

Light-Fidelity (Li-Fi) Technology: A Review

P.Loganathan¹, R.Dhilip Kumar², S.Ramachandran³

^{1,2,3}ECE, Gnanamani College of Engineering

Abstract- Li-Fi stands for Light-Fidelity, for the fast increasing gadgets and to improve more effective use of lights a new technology is developed which is called- LIFI. Li-Fi is a modern technology which is used in progression with WIFI technology. LIFI uses LED lights which helps in faster and flexible data transfer transmitted through Wi-Fi. As light is everywhere, using light as the transmission medium Li-Fi can provide wireless indoor communication. The data transfer through LIFI is in bits and is much faster than Wi-Fi. Dr. Herald Haas, the professor of mobile communications at the University of Edinburgh, UK, first time publically displayed the proof of Light Fidelity (Li-Fi), a method of Visible Light communication (VLC). Li-Fi is the transfer of data through light by taking fiber out of fiber optics and sending data through LED light.

Keywords-Li-Fi, Wi-Fi, LED Lights, Wireless, VLC, Bits and Fiber optics.

I. INTRODUCTION

The most important day-to-day activities in this fast world are the transfer of data and information. As the world is becoming faster the need of fast data transmission is also increasing. As the numbers of devices that access to the internet are increasing, the limited bandwidth leads to decrease in the speed of the data transfer.



Fig 1: Li-Fi Bulb.

To give a solution to this problem Li-Fi technology is introduced. Li-Fi stands for Light Fidelity. Li-Fi provides better bandwidth, efficiency, availability and security than Wi-Fi and thus increases the data transfer speed. Li-Fi technology provides transmission of data through illumination by taking the fibre out of fibre optics by sending data through an LED light bulb that varies in intensity faster than the human eye can follow. Li-Fi is ideal for high density wireless data coverage in confined area and for relieving radio interference issues.

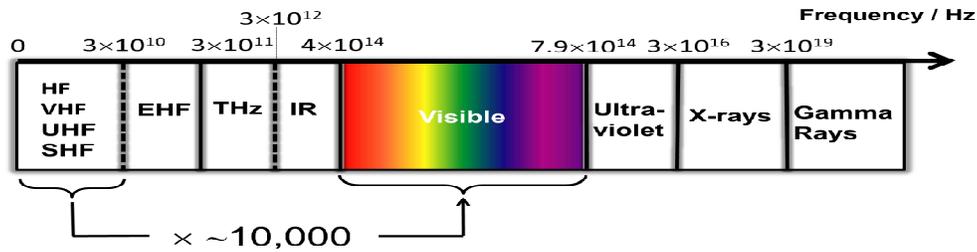


Fig 2: Electromagnetic Spectrum

Lifi uses visible light instead of Gigahertz radio waves for data transfer which makes it fast and cheap mode of wireless communication. The idea of Li-Fi was introduced by a German physicist, Harald Hass, which he also referred to as data through illumination. The term Li-Fi was first used by Haas in his TED Global talk on Visible Light Communication. According to Hass, the light, which he referred to as D-Light, can be used to produce data rates higher than 10 megabits per second which is much faster than our average broadband connection.

II. CONSTRUCTIONS OF LI-FI SYSTEM

The LIFI product consists of 4 primary sub-assemblies:

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

The PCB controls the electrical inputs and outputs of the lamp and houses the microcontroller used to manage different lamp functions. An 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 contents of the bulb to a plasma state at the bulb's centre; this controlled plasma generates an intense source of light. All of these subassemblies are contained in an aluminum enclosure.

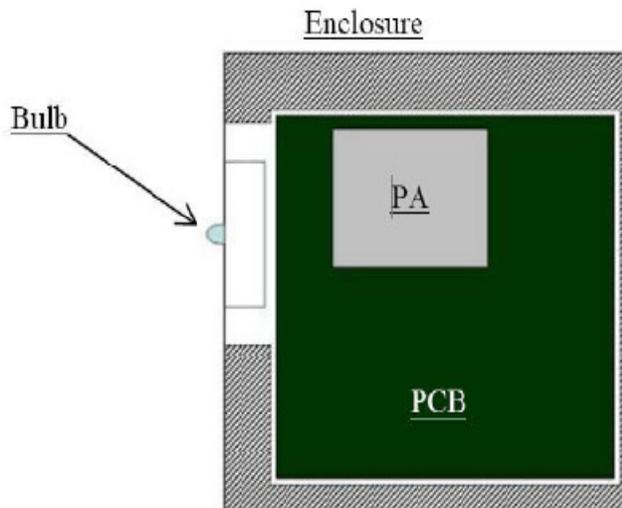


Fig 3: Block Diagram of Li-Fi sub-assemblies.

