

LI-FI Data Transmission through VLC

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Abstract : *Li-Fi stands for Light-Fidelity. Li-Fi provides transmission of data through illumination by sending data through an LED light bulb that varies in intensity faster than the human eye can follow. This paper focuses on developing a Li-Fi based system for data transmission and how Wi-Fi can be replaced by Li-Fi. Wi-Fi is great for general wireless coverage within buildings, whereas Li-Fi is ideal for high density wireless data coverage in confined area and for relieving radio interference issues. Li-Fi provides better bandwidth, efficiency, availability and security than Wi-Fi and has already achieved blisteringly high speed in the lab. By leveraging the low-cost nature of LEDs and lighting units there are many opportunities to exploit this medium, from public internet access through street lamps to auto-piloted cars that communicate through their headlights. Haas envisions*

a future where data for laptops, smart phones, and tablets will be transmitted through the light in a room.

Keywords: *Light Fidelity; LED; VLC; Wi-Fi;*

1. Introduction

Professor Harald Haas, the Chair of Mobile Communications at the University of Edinburgh, is recognized as the founder of Li-Fi. He coined the term Li-Fi. He gave a demonstration of a Li-Fi prototype at the TED Global conference in Edinburgh on 12th July 2011. He used a table lamp with an LED bulb to transmit data. Li-Fi can be regarded as light-based Wi-Fi, i.e. instead of radio waves it uses light to transmit data. In place of Wi-Fi modems, Li-Fi would use transceivers fitted with LED that could light a room as well as transmit and receive information. It makes use of the visible portion of the electromagnetic spectrum which is underutilized. Li-Fi can be considered better than Wi-Fi because there are some limitations in Wi-Fi. Wi-Fi uses 2.4 – 5 GHz radio frequencies to deliver wireless internet access and its bandwidth is limited to 50-100 Mbps. With the increase in the number of Wi-Fi hotspots and volume of Wi-Fi traffic, the reliability of signals is bound to suffer. Security and speed are also important concerns. Wi-Fi communication is vulnerable to hackers as it penetrates easily through walls.



Figure 1: Data transmission in binary format

2. Working of LI-FI

Li-fi is a visible light communication system for data transmission. Li-Fi essentially requires two main components to transmit data from one laptop to other laptop. The first component is high brightness LED which acts as the communication source which is at the sender side. Data from the sender is converted into an intermediate data representation i.e. byte format and then converted into light signals which are emitted by the transmitter. The second component is the photodiode which serves as the receiving element. The light signal is received by the photodiode at the receiver side. The reverse process takes place at the destination computer to retrieve the data back from the received light. LEDs are employed as the light sources. The model transmits digital signal by means of direct modulation of the light.

The emitted light is detected by an optical receiver.

Source: Data Reading → Data → Conversion Transmitter

Destination: Receiver → Interpretation → Display (GUI)

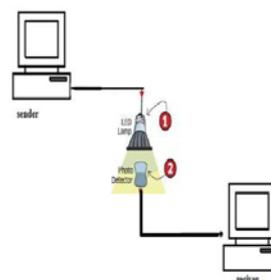


Figure 2: Working of Li-fi

The different components serve the following functions:

Data Conversion Module: converts data into bytes so that it can be represented as a digital signal. It can also encrypt the data before conversion.

Transmitter Module: generates the corresponding on-off pattern for the LEDs.

Receiver Module : has a photo diode to detect the on and off states of the LEDs. It captures this sequence and generates the binary sequence of the received signal

Data Interpretation Module: converts data into the original format. If encryption was done, it also performs decryption.

3. Advantages of LI-FI

1. A free band that does not need license. High installment cost but very low maintenance cost.
2. Cheaper than Wi-Fi.
3. Theoretical speed up to 1 GB per second: Less time & energy consumption
4. Lower electricity costs. Longevity of LED bulb: saves money.
5. Light doesn't penetrate through walls: secured access.

