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# LI-FI TECHNOLOGY FOR FAST DATA TRANSMISSION

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***Abstract*—**Li-Fi stands for Light-Fidelity. Li-Fi innovation, proposed by the German physicist—Harald Haas, gives transmission of information through illumination by sending information through an LED light bulb that changes in intensity quicker than the human eye can take after. This paper concentrates on building up a Li-Fi based framework and examines its performance as for existing innovation. Wi-Fi is exordinary for general wireless coverage within buildings, though Li-Fi is perfect for high thickness wireless data coverage in confined area and for relieving radio interference issues. Li-Fi gives better data transmissin, proficiency, accessibility and security than Wi-Fi and has already achieved high speed in the lab. Li-Fi communication innovation utilizes light frequencies instead of the standard radio waves which can deliver information rates quicker than 10 Megabits per second which is especially productive than our normal broadband association of Wi-Fi.

***Keywords*—**High-brightness LED, Li-Fi, Photodiode, Wi-Fi, Wireless communication.

## I. INTRODUCTION

Transfer of data from one place to another is one of the most important day-to-day activities. The present wireless networks that connect us to the internet are very slow when different devices are connected. As the number of devices that access the internet increases, the fixed bandwidth available makes it more and more difficult to enjoy high data transfer rates and connect to a secure network. Yet, radio waves are only a little piece of the spectrum available for information exchange.

A solution to this issue is by the utilization of Li-Fi. Li-Fi stands for Light-Fidelity. Li-Fi is transmission of information through illumination by removing the fiber from fiber optics by sending information through an LED light bulb that shifts in intensity quicker than the human eye can follow.

Li-Fi is the term some have used to name the quick and cheap wireless communication framework, which is the optical version of Wi-Fi. Li-Fi utilizes visible light instead of Gigahertz radio waves for information exchange.

**Figure.1. Light Bulp**

As light ventures speedier than the radio waves, it can be utilized to exchange the information around 250 times more than the high speed broadband. This innovation utilizes just lights in order to transmit information. The purpose behind that it is very efficient and low cost. Generally all the bulbs can be used for transmission of information that can lead to wasteful method for turning ON and OFF of the light bulbs because most light bulbs uses filaments which makes a little delay while glowing. Hence LED lights are the most ideal for information transmission that can be effectively turned ON and OFF immediately, as these lights utilizes electrodes inside them. The principle is to transmit the information at high speeds that gives illumination and communication at low cost.

The idea of Li-Fi was introduced by a German physicist, Harald Hass, which he also referred to as information through illumination‖. The term Li-Fi was initially utilized by Haas in his TED worldwide chat on Visible Light Communication.

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According to Hass, the light, which he referred to as D-Light, can be utilized to produce information rates higher than 10 megabits per second which is much speedier than our normal broadband connection. As a result, it can be utilized in high security military regions where RF communication is prone to eavesdropping.

## II. CONSTRUCTION OF LI-FI SYSTEM

Li-Fi is a quick and cheap optical version of Wi-Fi. It is depends on Visible Light Communication (VLC).VLC is a information communication medium, which utilizes visible light between 400THz (780 nm) and 800 THz (375 nm) as optical carrier for information transmission and illumination. It utilizes quick beats of light to transmit information wirelessly. The main components of Li-Fi system are as follows:

a) a high brightness white LED which acts as transmission source.

b) a silicon photodiode with good response to visible light as the receiving element.

LEDs can be turned on and off to produce digital strings of various combination of 1s and 0s. To produce a new data stream, data can be encoded in the light by differing the flickering rate of the LED. The LEDs can be used as a sender or source, by modulating the LED light with the information signal. The LED output appears constant to the human eye by virtue of the quick flickering rate of the LED. Communication rate greater than 100 Mbps is possible by using high speed LEDs with the help of various multiplexing techniques. VLC data rate can be increased by parallel information transmission using an array of LEDs where each LED transmits a different data stream. The Li-Fi emitter system consists of 4 primary subassemblies.

a) Bulb
b) RF power amplifier circuit (PA)
c) Printed circuit board (PCB)
d) Enclosure

The PCB controls the electrical inputs and outputs of the lamp and houses the microcontroller used to manage different lamp functions. A RF (radio-frequency) signal is generated by the solid-state PA and is guided into an electric field about the bulb.

The high concentration of energy in the electric field vaporizes the substance of the bulb to a plasma state at the bulb‘s center; this controlled plasma generates an intense source of light. All of these subassemblies are contained in an aluminium enclosure.

