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### **RESEARCH ARTICLE**

# Light Fidelity (LI-FI)-A Comprehensive Study

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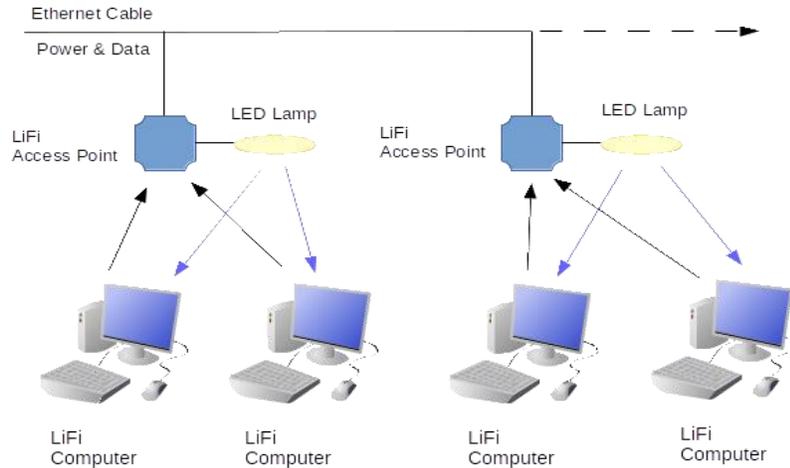
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*Abstract: - This latest technology Li-Fi (Light Fidelity) refers to 5G Visible Light Communication systems using light-emitting diodes as a medium to high-speed communication in a similar manner as Wi-Fi. Harald Haas says his invention, which he calls D-LIGHT, can produce data rates faster than 10 megabits per second, which is speedier than your average broadband connection. In the days where internet has become a major demand people are in a search for Wi-Fi hotspots. Li-Fi or New Life of data communication is a better alternative to Wi-Fi in wireless communication. Li-Fi has thousand times greater speed than Wi-Fi and provides security as the visible light is unable to penetrate through the walls, which propose a new era of wireless communication. Such technology has brought not only greener but safer and cheaper future of communication.*

*Keywords: - LI-FI, WI-FI, LED, D-Light (Data Light), Visible Light Communication*

## **INTRODUCTION**

Now a day's Wi-Fi is widely used in all the public areas like home, cafes, hotels, airports. Due to this radio frequency is getting blocked day by day, at the same time usage of wireless data is increasing exponentially every year. Everyone is interested to use wireless data but the capacity is going down. Wireless radio frequencies are getting higher, a complexities are increasing and RF interferences continue to grow. In order to overcome this problem in future, light –fidelity (Li-Fi) technology came into existence since 2011. Li-Fi is a wireless communication system in which light is used as a carrier signal instead of traditional radio frequency as in Wi-Fi. Li-Fi is a technology that uses light emitting diodes to transmit data wirelessly. Visible light communication (VLC) uses rapid pulses of light to transmit information wirelessly that cannot be detected by human eye. This paper will focus on Li-Fi technology over Wi-Fi technology and challenges for the new VLC technology.



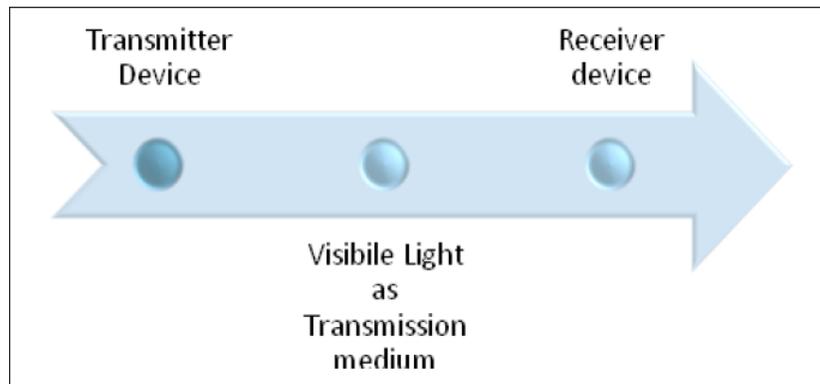
**Fig. 1 Li-Fi Wireless Access Point System Could Work Using Room Lighting**

**WHY USE VISIBLE LIGHT COMMUNICATION**



**Fig. 2 Different rays**

- The Gamma rays cannot be used as they could be dangerous.
- X-rays has similar health issues.
- Ultraviolet light is good for place without people, but otherwise dangerous for the human body.
- Infrared, due to eye safety regulation, can only be with low power.
- Radio waves penetrate through the walls so they arises security issues.
- Hence we left with the only the visible- “Light Spectrum”.