III. FUNCTIONS OF THE BULB SUB-ASSEMBLY

At the heart of LIFI™ is the bulb sub-assembly where a sealed bulb 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; first as a waveguide for the RF energy transmitted by the PA and second 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.

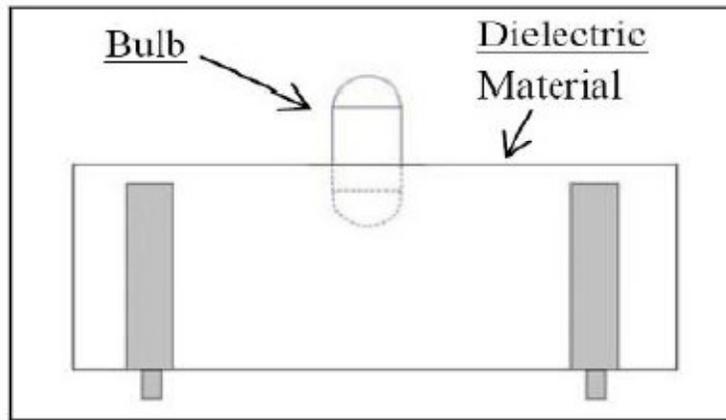


Fig 3: Bulb sub-assembly.

IV. WORKING OF LI-FI

A new era of large brightness light-emitting diodes forms the core part of lifi technology. The logic is so simple as follows-If the LED light is on, a digital 1 is transmitted. If the LED light is off, a digital 0 is transmitted. These large brightness LEDs lights can be switched on and off very quickly which gives us a very nice chance for transmitting data through light. The working of Li-Fi is very easy as Wi-Fi . There is a light emitter on one corner, for example, an LED, and a photo detector (light sensor) on the other corner. The photo detector registers a binary one when the LED is on; and a binary zero if the LED is off same as microprocessor. To generate any message, flash the LED numerous times or use an array of LEDs of perhaps a few different colours, to obtain data rates in the range of hundreds of megabits per second.

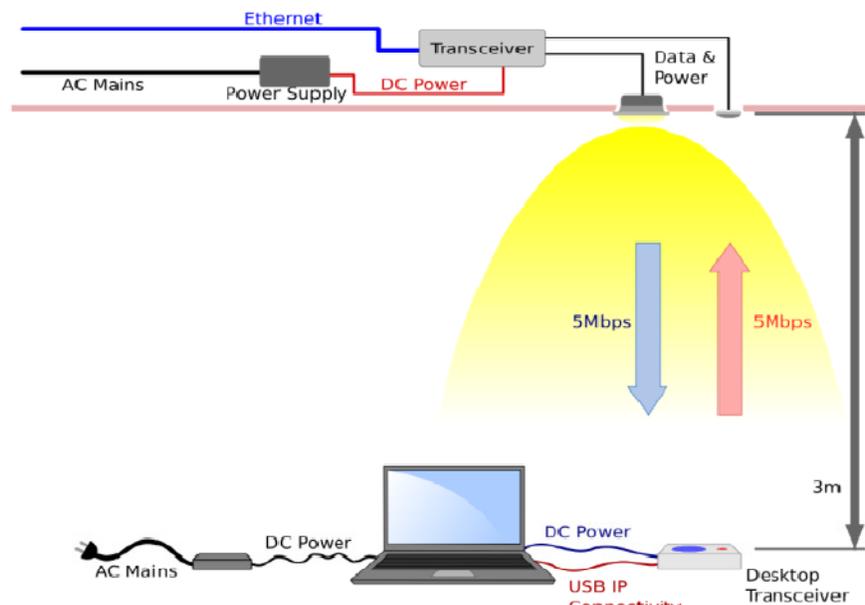


Fig 4: Working Principle of Li-Fi Technology.

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. Light-emitting diodes can be switched 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 data transmission using binary codes: switching on an LED is a logical '1', switching 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 different combinations of 1s and 0s. This method of using rapid pulses of light to transmit information 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.

