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Article Title: The Future of Wireless Communication with Light Fidelity (Li-Fi)

The Future of Wireless Communication with Light Fidelity (Li-Fi)

Garvita Vishwakarma[1], Chandra Madhab Banerjee[2]

[1]Student, Department of Electrical Engineering, Medi-Caps University, Indore, MP, India, en19ee302002@medicaps.ac.in

[2]Assistant Professor Department of Electrical Engineering, Medi-Caps University, Indore, MP, India, cmbanerjee90@gmail.com

ABSTRACT

The German physicist Harald Haas developed Li-Fi technology, also known as light fidelity technology. As the name implies, Li-Fi is a method of transmitting data that employs light as a communication medium or illumination to deliver data. It uses an LED bulb to transmit data and the LED bulb transmits data at a rate that is significantly faster than the speed of the human eye. Other names for it include optical wireless technology or luminous networking. The goal of this paper is to examine this ground-breaking innovation and compare Li-Fi to other wireless communication methods like Wi-Fi. Having wireless coverage inside of buildings, Wi-Fi is ideal for data transmission. However, Li-Fi offers faster speeds, greater bandwidth, greater safety and reliability.

Keywords: Li-Fi, LED Bulb, Wi-Fi, Optical Wireless Technology.

1 Introduction

Professor Haas and his research team at University of Edinburgh created the visible-light technique for communication known as Light Fidelity (Li-Fi). Professor Haas is the author of this name. With the help of LED light, data can be remotely transmitted via the wireless communication technology known as Light Fidelity. Light Fidelity uses steady-state lighting devices' cutting-edge capacity to create binary code with barely noticeable LED illumination. Electronic devices containing photo-diodes can be used to acquire information when they are close to visible light. It follows that whenever LEDs are utilised, light bulbs can simultaneously deliver wireless connection and illumination to any location. Wi-Fi is effective in providing wireless data coverage inside of buildings, however Li-Fi will provide strong density data coverage in a specific location without any radio interference issues [1]. Li-Fi outperforms Wi-Fi in terms of latency, efficiency, availability, and protection; during tests, it even attained extraordinary speeds exceeding 1 Gbps.

2 Construction of the Li-Fi System

Li-Fi appears to be a quick and reasonably priced optical variant of Wi-Fi, which may be the data networking of the future. Visible light communication (VLC), which refers to Li-Fi,

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denotes that it makes use of visible light in the electromagnetic spectrum between 400 and 800 THz to transmit data and provide lighting. It uses brief light pulses to send [2] information via a wireless medium. The following are potential major components of a simple Li-Fi system:

- A white LED with a high luminance that serves as a transmission source.
- Employing a silicon photo diode, which reacts well to bright illumination, as the receiving component.

Multiple permutations of 1s and 0s can be produced in digital strings by alternately turning on and off LEDs. [3] By storing data in light and changing the pace at which LEDs flicker, newly acquired information can be produced. LEDs can function in this way as a transmitter by fusing light modulation with data transmission. Because LEDs are made to flicker at an incredibly high rate (millions of times per second), which is too rapid for human eye to detect, the LED output appears steady to humans. With the use of several multitasking approaches, high-speed LED switches can be employed to reach transmission rates of over 100 Mbps. Furthermore, by using a group of LED illumination, each of which broadcasts a distinct information site, the VLC data rate may be enhanced up to a maximum of 10Gbps.