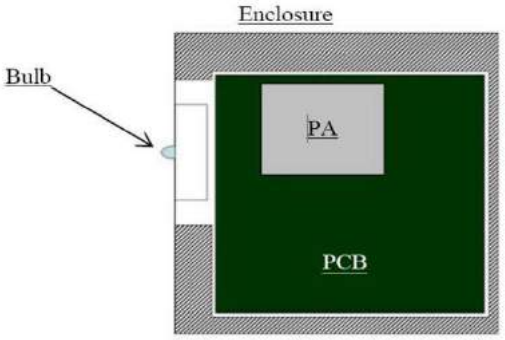


**Fig.2. Block diagram of Li-Fi**

The bulb sub-assembly is the heart of the Li-Fi emitter. It consists of a sealed bulb which is embedded in a dielectric material. This design is more reliable than conventional light sources that insert degradable electrodes into the bulb. The dielectric material serves two purposes. It acts as a waveguide for the RF energy transmitted by the PA. It also acts as an electric field concentrator that focuses energy in the bulb. The energy from the electric field rapidly heats the material in the bulb to a plasma state that emits light of high intensity and full spectrum.

## III. WORKING OF LI-FI

Another era of high brightness light-emitting diodes shapes the core part of light fidelity technology. The logic is very simple. If the LED is on, a digital 1 is transmitted. If the LED is off, a digital 0 is transmitted. These high brightness LEDs can be turned on and off very quickly which gives us a very nice opportunities for transmitting information through light.

The working of Li-Fi is very simple. There is a light emitter toward one end, for example, an LED, and a photo detector (light sensor) on the other. The photo detector registers a binary one when the LED is on; and a binary zero if the LED is off. To build up a message, flash the LED numerous times or use an array of LEDs of perhaps a few various colors, to obtain information rates in the range of hundreds of megabits per second.

The data can be encoded in the light by varying the flickering rate at which the LEDs flicker on and off to generate different strings of 1s and 0s. The LED intensity is modulated so rapidly that human eye cannot notice, so the light of the LED appears constant to humans.

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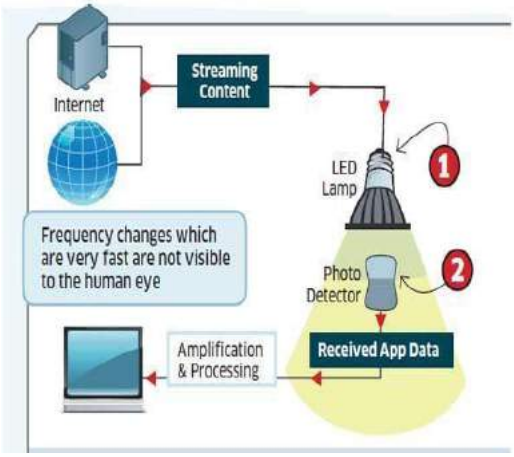


**Figure. 3. Block diagram of Li-Fi system**

Light-emitting diodes (generally referred to as LEDs and found in traffic and street lights, car brake lights, remote control units and countless other applications) can be turned on and off faster than the human eye can detect, causing the light source to appear to be on continuously, even though it is in fact 'flickering'. The on-off activity of the bulb which seems to be invisible enables information transmission using binary codes: switching on an LED is a logical '1', turning it off is a logical '0'. By varying the rate at which the LEDs flicker on and off, information can be encoded in the light to various combinations of 1s and 0s. This method of utilizing fast beats of light to transmit data wirelessly is technically referred to as Visible Light Communication (VLC), though it is popularly called as Li-Fi because it can compete with its radio-based rival Wi-Fi.

**Fig. 4. Li-Fi connecting devices in an office**

Numerous other complex procedures can be utilized to significantly increase VLC information rate. Teams at the University of Oxford and the University of Edinburgh are focusing on parallel information transmission utilizing array of LEDs, where each LED transmits a various information stream. Other groups are utilizing mixtures of red, green and blue LEDs to the light frequency encoding a different information channel.

## IV. COMPARISON OF LI-FI &WI-FI

Li-Fi is the name given to describe visible light communication technology applied to obtain high speed wireless communication. It derived this name by virtue of the similarity to Wi-Fi. Wi-Fi works well for general wireless coverage within buildings, and Li-Fi is ideal for high density wireless data coverage inside a confined area or room and for relieving radio interference issues. Table I gives a comparison of transfer speed of different wireless technologies.