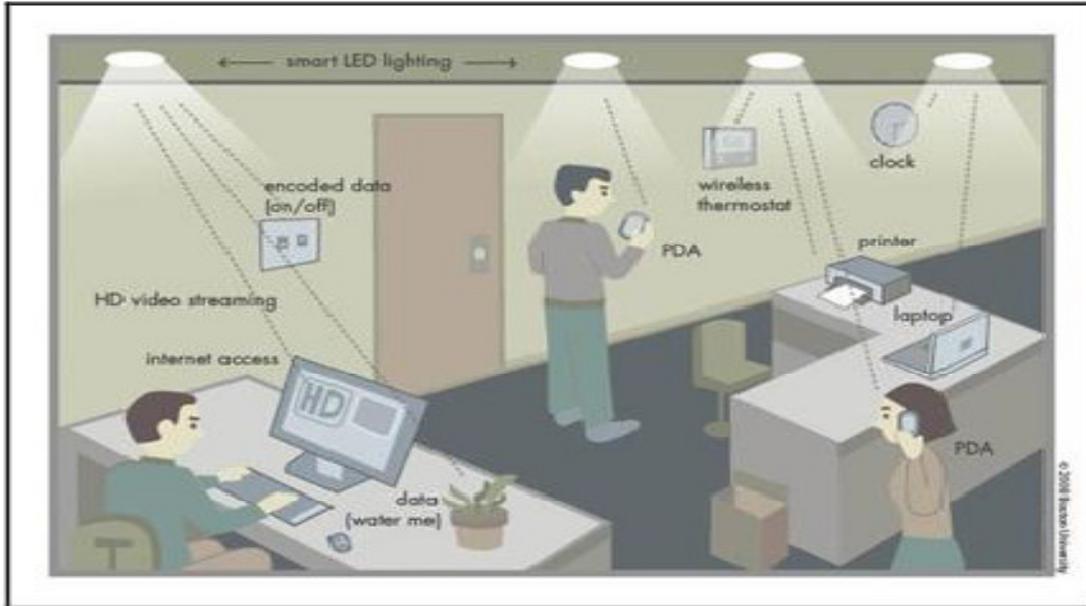


Fig 5:Li-Fi system connecting devices in a room.

V. RECENT ADVANCEMENT ON LI-FI TECHNOLOGY

- Researchers at the Heinrich Hertz Institute in Berlin, Germany: have reached data rates of over 500 megabytes per second. A consortium called Li-Fi Consortium 'was formed in October 2011 by a group of companies and industry groups to promote high-speed optical wireless systems and overcome the limited amount of radio based wireless spectrum. According to the Li-Fi Consortium, it is possible to achieve more than 10 Gbps of speed, theoretically which would allow a high-definition film to be downloaded in just 30 seconds.
- Researchers at University of Strathclyde in Scotland: began the task of bringing high-speed, ubiquitous.

VI. ADVANTAGES OF LI-FI

LiFi technology is based upon lights might be any sort of lights. The transfer of data takes place in presence of any kinds of light whatever may be the band width. Due to which the depend of transmitting the data or information will be great and also sufficient information, music, movies, games anything can be downloaded using very less time.

1. **Capacity:** Light itself has 10000 times wider bandwidth than radio waves. Due to which the transfer of data is more effectively possible. So lifi has better capacity.
2. **Efficiency:** LED lights consume less energy and very efficient. As it uses less energy it is cheap and easy to use.

3. **Availability:** As light is present everywhere, Lifi is available everywhere. But for more efficient use of lifi technology LED bulbs must be placed for proper transmission on data for proper transmission on data.
4. **Security:** Light waves cannot penetrate through walls. So they cannot be misused.
5. **Bandwidth:** The visible light is unlicensed and free to use and gives a very large bandwidth.
6. **Data Density:** Li-Fi can achieve about 1000 times the data density of Wifi because visible light can be well contained in the tight illumination area.
7. **Low Cost:** As it requires very few components the cost of it is comparatively low.

VII. LIMITATION OF LI-FI

1. As lifi technology uses light as transmission medium, so if the receiver is somehow blocked in a way then the signal will immediately will be cut out.
2. While data transfer interference from external light sources such as sunlight, normal bulbs, and opaque materials can cause loss of reliability and network.
3. As Lifi works in direct line of sight. Slight disturbance can cause to interruption.