- Printed Circuit Board (PCB)
- Enclosure
- RF Power Amplifier Circuit (PA)
- Bulb

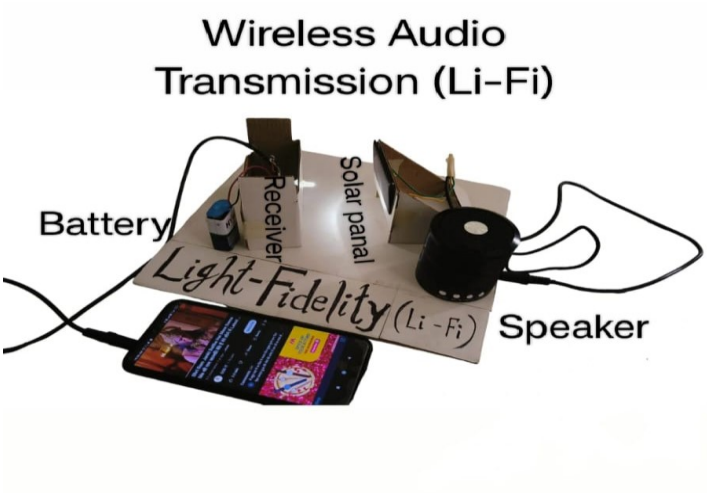

Figure 1: *Li-Fi system Setup*

3 Background

Professor Harald Haas of the University of Edinburgh made the initial mention of Li-Fi in 2011. LED light bulbs are used in the technology to convey data quickly.[4] The light waves that are emitted by these bulbs can be manipulated at high frequencies to carry data. The photo detector

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receives the data and changes the light waves back into electrical signals so that electronic equipment can process it.

4 Working of Li-Fi

Wireless communication devices using Light Fidelity technology mostly employ the violet (800 THz) and red (400 THz) observable spectrums. The uniform and controlled modulation of the amplitude of the LED sources utilized to transfer data is the primary tenet of Li-Fi. The device has a photo detector on one end and an LED transmitter on the other. Li-Fi is highly quick and easy to use. By altering the rate at which binary code (1s and 0s) is created by LEDs as they flicker "on" and "off," the data input to an LED transmitter is converted into light. Because LEDs turn on and off in less than a microsecond, this LED transmitter activity seems undetectable to the human eye. The transfer of data is done in accordance with receiving binary codes made when the LED is switched on, whereas switching it off is logically "0." Data can be encoded in light by changing the pace at which LEDs flash onto and off to produce different mixtures of 1s and 0s.

5 Advantages

Proficiency:

Using LED lighting, which is now available for lighting purposes in homes, workplaces, malls and other locations, can reduce energy use. [5] As a result, little more power is needed for information transmission which increases its energy and cost efficiency.

- **Cost –** Li-Fi requires less equipment to work and only requires a tiny bit of extra capacity for data transfer.
- **Availability –** Being accessible is not a problem because there are light sources everywhere. In this sense, lights can be used as a metaphor for transfer of information.
- **Security –** Security is one of Li-Fi's main benefits. Li-Fi web is only accessible to clients inside the defined area and cannot be detected or used incorrectly far beyond the operational region because light is unable to pass past opaque objects.
- **High Speed -** Li-Fi is able to provide huge data speeds, such as 1 Gbps or maybe greater, because of a combination of minimal disturbance, huge bandwidths, and a large output quantity.

6 Disadvantages

- To access the internet, a light source must be available. This can limit the places and circumstances where Li-Fi can be used [6].
- Perfect line of sight or a close proximity are needed to exchange data.
- Li-Fi's range is significantly lower than Wi-Fi's because electromagnetic radiation cannot go through solid surfaces.
- Transmittal of data is hampered by opaque barriers on paths.

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- Information transfer speed can be impacted by ambient light, direct sunlight and regular electric light.
- Exorbitant price to install VLC systems.

7 Applications

- **In Aircrafts** – Passengers on aeroplanes pay hefty rates for slow internet, yet Li-Fi offers high-speed internet at reasonable costs.
- **Health Technologies** – Since using Hospitalization Wi-Fi interferes with mobile devices and laptops, which interfere with monitoring devices signals Li-Fi has taken the place of Wi-Fi in many hospitals.
- **Traffic Application** – Li-Fi can be used in traffic management to communicate with bus LED lights, which can assist manage traffic more effectively and prevent accidents by alerting other drivers when a vehicle is approaching too closely [7].
- **Disaster management** – When a disaster strikes such as a seismic tremor or a storm, Li-Fi is able to be utilized for a revolutionary form of transmission because it is unaffected by usual dead zones.
- **Power Plant application** – Since using Wi-Fi and other radiation sources is not allowed, Li-Fi is becoming increasingly safe and is always available via the board of the electrical facility.

