



Light Fidelity(LiFi)- Wireless Optical Networking Technology

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Abstract: The study LiFi (Light Fidelity) demonstrates about how can we use this technology as a medium of communication similar to Wifi . This is the latest technology proposed by Harold Haas in 2011. It explains about the process of transmitting data with the help of illumination of an Led bulb and about its speed intensity to transmit data. Basically in this paper, author will discuss about the technology and also explain that how we can replace from WiFi to LiFi . WiFi generally used for wireless coverage within the buildings while LiFi is capable for high intensity wireless data coverage in limited areas with no obstacles .This research paper represents introduction of the Lifi technology,performance,modulation and challenges. This research paper can be used as a reference and knowledge to develop some of LiFitechnology.

Keywords - Challenges, Intensity, LiFi, Modulation, Performance.

I. INTRODUCTION

Li-Fi is termed as Light Fidelity. This is the latest technology proposed by Harold Haas in 2011. Li-Fi transmits the data by illumination of an led bulb to send data at faster intensity that is not visible to human eye. Lifi is the technology that uses light as a medium of communication by replacing the regular cable wire communication. LiFi technology is evolved to overcome rate of speed of WiFi. Basically in this paper, author will discuss about the technology and also explain that how we can replace from WiFi to LiFi . WiFi generally used for wireless coverage within the buildings while LiFi is capable for high intensity wirelss data coverage in limited areas with no obstacles . LiFi is an wireless optical networking technology that uses light emitting diodes (LEDs) for transmission of data. Similar to WiFi , LiFi is an medium to deliver high speed communication.Lifi is refered to as visible light technology(VLC). LiFi has its advantages which gives better bandwidth, availability, efficiency and security than WiFi and also has achieved high speeds in lab. In the paper, the author has discussed detailed study about LiFi technology and its futurescope.

The main difference in technical terms is Wifi uses radio frequency to induce a voltage in antenna to transmit data, whereas Lifi requires modulation of light intensity to transmit data.This technology is referred to as Visible Light Communications(VLC) and working is done by switching current to LEDs off and on at very high speed which is not noticeable to human eye. Lifi technology uses light waves for communication, which cannot penetrate walls which leads to lower hacking potential relative to Wifi.

As there are some limitaitons in Wifi ,LiFi is considered more better than Wifi. Radio frequencies ranging from 2.4 GHz to 5 GHz are used to deliver wireless internet access and the bandwidth is limited to 50 Mbps to 100 Mbps. The reliability of signals suffers due to increasing number of Wifi hotspots and volume of WiFi traffic. The main concern is security and speed. For hackers, WiFi communication is vulnerable as it can easily penetrate through walls.

According to LiFi and WiFi has the difference associated with the congestion, density, security, safety, and speed. The more WiFi enabled device exists, the congestion may occur. Within the technology of WiFi we cannot increase number of routers if the number of user is increased, while we are able to add rays in LiFi. Efficiency and safety of the web are the dominating issues without delay. The LiFi performance is claimed more better than the performance of WiFi. The speed of LiFi is 1000 times faster than WiFi. For safety of the web, LiFi is safer than the WiFi supported the spread of the signal. LiFi contains a light characteristic that light cannot undergo the wall. It's different from the signal of WiFi can bear anywhere. Supported those two technologies, in a very simple conclusion is LiFi has safer communication instead of the WiFi. The vulnerability exists if there are leakage within the wall while having an interior communication. Security threat that will exist is an intruder can spoof the info using the leakage wall.