VIII. APPLICATIONS OF LI-FI

Some of the future applications of lifi are as follows:

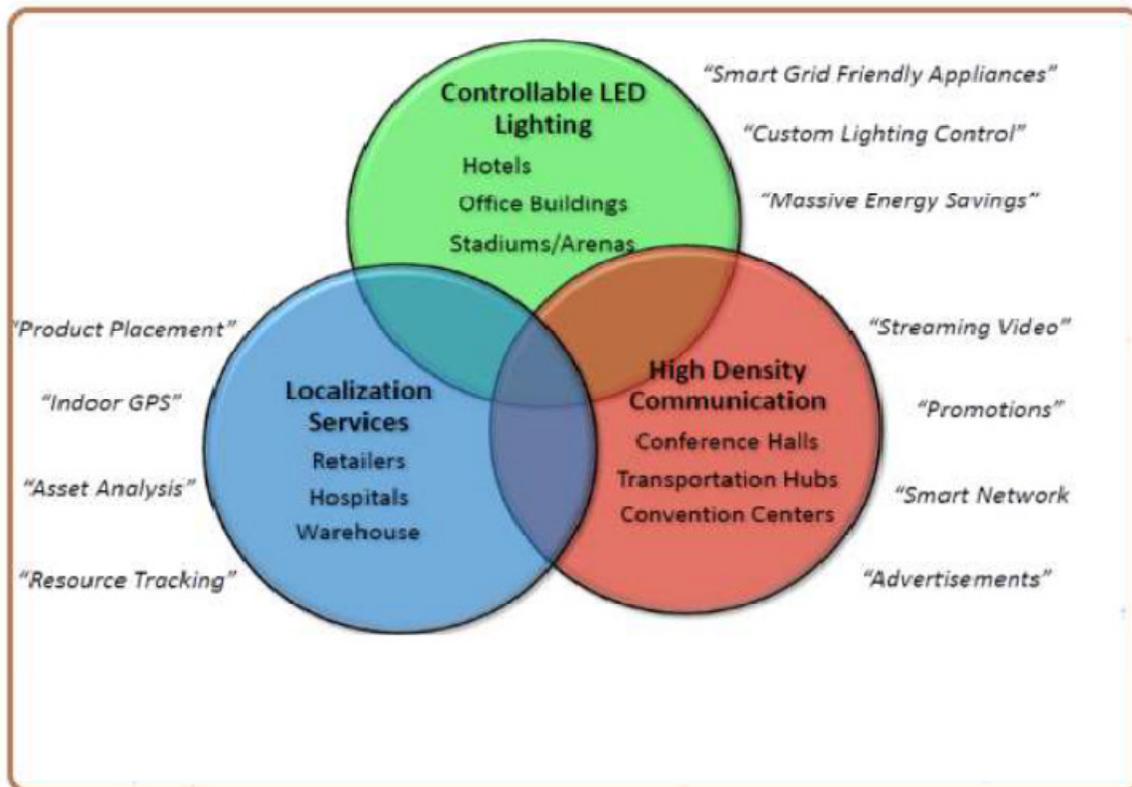


Fig 6: Applications of Li-Fi Technology

1. **Education System:** Lifi is the latest technology that can provide fastest speed internet access. So it can replace the Wifi at Educational Institution and at companies so that they can use the same internet with more fast speed.
2. **Medical applications:** As wifi uses radiations waves which can cause hazardous to the patients in OT(Operation Theatres) while radioactive operations. So Wifi is not allowed there as it can block the signals

3. **Internet in Aircrafts:** In Aircrafts wifi cannot be used as it can interfere with the navigational systems of the pilots. Thus Lifi Can be used for data transmission. Lifi can Provide high speed internet using the every light source such as overhead reading bulbs.
4. **Underwater Applications:** Lifi can work underwater where Wifi fails completely, thereby providing open endless opportunities for military operations.
5. **Disaster Management:** Lifi can be powerful means of communication in times of earthquakes or hurricanes. Lifi bulbs could provide cheap high speed Web access to every street corner.
6. **Applications in Sensitive Areas:** wifi are bad for sensitive areas such as power plants. Lifi can provide much safer connectivity in such sensitive areas. Also Lifi can be used in petroleum or chemical plants where other transmission medium can be hazardous.
7. **Traffic management:** In traffic signals Lifi can be used which will communicate with the Led lights of the car which can help in traffic management. Also LED car lights can alert drivers when other vehicles are too close thus reducing the chances of accidents.
8. **Replacement for other Technologies:** Lifi can be used in the areas where radio waves technologies such as Wifi are banned.

