

Li-Fi: The Future Bright Technology

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Abstract- In our day-to-day routine, one of the most important activities is transfer of data from one place to another. But, the current wireless networks are very slow when multiple devices are connected to the internet. Wi-Fi based on radio waves. When the number of devices connected to the internet increases, the fixed bandwidth makes it more difficult to transfer data easily, as the radio waves are small part of spectrum for data transmission. As radio waves can penetrate through the walls, one can misuse it and this can cause security concern for Wi-Fi. Like most technologies, Wi-Fi also has some limitations as its bandwidth is typically limited. Also, the radio waves are restricted in particular areas like aero planes, hospitals, petrol pumps and petrochemical plants. Hence, in such places we cannot connect to internet. Wi-Fi provides good data transmission but does not allow large data like HDTV movies, music libraries and video games. To overcome such problems Li-Fi technology is developed. Li-Fi provides transmission of data through illumination by sending data through an LED light bulb. This paper focuses to analyze the performance of Li-Fi as compared to existing technologies. In confined area and for relieving radio interference issue Li-Fi is effective. Li-Fi provides high bandwidth, efficiency availability and security as compared to Wi-Fi.

Keywords- Li-Fi, Wi-Fi, LED

I. INTRODUCTION

Li-Fi means Light Fidelity. This technology was proposed by Prof. Harald Hass, a German scientist, along with his team including Dr. Gordon Povey, Dr. Mostafa Afgani at the University of Edinburgh. Li-Fi provides transmission of data through illumination by sending data through an LED light bulb. It is a VLC (Visible Light Communication) technology deals with the transfer of data through illumination by taking fiber out of fiber by sending data through LED light bulb. LED is a p-n junction diode which emits light when activated and helps in Li-Fi technique. The flow of Li-Fi is bidirectional. It provides high speed and is cheap wireless communication via light. Li-Fi uses light instead of radio waves in Wi-Fi for the transfer of data.

The scientist Harald Hass referred this technology as "Data through illumination".

As compared to general broadband connection, this technology provides higher data speed than 10 Mbps which is much faster. Li-Fi is an OWC (Optical Wireless Communication) system which uses light from LED (light Emitting Diode), acts as a medium to deliver networked, and mobile, high-speed communication similar to Wi-Fi. Both Wi-Fi and Li-Fi transmit the data over the electromagnetic spectrum only difference is that Wi-Fi utilizes radio waves whereas Li-Fi utilizes visible light. As the velocity of light is much large, hence due to this the rate of data transmission is more as compared to Wi-Fi which uses radio waves for data transmission.

II. CONSTRUCTION OF LI-FI SYSTEM

The Li-Fi technique is very cheap and fast for the communication of data. It is also called the optical version of Wi-Fi. It is based on VLC which is a data communication medium for the transmission of data through light in the range between 375nm and 780nm. Li-Fi is implemented using LED lights. The main components used in this technology are as follows:

- High brightness white LED which acts as transmission source.
- A silicon photodiode with good response to visible light as the receiving element.

It is possible to get high speed i.e. greater than 100 Mbps by using high speed LED's with the help of various multiplexing techniques. The transmission of data can be increased by using array of LED's, as each LED transmits various data stream. The Li-Fi emitter system consists of 4 primary sub-assemblies:

- Bulb
- RF power amplifier circuit (PA)
- Printed circuit board (PCB)
- Enclosure

III. WORKING OF LI-FI

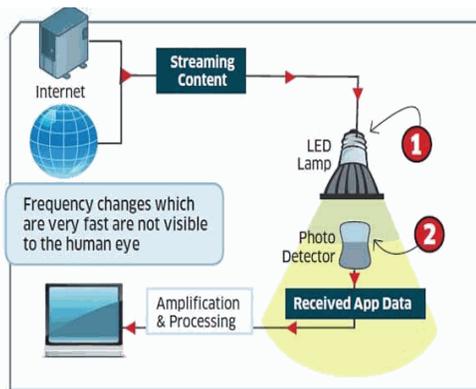
The Li-Fi technology is based on the VLC system which uses light for the data transmission. As the velocity as well as the intensity of the light is very high, hence the data transmit with high speed. The working of this technology is very simple. The LED which acts as light emitter is fitted on one end and the photo detector (photo sensor) on another end. When the LED is ON, the photo detector recognizes the binary 1 and if the LED is OFF, the photo detector recognizes the binary 0. To build up a message, flash the LED numerous times or use an array of LED of perhaps a few different colors to obtain data rules in the range of hundreds of megabits per seconds [1]. The data is received and encoded in the light by varying the flickering rate at which the LED's flicker ON and OFF to generate different strings of 1s or 0s.