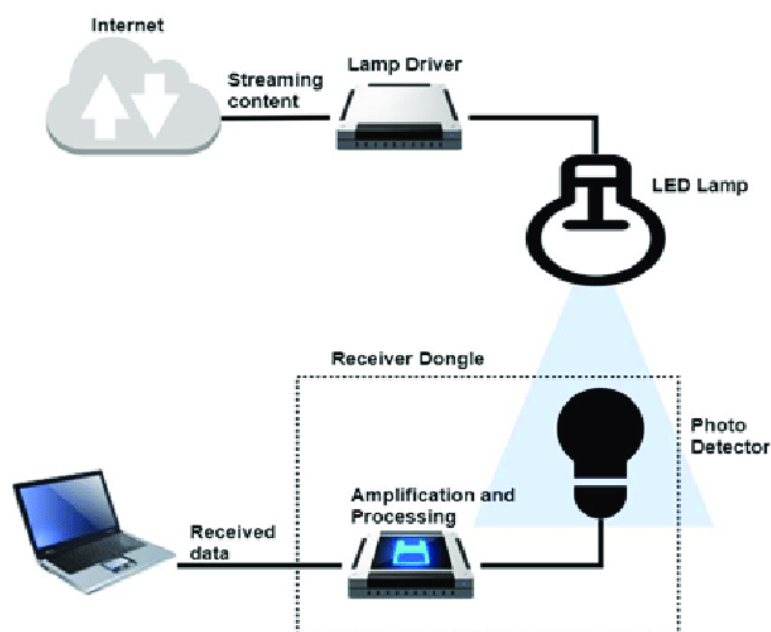


Figure 1 . Basic concept diagram of LiFi

1.1 Following key problems of Wi-Fi that need to be overcome :

- a) **Capacity:** The radio waves utilized by Wi-Fi to transmit data are limited still as expensive. With the event of 3G and 4G technologies, the quantity of accessible spectrum is running out.
- b) **Efficiency:** Worldwide there are 1.4 million cellular radio masts. Instead of transmission of radio waves these poles consume massive amounts of energy, most of it is employed for cooling the station instead of transmission of radio waves. In fact, the efficiency of such stations is barely 5%.
- c) **Availability:** Radio waves can't be employed in all environments, particularly in airplanes, chemical and power plants and in hospitals.
- d) **Security:** Radio waves can penetrate through walls. This results in many security concerns as they will be easily intercepted.

1.2 LiFi addresses some issues with WiFi as follows:

- a) **Capacity:** The visible spectrum radiation is 10,000 times wider than the radio waves spectrum. Additionally, the light sources are already installed. Thus LiFi bandwidth is greater and equipment which is already available.
- b) **Efficiency:** LED lights require less amount of energy and are highly efficient also.
- c) **Availability:** Light sources are present at all corners of the planet. Hence, availability is not a difficulty. The billions of normal bulbs worldwide need only get replaced by LEDs.
- d) **Security:** Light in fact doesn't penetrate through walls and thus data transmission that uses light waves are safer.

II. WORKING OF LIFI

Light emitting diodes (LEDs) are switched on and off at faster speeds than it is not visible through human eye, hence causes the light source to be continuously on. The on and off activity enables data transmission which uses binary codes. As per binary terms, switching on an LED is (binary 1) and switching off an LED is (binary 0). Possibly we can encode data in light by varying the rate at which LED's flicker on and off which gives different strings of 1s and 0s. Modulations perform rapidly that humans cannot notice it. A signal is received by a light sensitive device (photo detector) which converts it back into original data.

The methodology of performing rapid pulses of light to transmit information wirelessly is referred to as Visible Light Communication (VLC). The VLC consumes light between 400 THz (780 nm) and 800 THz (375 nm) as the optical carrier for data transmission and for illumination.

By using high speed LEDs with adequate multiplexing we can achieve data rates greater than 100 Mbps. To increase the VLC data rate it requires parallel data transmission using arrays of LEDs where each LED transmits a separate stream of data. Lights can be dimmed to an extent that they are not visible to humans in order to transmit data.

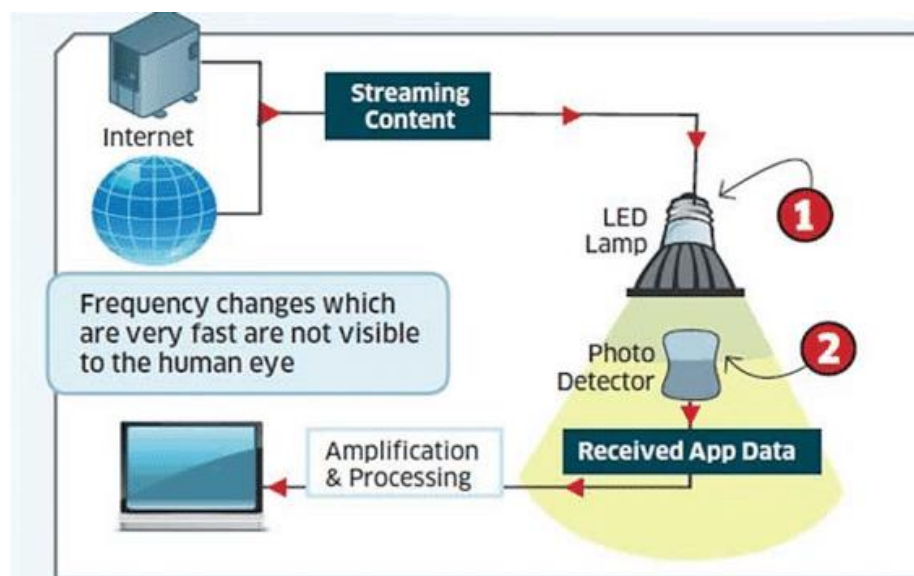


Figure 2. Working of Lifi

III. MODULATION TECHNIQUES IN LIFI

The Modulation signals are required to switch LED at desired frequencies that contains information to be transmitted. Modulation technique is used so that the communication is still available even when the illumination is not required. As a result, this modulation technique may support a dimmable illumination. The information in the message signal is corresponding to the variation in intensity of light. There are many types of modulations such as: Single Carrier Modulation(SCM), Multiple Carrier Modulation(MCM), and Colour Modulation .