**Fig. 3 Data transmission from source to destination by Visible Light Communication.**

**OPERATIONAL PROCEDURE**

The operational procedure is very simple, if the LED is ON, you transmit a digital 1, if it is OFF you transmit a 0. The LEDs can be switched on and off very quickly. Li-Fi is a wireless optical networking technology that uses light-emitting diodes (LEDs) for data transmission.

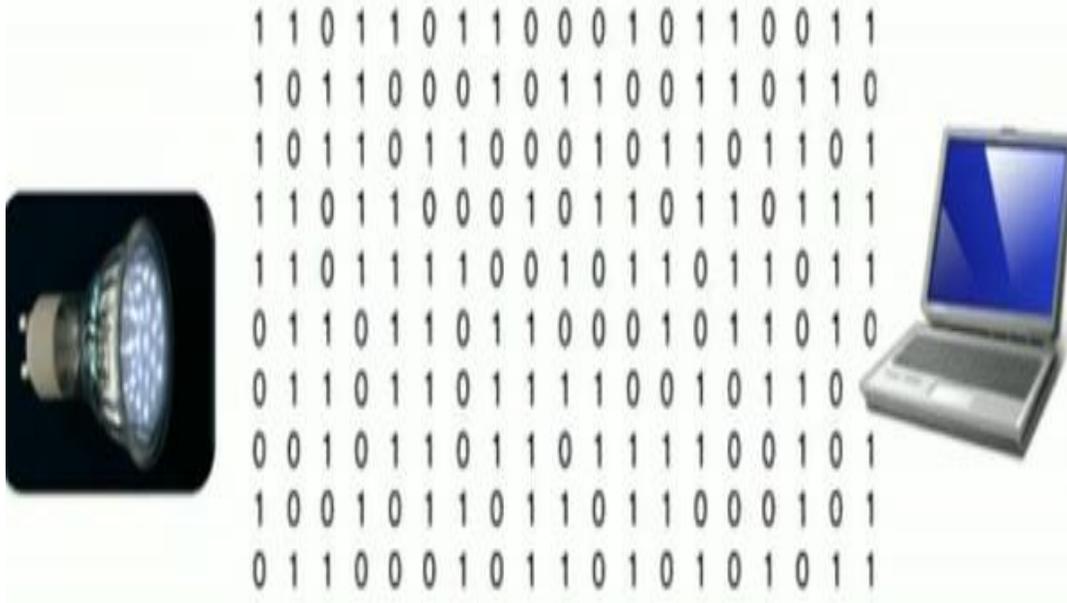


Fig. 4 visible light wireless data transmission

Li-Fi is designed to use LED light bulbs similar to those currently in use in many energy-conscious homes and offices. However, Li-Fi bulbs are outfitted with a chip that modulates the light imperceptibly for optical data transmission. Li-Fi data is transmitted by the LED bulbs and received by photoreceptors. Modulation is so fast that the human eye doesn't notice. A light sensitive device (photo detector) receives the signal and converts it back into original data. This technique of using rapid pulses of light to transmit information wirelessly is technically referred as Visible Light Communication though its potential to compete with conventional WI-FI has inspired the popular LI-FI.