8 Comparative between Li-Fi, Wi-Fi, and other radio communication technologies

Users of both Wi-Fi and Li-Fi can access the Internet wirelessly and both techniques employ the electromagnetic spectrum to transport data. Li-Fi is a wireless technology that uses visible light to achieve high-speed connection [8, 9]. The difference is the fact that the technology known as Li-Fi transmits data using light waves, whereas Wi-Fi employs radio frequencies. Li-Fi is ideal for providing high-density wireless data acceptance inside a small space or room and has no reception problems like Wi-Fi. For general wireless coverage throughout the structure, site, or complex, Wi-Fi works effectively.

Table 1: *Li-Fi and Wi-Fi comparative*

Parameter	Li-Fi	Wi-Fi
Spectrum used	Visible Light	RF
Standard	IEEE .802.15.7	IEEE 802.11
Range	Based on Light Intensity(<10m)	Based on Radio Propagation &interference (<300m)

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Data Transfer Rate	Very High (- 1 Gbps)	Low(100Mbps-1Gbps)
Power Consumption	Low	High
Cost	Low	High
Bandwidth	Unlimited	limited

9 Future Scope

Li-Fi [10] Technology has a lot of potential because light is free and accessible everywhere. If this technique develops, each Li-Fi context is able to send wirelessly information. By making Li-Fi innovation more widely used, it will enable connections that are more secure, healthier, and more beneficial to the environment. Additionally, it has a bright aftertaste. Li-Fi is gaining popularity because it offers a speedier and more affordable way of delivering data. If this innovation advances more swiftly, a growing number of people will use it.

10 Proposed Methodology

Many of us require access to the internet in order to work, learn, purchase goods, conduct enterprise, communicate with loved ones, or simply pass the time. Considering that we are currently dealing with a global pandemic, our use of the web has further increased. Thanks to Wi-Fi, we can be connected 24/7, whether we are at home or outside for a moment. But here is some flash news—while Wi-Fi is everywhere, we cannot use it forever. Wi-Fi is a wireless technology that utilizes radio frequencies to transmit internet data to our phones and laptops. [11] You can say the same for cellular or mobile data connections. However, the radio frequency range is not limitless. The daily desire for data from billions of people worldwide is going to exceed the capacity of Wi-Fi and cellular technology. Another type of wireless networking is required. This is where Li-Fi technology steps in. [12]

- Light source: The first step is to use a light source such as an LED bulb that emits light. The light source needs to be modulated so that it can transmit data. This can be achieved by varying the intensity of light or by using different colors of light.
- Photodetector: The second step is to use a photodetector that can detect the light signals and convert them into electrical signals. The photodetector can be a photodiode, a phototransistor, or a photomultiplier tube.
- Modulation: The third step is to use a modulation technique to encode the data onto the light signal. This can be achieved using various techniques such as amplitude modulation (AM), frequency modulation (FM), or phase modulation (PM).
- Transmission: The fourth step is to transmit the modulated light signal over the air to the receiver. The transmission can be line of sight or non-line of sight.[13]

- Reception: The fifth step is to receive the modulated light signal using a photodetector and convert it back into electrical signals.
- Decoding: The final step is to decode the data from the electrical signals and retrieve the original information.[14,15]

11 Conclusions

In conclusion, Li-Fi is a promising new technology with numerous potential applications. While it is still in the early stages of development, Li-Fi has already demonstrated its potential to revolutionize wireless communication. As researchers continue to refine the technology and overcome its limitations, we can expect to see Li-Fi become an integral part of our wireless communication infrastructure in the future.

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