**TABLE I. COMPARISON OF VARIOUS WIRELESS TECHNOLOGIES.**

| Technology | Speed |
|---|---|
| Wi-Fi – IEEE 802.11n | 150 Mbps |
| Bluetooth | 3 Mbps |
| WiGig | 2 Gbps |
| Giga- IR | 1 Gbps |
| Li-Fi | >1 Gbps |

### A. Problems in Wi-Fi

**Capacity**: Wireless information is transmitted through radio waves which are constrained and costly. It has a constrained bandwidth. With the quickly developing world and advancement of innovations like 3G, 4G et cetera we are coming up short on range.

b) **Efficiency**: There are 1.4 million cellular radio base stations that consume massive amount of energy. Most of the energy is used for cooling down the base station instead of transmission. Therefore efficiency of such base stations is only 5%.

c) **Availability**: Availability of radio waves is a big concern. It is not advisable to use mobile phones in aero planes and at places like petrochemical plants and petrol pumps.

d) **Security**: Radio waves can penetrate through walls. They can be intercepted. If someone has knowledge and bad intentions, they may misuse it.
This causes a major security concern for Wi-Fi.

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B**. Advantages of Li-Fi**

Li-Fi technology is based on LEDs or other light Source for the transfer of data. The transfer of the data can be with the help of all kinds of light. That is, the light can belong to the invisible, ultraviolet or the visible part of the spectrum. Also, Li-Fi removes the limitations that have been put on the user by the Wi-Fi.

a) **Capacity**: Light has 10000 times wider bandwidth than radio waves. Also, light sources are already installed. So, Li-Fi has got better capacity and also the equipments are already available.

b) **Efficiency**: Data transmission using Li-Fi is very cheap. LED lights consume less energy and are highly efficient.

c) **Availability**: Availability is not an issue as light sources are present everywhere. There are billions of light bulbs worldwide; they just need to be replaced with LEDs for proper transmission of data.

d) **Security**: Light waves do not penetrate through walls. So, they can't be intercepted and misused.

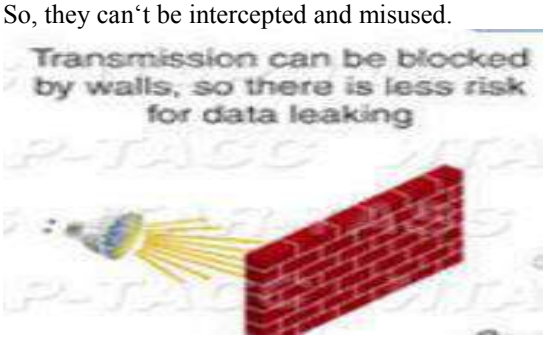


**Figure. 5. Comunication Security**

e) **Smarter Power Plants:** Power plants need fast and data systems with interconnected to monitor things like grid integrity,demand and (in nuclear plants) core temperature and Wi-Fi could not work properly in these areas as these are more sensitive to radio frequency like as in petrochemical plants. LI-FI could work properly in these sensitive areas and it also saves money.

**f) Multi User Communication:** LI-FI helps to share multiple things at a single instance which supports the broadcasting of network.

**Figure. 6. Multiuser Communication**

g) **Fill Green information technology:** LI-FI never gives any side effects on any living thing like radio waves and other communication waves which effects on the birds, human bodies, etc.

**Figure. 7. LI FI in an Airways**

C**. Disadvantages of LiFi**

One of the major demerits of this technology is that the artificial light cannot penetrate into walls and other opaque materials which radio waves can do. So a Li-Fi enabled end device will never be as fast and handy as a Wi-Fi enabled device in the open air. Also, another shortcoming is that it only works in direct line of sight. Still, Li-Fi could emerge as a boon to the rapidly depleting bandwidth of radio waves. And it will be the first choice for accessing internet in a confined room at cheaper cost.

## V. APPLICATIONS OF LI-FI

a) **Education systems:** Li-Fi is the latest technology that can provide fastest speed internet access. So, it can replace Wi-Fi at educational institutions and at companies so that all the people can make use of Li-Fi with the same speed intended in a particular area.
b) **Medical Applications:** Operation theatres do not

allow Wi-Fi due to radiation concerns.

Usage of Wi-Fi at hospitals interferes with the mobile and pc which blocks the signals for monitoring equipments. So, it may be hazardous to the patient's health. To overcome this and to make OT tech savvy Li-Fi can be used to accessing internet and to control medical equipments. This can even be beneficial for robotic surgeries and other automated procedures.

c) **Mobile Connectivity:** Li-Fi interconnects laptops, smart phones, tablets and other mobile devices. Short range links give very high data rates and also provides security.

d) **Traffic management:** In traffic signals Li-Fi can be used which will communicate with the LED lights of the cars which can help in managing the traffic in a better manner and the accident numbers can be decreased.

## V. CONCLUSION

As the electromagnetic spectrum shrinking continuously the Li-Fi system will going to provide a greener, safer, better and healthier future for communication system. When this system will be developed each light source can be used as a Li-Fi AP means where is a light there is a Internet. Also it will shapes the better future for human kind by reducing the energy consumption, data as well as light at low cost, minimal cellular infrastructure and creating the employments opportunities at large scale. In short the Li-Fi system will be going to change the scenario off wireless communications in many greener ways.

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