**Tools Used in Visible light communication:** The technology uses fluorescent lamps (ordinary lamps, not special communications devices) to transmit signals. Specially designed electronic devices generally containing a photodiode receive signals from light sources. Avalanche photodiode (sensitive reception) and image sensor (for image acquisition and data reception)



Fig. 5 Devices used in Visible light communication

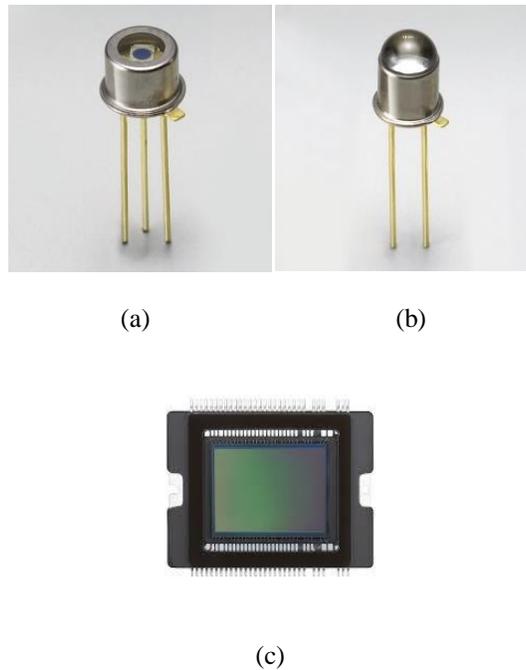


Fig. 6 (a) Pin Photodiode ,(b) Avalanche photodiode, (c)image sensor

### DATA TRANSFER IN LI-FI

As WI-FI hotspot and cloud computing are rapidly increasing reliable signal is bound to suffer. Speed and security are also major concerns. They are vulnerable to hackers as it penetrates through walls easily. LI-FI is said to overcome this. This new technology is comparable to infrared remote controls which send data through an LED light bulb that varies in intensity faster than the human eye can see. In near future we can see data for laptops, smart phones and tablets transmitted through the light in a room. Li-Fi (Light Fidelity) is a fast and cheap optical version of Wi-Fi, the technology of which is based on Visible Light Communication (VLC). VLC is a data communication medium, which uses visible light between 400 THz (780 nm) and 800 THz (375 nm) as optical carrier for data transmission and illumination. It uses fast pulses of light to transmit information wirelessly. The main component of this communication system is a high brightness white LED, Which acts as a communication source and a silicon photodiode which shows good response to visible wavelength region serving as the receiving element? LED can be switched on and off to generate digital strings of 1s and 0s. Data can be encoded in the light to generate a new data stream by varying the flickering rate of the LED. To be clearer, by modulating the LED light with the data signal, the LED illumination can be used as a communication source. As the flickering rate is so fast, the LED output appears constant to the human eye. A data rate of greater than 100 Mbps is possible by using high speed LEDs with appropriate multiplexing techniques. VLC data rate can be increased by parallel data transmission using LED arrays where each LED transmits a different data stream. There are reasons to prefer LED as the light source in VLC while a lot of other illumination devices like fluorescent lamp, incandescent bulb etc. are available.

LI-FI technology uses semiconductor device LED light bulb that rapidly develops binary signals which can be manipulated to send data by tiny changes in amplitude. Using this innovative technology 10000 to 20000 bits per second of data can be transmitted simultaneously in parallel using a unique signal processing technology and special modulation.