IX. COMPARISON BETWEEN LI-FI/WI-FI

SR. NO	Li -Fi	Wi-Fi
1	Data transmission takes place using bits.	Data transmission takes place using radio waves.
2	Fast speed internet (1- 3.5Gbp0073)	Comparatively slow speed (54-250 Mbps)
3	Range is limited (10 Meters)	Extended range (20-100 meters)
4	The Spectrum range is 10000times than Wi-Fi	It has radio spectrum range.
5	It uses Point-To-Point network topology.	It uses Point-To-Multi network topology.
6	It uses light as its data transfer medium	It uses radio spectrum as data transfer medium.
7	The frequency band is 100 times of Tera HZ.	The frequency band is 2.4GHz.
8	It is cheaper because free band doesn't need license and it uses light	Expensive because it uses radio spectrum.
9	Data density is high	Data Density is comparatively low
10	Lifi is more secured	Comparatively less secured.
11	Market Maturity is low	Market Maturity is high.

Fig 7: Table of Comparison between Li-Fi /Wi-Fi

X. DESIGN OF LI-FI

Important factors we should consider while designing Li-Fi as following:

1. Presence of Light must be line-of-sight.
2. Lamp driver where internet connection, switch and LED lamp connected.
3. For better performance use LED bulbs.
4. A photo detector received data.

X. FUTURE SCOPE

As light is everywhere and free to use possibilities increases to a great extent of the use of Li-Fi technology. If this technology comes to practice each lifi bulb will be used as Wi-Fi hotspot to

transmit wireless data. As the lifi technology will be used which will lead to a cleaner, greener, safer and bright future and environment. The concept of lifi is attracting many people as it is free to use without any license and faster means of data transfer. If it develops faster people will more and more use this technology instead of wifi.

XII. CONCLUSION

With the growing technology and increasing use of the internet services, possibilities are very high that use of Lifi technology will be soon in practice. Every bulb will be replaced by Lifi bulbs and might be used like a wifi hotspot for the transmission of data. Using Lifi technology will grant a cleaner, greener and brighter future and environment. The concept of lifi is spreading so fast as it is easy to use, it is attracting interest of people. The use of lifi technology gives a very golden opportunity to replace or to give alternative to the radio based wireless technologies. As the number of people and the access of internet is increasing on such a large scale , accessing internet through wifi will soon be insufficient as the usage is increasing but the bandwidth remains the same. As network traffic will increase it will result in lowering the speed of accessing the internet thus more increasing prices. The airways become clogged making it more difficult to use. Thus the use of Lifi will increase the speed of data transfer and also it is accessible in many banned places thus it will be available for all.

REFERENCES

- [1] Jyoti Rani, Prerna Chauhan, Ritika Tripathi, —Li-Fi (Light Fidelity)-The future technology In Wireless communication, International Journal of Applied Engineering Research, ISSN 0973-4562 Vol.7 No.11 (2012).
- [2] Richard Gilliard, Luxim Corporation, —The lifi® lamp high efficiency high brightness light emitting plasma with long life and excellent color quality.
- [3] Richard P. Gilliard, Marc DeVincentis, Abdeslam Hafidi, Daniel O'Hare, and Gregg Hollingsworth, —Operation of the LiFi Light Emitting Plasma in Resonant Cavity.
- [4] pureVLC, "pureVLC Li-1st." video. <http://purevlc.co.uk/li-fire/purevlc-li-1st/>.
- [5] <http://spectrum.ieee.org/tlecom/internet/lifi-gets-ready-to-compete-with-wifi>
- [6] <http://purelifi.com/li-fire/li-flame/>
- [7] Phil Mercer (august 11, 2012), —wi-fi, dual-flush loops and eight more australian inventions BBC News.
- [8] <http://visiblelightcomm.com/an-ieee-standard-for-visible-light-communications>.
- [9] Ekta, Ranjeet Kaur Light "Fidelity (LI-FI)-A Comprehensive Study" *International Journal of Computer Science and Mobile Computing* Vol. 3, Issue. 4, April 2014, pg.475 – 481 ISSN 2320-088X
- [10] <http://visiblelightcomm.com/what-is-visible-light-communication-vlc/>
- [11] D. Tsonev, S. Sinanovic, and H. Haas, "Novel Unipolar Orthogonal Frequency Division Multiplexing (U-OFDM) for Optical Wireless Communication", in *Proc. of Vehicular Technology Conference (VTC Spring 2012)*, to appear.
- [12] Mohammad Noshad, Member, IEEE, and Ma'it'e Brandt-Pearce, Senior Member, IEEE "Hadamard Coded Modulation for Visible Light Communications"