The light source appears constant because the LED's can be switched ON and OFF quickly and the intensity is modulated so rapidly that human eye cannot detect, even though it is in fact flickering. The ON-OFF activity of the bulb which seems to be invisible, enables data transmission using binary codes: switching ON LED is a logical '1', switching it OFF is a logical '0'. This method of using rapid pulses of light to transmit information wirelessly is technically referred to as visible light communication (VLC) [3].

In Wi-Fi, the radio waves can penetrate through the walls, which become disadvantage relative to security purpose. Due to this, one can misuse it. But, in Li-Fi, optical signals are not able to penetrate through walls, which is as advantage relative to security issue. This technique also contains two main components: Li-Fi room connector and Li-Fi router.

Optical signals are unable to penetrate through walls. However, the rooms need to be connected to each other in order to provide an optical wireless local area network. This can be possible using Li-Fi room connector. The Li-Fi room connector acts as a replicator which sends data from one side of the wall to another one using optical fiber cable. To connect to the external link, Li-Fi router is useful. It connects office and/or entertainment equipment and covers a radius of 20 meters with 100 Mbps transmission speed. Li-Fi system sends data using light rather than radio waves with 'Li-Flame' prototype that knows which light source it is supposed to be receiving data from [2]. As LED's are most common source used for lightening the rooms, giving the new pathway for connecting the devices to the internet with high speed and quicker response time than Wi-Fi. "All the components, all the mechanisms exist already", Hass says, "you just have to put them together and make them work" [1].

The block diagram of the Li-Fi system is shown in the following figure [6]:



Teams at the University of Oxford and the University of Edinburgh are focusing on parallel data transmission using array of LED's, where

each LED transmits a different data stream. Other groups are using mixtures of red, green and blue LED's to alter the light frequency encoding a different data channel [7].

Following table shows the comparison of various wireless

Technology	Speed	Data density
Wireless(current)		
Wi-Fi-IEEE 802.11n	150 Mbps	*
Bluetooth	3 Mbps	*
IRDA	4 Mbps	***
Wireless(future)		
WiGig	2Gbps	**
Giga-IR	1Gbps	***
Li-Fi	>1Gbps	****

technologies [9]:

ADVANTAGES OF LI-FI

- The Li-Fi technology is based on all kinds of light. The light belongs to the invisible, ultraviolet or visible part of spectrum, hence no matters the part of the spectrum they

belong. This gives the high speed for the communication purpose, downloading movies, games, music and all applications more than sufficient.

- The light is present everywhere. There are many light bulbs worldwide, only they need to be replaced by LED's for proper transmission of data.
- Light has 10000 times wider bandwidth than radio waves [9]. Hence, Li-Fi proves better capacity compared to Wi-Fi.
- The light waves cannot penetrate through walls which makes more security from hacking.
- Li-Fi is very cheap for transmission purpose. LED light consume less energy and are highly efficient [9].
- Li-Fi can be used in such area where radio waves are problematic. Li-Fi is useful in electromagnetic sensitive areas such as in aircraft cabins, hospitals and nuclear power plant without causing electromagnetic interference [9].
- The Wi-Fi does not work under water in sea and hence, light can be used undersea explorations are good to go.
- Using this technology, every street light would be free data hotspot.

DISADVANTAGES OF LI-FI

One of the major disadvantages is that the artificial light cannot penetrate into the wall and other opaque materials which radio waves can do. Hence, we cannot transfer the data from one enclosed room to another one. Li-Fi is not able in the works in direct line of sight.

APPLICATIONS OF LI-FI

The applications of Li-Fi are as follows:

- Li-Fi never gives any harm to living thing like radio waves affect human body as well as birds, plants.
- This technology is useful in airlines, power plants, petrochemicals etc.
- This technology provides better way to manage traffic. It can avoid accidents.
- It is applicable in GPS usage [14].

CONCLUSION

This technology is advanced to Wi-Fi as potential for wider bandwidth is high and quicker response time. Every light can be replaced by LED light which acts as photo detector to transfer data. As it is very cheap and faster everyone access it easily. If this technology is developed, it will be easier to transfer data within a second. If all the light bulbs are replaced by LED's, we could proceed to greener, cleaner, safer and brighter future. The problem of shortage of radio-frequency bandwidth can be reduced by using this technique. If this technology is developed, this will be great revolution in the field of technology. As we know that the airways are getting clogged day by day Li-Fi can offer a genuine and very efficient alternative. Li-Fi is enabled by advanced digital transmission technologies [1].

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