4. Limitation of LI-FI

1. The main problem is that light cannot pass through objects, so if the receiver is inadvertently blocked in any way, then the signal will immediately be cut out. If the light signal is blocked one could switch back over to radio waves.
2. Reliability and network coverage are the major issues to be considered by the companies while providing VLC services. Interference from external light sources like sunlight, normal bulbs; and opaque materials in the path of transmission will cause interruption in the communication.

5. Comparison with WI-FI

Sr.no	Parameter	Li-fi	Wi-fi
1	Speed	High speed(>1Gbps)	High speed(150Mbps)
2	Medium	Light	Radio Spectrum
3	Spectrum Range	10,000 times broader than that of Wi-Fi	Narrow spectrum
4	Cost	Low	High
5	Security	High security due to non-penetration of light through walls	Less secure due to transparency
6	Obstacle interference	High	Low

6. Application of LI-FI

Li-Fi technology can find application in a wide variety of fields. A detailed discussion of its various applications is given below.

- I. Medical and Healthcare -Due to concerns over radiation, operating rooms do not allow Wi-Fi and even though Wi-Fi is in place in several hospitals, interferences from computers and cell phones can block signals from medical and monitoring equipment. Li-Fi solves these problems. Lights are an essential part of operating rooms and Li-Fi can thus be used for modern medical instruments. Moreover, no electromagnetic interference is emitted by Li-Fi and thus it does not interfere with any medical instruments such as MRI scanners.
- II. Airlines and Aviation- Wi-Fi is often prohibited in aircrafts. However, since aircrafts already contain multiple lights, thus Li-Fi can be used for data transmission.
- III. Power Plants and Hazardous Environments – WiFi is not suitable for sensitive areas like power plants. However, power plants still require fast and interconnected data systems for monitoring grid intensity, demand, temperature etc. In place of Wi-Fi, Li-Fi can provide safe connectivity throughout the power plant. Li-Fi offers a safe alternative to electromagnetic interference due to radio waves in environments such as petrochemical plants and mines.
- IV. Underwater Explorations and Communications Remotely operated underwater vehicles or ROVs work well except in situations when the tether is not long enough to fully explore an underwater area or when they get stuck. If instead of the wires, light were used then the ROVs would be freer to explore. With Li-Fi, the headlamps could also then be used to communicate with each other, data processing and reporting findings back to the surface at regular intervals, while also receiving the next batch of instructions. Radio waves cannot be used in water due to strong signal absorption. Acoustic waves have low bandwidth and disrupt marine life. Li-Fi offers a solution for conducting short-range underwater communications.
- V. Traffic- Li-Fi can be used for communications between the LED lights of cars to reduce and prevent traffic accidents. LED headlights and tail-lights are being implemented for different cars. Traffic signals, signs and street lamps are all also transitioning to LED. With these LED lights in place, Li-Fi can be used for effective vehicle-to-vehicle as well as vehicle-to-signal communications. This would of course lead to increased traffic management and safety.

VI. GigaSpeed Technology- The Li-Fi Consortium provides the fastest wireless data transfer technology presently available. Our current solutions offer effective transmission rates of up to 10 Gbps, allowing a 2 hour HDTV film to be transferred in less than 30 seconds. This can be extended to several 100 Gbps in future versions Smart Lighting -Street lamps can in the future be used to provide Li-Fi hotspots and can also be used to control and monitor lighting and data.

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7. Conclusion

Li-Fi is certainly not useless, but it has certain inherent limits for the technology. Li-Fi may not be able to replace conventional radios altogether, but it could turbo charge the development of wireless television and make it easier to throw a wireless signal across an entire house. At present, finding the ideal position for a wireless router is something of a divine art. If the signal could be passed via VLC from Point A to Point B inside a home, small local routers at both points could create local fields with less chance of overlapping and interfering with each other. Large scale areas that are saturated with radio signals or that doesn't permit them for security reasons could use Li-Fi as an alternate high-speed wireless network solution.

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