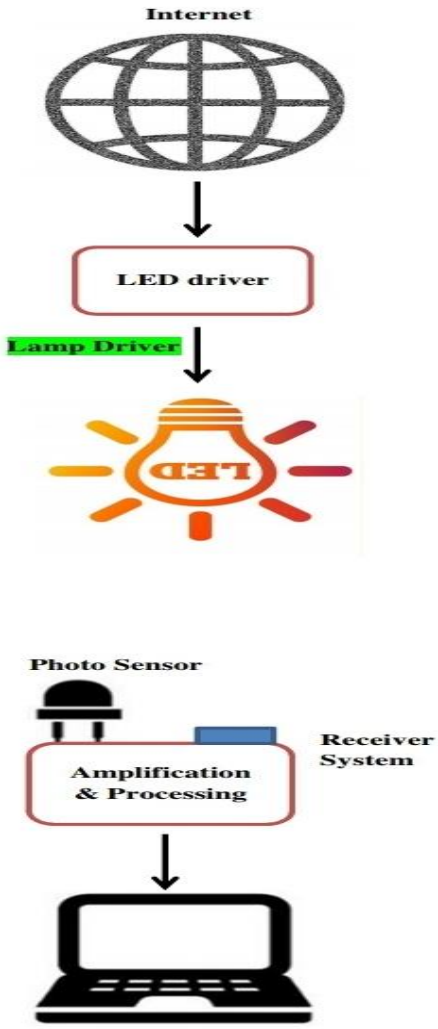

Fig 4: Basic Architecture of Li-Fi

Fig 5: Experimental Set-up

In this experimental set-up a Li-Fi transceiver using Arduino boards has been deployed. There are two Arduino boards, one for transmitter and one for receiver respectively. Here transmitter section consists of an Arduino board interfaced with a LED which generates the signal. The receiver section consists of an Arduino interfaced with a LDR sensor. The LDR sensor will sense the light signal transmitted from LED. The keypad is connected to Arduino pins for input. The LED display shows the output. A fire sensor is also attached to be used in case of fire emergency.

V. CONCLUSION

The developed experimental model worked successfully. This model will enhance connectivity on road thereby decreasing the probability of deadly road accidents due to lack of communication among the vehicles running on the highways. Li-Fi stands poised to revolutionize vehicular communication, paving the way for safer roads and efficient traffic management in the future.

REFERENCES

[1] Rahul George, Srikumar Vaidyanathan, Amandeep Singh Rajput , K Deepa,, “LiFi for Vehicle to Vehicle Communication – A Review,” Procedia Computer Science, Vol. 165, pages 25-31, 2019.

[2] M.Pavan Kalyan , M.Bhanu Prakash , K.Teja Venkata Sai , K.Helen Prabha, “LIFI Based Vehicle to Vehicle Data Communication,| IJIRT | Volume 6 Issue 12 | ISSN: 2349-6002, 2020.

[3] Sabih ur Rehman , M. Arif Khan , Tanveer A. Zia , Lihong ZhengVehicular Ad-Hoc Networks (VANETs) - An Overview and Challenges Journal of Wireless Networking and Communications 2013; 3(3): 29-38.

[4] S. R. Mugunthan, “Concept of Li-Fi on Smart Communication between Vehicles and Traffic Signals,” Journal of Ubiquitous Computing and Communication Technologies , Vol.02/ No. 02 Pages: 59-69, 2020.

[5] Ameen, Hussein & Mahamad, Abd & Saon, Sharifah & Nor, Danial & Ghazi, Kareem., “A review on vehicle to vehicle communication system applications. Indonesian Journal of Electrical Engineering and Computer Science”, Pages: 188-198, 2020.

[6] Abdul Aleem Jamali , Mahesh Kumar Rathi, Abdul Hakeem Memon, Bhagwan Das , Ghanshamdas, Shabeena, “Collision Avoidance between Vehicles through LiFi based Communication System,” IJCSNS International Journal of Computer Science and Network Security, VOL.18 No.12, December 2018.

[7] Anurag Sarkar & Prof. Shalabh Agarwal, “Li-Fi Technology: Data Transmission through Visible Light”, Volume 3, Issue 6, June 2015

[8] Harald Haas Member, Liang Yin Student Member,Yunlu Wang Student Member and Cheng Chen Student Member, “What is LiFi?”, 2015

 DOI : 10.35291/2454-9150.2024.0311