Following are some of the modulation techniques :

3.1 Single Carrier Modulation : SCM is a type of modulation multiplexed by any number of signal, later modulated individually with different frequencies. SCM involves on and off keying (OOK), pulse-modulation(PPM) and pulse-amplitude modulation(PAM). SCM is preferable for low to moderate data rate applications.

3.2 On-Off Keying (OOK): To keep the period of pulses same as the period of the negative ones , the 802.15.7 standard uses Manchester coding, hence it doubles the bandwidth required for transmission. Run length limited (RLL) coding is used for higher bit rates which is more efficient. By adding an OOK extension dimming is supported which adjusts the aggregate output to the correct level.

3.3 Variable Pulse Position Modulation (VPPM): Encoding of data is done by PPM which uses the position of the pulse within the set period of time..To allow identify different positions the duration of the period containing pulse must be long enough. VPPM and PPM is similar , however it allows the width of the pulse to be controlled to support light dimming .

3.4 Colour Shift Keying (CSK): If the illumination system uses RGB-type LEDs ,CSK is used. Information bits are coded by producing different colors using mixing of primary RGB sources. the main disadvantage of that is it increases the complexity of the transceivers.

3.5 SIM-OFDM (Sub-Carrier Index Modulation OFDM): It is excellent for the situations where multiple transmitters are used simultaneously which avoid shadowing effects and the interference can be mitigated by shifting the system bandwidth to higher frequency.

IV. ADVANTAGES AND LIMITATIONS OF LIFI

4.1 Advantages of LiFi :

Light	Per watt more light is produced by LEDs than incandescent bulbs.
On-Off Time	LEDs light up more quickly.
Toxicity	LEDs do not contain mercury, unlike the flurosent lamps.
Free Band	It does not need any licensing for use of free band .
Airlines	Without affecting airlines signals Lifi can be used safely in aircrafts.
Underwater	Lifi can be used for underwater explorations as Wifi does not work underwater.
Street Lamps	Street Lamps can be converted into data access point .
Spectrum Relief	Using Lifi we solve the issue of shortage of radio frequency bandwidth.
Traffic Control	Similarly by using car LED headlights and backlights can be used for traffic control applications.

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4.2 Disadvantages of LiFi :

- 1) The main problem is the light which cannot pass through objects, so if the receiver accidentally blocks the way, the signal will instantly be cut out. So when the light signal is obstructed, one can switch back over to radio waves.
- 2) While providing VLC services, reliability and network coverage are the major issues that any companies need to consider.
- 3) By accepting this technology, high installation cost of the systems can be added by large-scale implementations of VLC and also reduces the further operating costs like electricity charges, maintenance etc.
- 4) We still need radio frequency cellular systems and WiFi. It cannot be reliable to provide data to a high speed moving object through only a light bulb or to provide data in remote areas where there are walls, trees and obstacles.

4.3 Challenges Faced in LiFi are as follows :

4.3.1 Modulation : Modulation technique is the key of LiFi communication. The challenge is about how we can send data while the illumination of LED is low, while the dimming process is proportional to LEDs brightness. The challenge of dimming technology is about how LiFi can fulfill the user satisfaction in order to dimming of LED can stay safe for the user.

4.3.2 Infrastructure : The basic infrastructure in LiFi is indoor and outdoor. Same as the optical characteristic, a LiFi also has an effect of shadowing while transmission. The process of sending and receiving data is the shadowing effect while transmission. In LiFi communication there is few research about the shadowing effect.

4.3.3 Security : A threat like spying can happen in LiFi. The main cause of this is when there is gap between the floor and the door, the light may spread out between them.

4.3.4 Interference : The hard part is to provide optical uplink service based on optical illumination. It occurs because it can interfere the downlink signal. This problem is one of the challenge in the interference issue.

V. CONCLUSION

LiFi technology has great potential in wireless data transmission field. It has more scope for future innovations and research instead of its still in its incipient stages. If LiFi technology is brought into practical use every light bulb can be used as WiFi hotspot for transmitting wireless data. However it will allow internet connection where WiFi is banned in some places such as aircrafts and operation theatres. Whereas one of the shortcoming is that it works in direct line of sight only while LiFi is the future technology of data transmission. As it is easy to generate light waves, it has very advantages and can be easily implemented in the various fields. Therefore the future application can be extended to various fields like traffic. The four key criteria that are used are as follows: the system can provide bi-directional communication, LiFi can operate within a complex physical environment, traffic and security information can be pushed to smartphones and system of audio-messaging is developed to enable tourist and people to be guided.

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