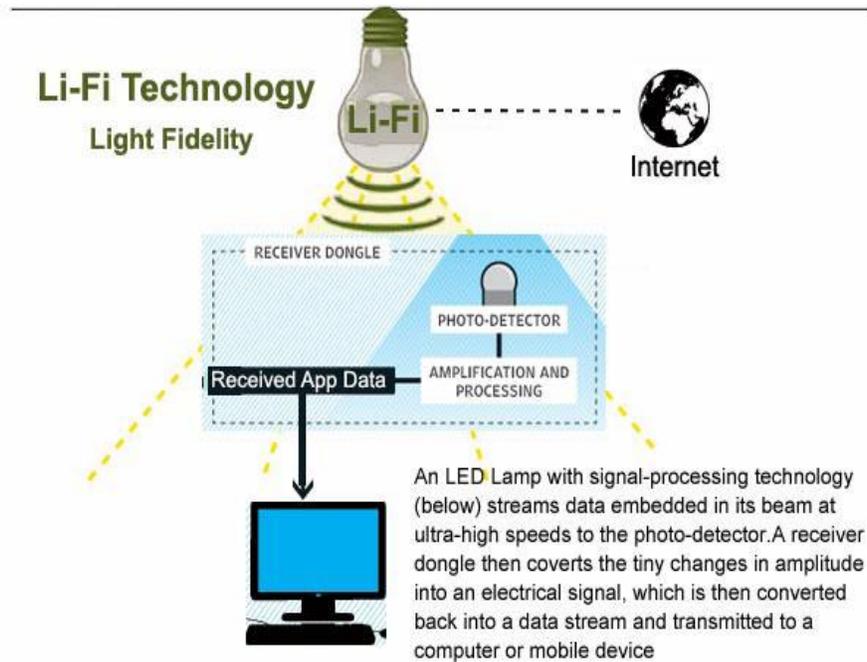


Fig. 7 Data Transmission using LI-FI

## APPLICATION OF LI-FI

**Education systems:** As with the advancement of science the latest technology is the LIFI which is the fastest speed internet access service. So this will lead to the replacement of WIFI at institutions and at companies so that all the people can make use of LIFI with same speed intended in a particular area.

**Significantly Lower Power Consumption:** Radio masts are very inefficient and require vast sums of power in order to broadcast and in some cases keep them cool enough to operate. LEDs on the other hand use very little power (much less than a fluorescent bulb), meaning Li-Fi also uses very little power. At the same time Li-Fi can also light a room, meaning it can do two jobs for the price of one.

**Reduction in accident numbers:** At traffic signals, we can use LIFI in order to communicate with LED lights of the cars by the number of accidents can be reduced. Data can be easily transferred by making use of LIFI lamps with the street lamps.

**Airlines:** Airline Wi-Fi Nothing says captive audience like having to pay for the "service" of dial-up speed Wi-Fi on the plane. The best I have heard so far is that passengers will be offered a "high-speed like" connection on some airlines. United is planning on speeds as high as 9.8 Mbps per plane. Li-Fi could easily introduce that sort of speed to each seat's reading light.

**Medical field:** For a long time, medical technology has lagged behind the rest of the wireless world. Operating rooms do not allow Wi-Fi over radiation concerns, and there is that whole lack of dedicated spectrum. While Wi-Fi is in place in many hospitals, interference from cell phones and computers can block signals from monitoring equipment. Li-Fi solves both problems: lights are not only allowed in operating rooms, but tend to be the most glaring (pun intended) fixtures in the room.

**Li-Fi is More Secure:** One of Wi-Fi’s biggest pit falls is it will travel through walls and out of a buildings, therefore letting anyone to try and connect to it. Li-Fi will not travel through walls; it can only go where light can travel. Therefore if you close your blackout curtains, not even someone stood directly outside your window will be able to try and connect to your Li-Fi network.

**COMPARISON BETWEEN WI-FI AND LI-FI**

Li-Fi is a term of one used to describe visible light communication technology applied to high-speed wireless communication. It acquired this name due to the similarity to Wi-Fi, only using light instead of radio. Wi-Fi is great for general wireless coverage within buildings, and Li-Fi is ideal for high-density wireless data coverage in confined area and for relieving radio interference issues, so the two technologies can be considered complimentary.

TECHNOLOGY	SPEED	DATA DENSITY
<b>Wireless (current)</b>		
Wi-Fi – IEEE 802.11n	150 Mbps	*
Bluetooth	3 Mbps	*
IrDA0	4 Mbps	* * *
<b>Wireless (Future)</b>		
WiGig	2 Gbps	* *
Giga-IR	1 Gbps	* * *
Li-Fi	>10 Gbps	* * *

**Table 1. Comparison between current and future technology**

**CONCLUSION**

From the above study we analyze that in future, data for laptops, smart phones & tablets can be transmitted through light in room by using Li-Fi .Researcher are developing micron sized LED which are able to flicker on and off around 1000 times quicker than larger than LED. They offer the faster data transfer and take up less space so we could save space or add more LED’s to further boost the channel of communication. This technology may solve issues such as shortage of radio frequency bandwidth and also allow the internet where the traditional radio based wireless isn’t allowed such aircraft and hospitals. One of shortcoming however is that it only work in direct line of sight.

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