

Light Fidelity (Li-Fi) – The Resent Trend in Wireless Network Communication

Prof. M. R. Khan, Assistant professor, HMIMT in the Department of (MCA), Amravati, India
Prof. Nikhilesh .Yadav, Assistant professor, HMIMT in the Department of (MCA), Amravati, India

Abstract –The Light Emitting Diodes (LED) technology is used in different areas of our everyday life. These LED are winding its application areas as it provides us not only lightening capabilities, but also it is used for data transmissions as well. In this paper, we are going to study the technology of Light Fidelity (Li-Fi) based on the LED and its applications in transferring data. By using this Li-Fi one can transfer data from one computer system to another computer system. Li-Fi stands for Light Fidelity, which is proposed by the German physicist popularly named as “Harald Haas”. He gives the solution for illumination of light for data transfer. Using this technology, it is easy to provide transmission of data through illumination by sending data from LED light bulb. This technique is much more efficient that is faster than the human eye can follow. Li-Fi is more secure than the current Wi-Fi technology as it is using VLC and not by radio-waves for the transmission of data. It provides better efficiency, greater bandwidth and larger speed. The technology of Li-Fi is implemented through visible light communication (VLC) technology. This VLC technology uses the medium that deliver high-speed data communication for our Li-Fi technology in a manner that is similar to Wi-Fi. As today's needs is of growing needs for faster rate of data transmission, Li-Fi is trying to meet this requirement by offering much faster data rate than Wi-Fi technology. In this paper, the authors present the detailed study of the Li-Fi technology, its advantages and limitations.

Index Terms: Light Emitting Diode (LED), Light Fidelity(Li-Fi), Wi-Fi technology, data transmission, visible light communication (VLC), Wireless Network Communication.

1. INTRODUCTION

Li-Fi is one of the new and advance technology that uses visible light communication (VLC) technology instead of radio waves. This Li-Fi technology uses LED lights which transmits lights along with data which offers faster rates. This refers to fifth generation 5G Visible Light Communication technology designed using Light Emitting Diodes (LEDs). This technology works as a medium to high-speed communication in a similar manner or more efficiently than Wi-Fi [2]. As this technology performs two task simultaneously that is of providing lights and data it helps to conserve a large amount of electricity by transmitting data with the help of light bulbs and other such lighting equipment's. This technology can be used in aircrafts also. Li-Fi uses light as a medium as opposed to the use of radio waves as in Wi-Fi that penetrate walls, hence it is more secure for any human being. This Li-Fi technology for data transmission is implemented using normally white LED bulbs at the downlink transmitter [1]. This is the principle of this Li-Fi which is varying the current through the LED at much more high speed, we can vary the output at very high speeds that can use the flickers that can encode various data and transmit it. The working principle of the Li-Fi is much simple and based mostly on the digital concept-if the LED is ON, the signal transmitted is a digital 1 whereas if it is OFF, the signal transmitted is a digital 0. When the LED is ON i.e. 1 we get the data, otherwise the LED is OFF i.e. 0 we are unable to get data transmission. This technology uses the electromagnetic spectrum that is still not greatly utilized- The Visible Spectrum for its transmission. As the Light is very much important part of our daily lives form millions of years and it does not cause any major ill-effects. Moreover there is increasing needs of lights as we are spreading in the space and time. This LED technology is much more effective in providing the light sources. This LED technology is widening its area as it is possible to encode data in the light. This can be done by varying the rate at which the

LEDs flicker on and off this is same for 1s and 0s as the digital media. The intensity of the LED is modulated much rapidly and hence human eyes cannot notice it, so the output appears to be at the constant rate.

The mission of Li-Fi technology is announced as “*The Li-Fi seeks to resolve the global struggle for diminishing wireless capacity by developing and delivering technology for more secure, reliable, high speed communication networks that seamlessly integrate data and lighting utility infrastructures or significantly reduce energy consumption at the same time [3].*” The Li-Fi technology is based on narrowly-focused ‘beams’ that unable to travel through walls. Moreover, LED lights are natural beam-formers, this makes it easier to create the separate uplink as well as downlink channels. It serves as a means of more secure internet browsing, that gives both channels have to be ‘intercepted’ if someone managed to coerce their way into that same room as us. The Li-Fi technology allows us to works along with an off-the-shelf and an unmodified light fixture. At the time of communication the desktop unit has infrared LEDs in the uplink channel. The use of this is shown in **figure1**. The Li-Fi is capable of delivering a capacity of 5 Mbps in the channels in both ways as uplink and downlink, covering a range of up to three meters and above. It is important advantage that Li-Fi has the capability to give the speeds of up to 10 Gbps. More sophisticated techniques are used for increase VLC data rates which in turn increases the Light Fidelity (Li-Fi) technology. Researcher's team at the University of Oxford and the University of Edinburgh are making their focus on parallel data transmission as parallel data transmission works faster and it is done by using arrays of LEDs. Here each different LED transmits a different data stream. Some uses the groups that are using mixtures of red, green and blue color combination LEDs for altering the light's frequency, here each frequency encoding at different data channel. Researchers at the Heinrich Hertz Institute have reached data rates of

over 500 mbps. The Li-Fi is capable of transmitting data at 100 MB/s that is faster than most UK broadband connections. This paper is further organized as, the next section gives the working of LED in the Li-Fi and working of Li-Fi using the VLC technology. Then, it shows the advantages of Li-Fi technology over Wi-Fi. The advantages and Disadvantages of Li-Fi technology are studied further. The vast and developing application area of Li-Fi technology is given in the next section. Finally, the conclusion and Future scope information of Li-Fi that is Gi-Fi is given.

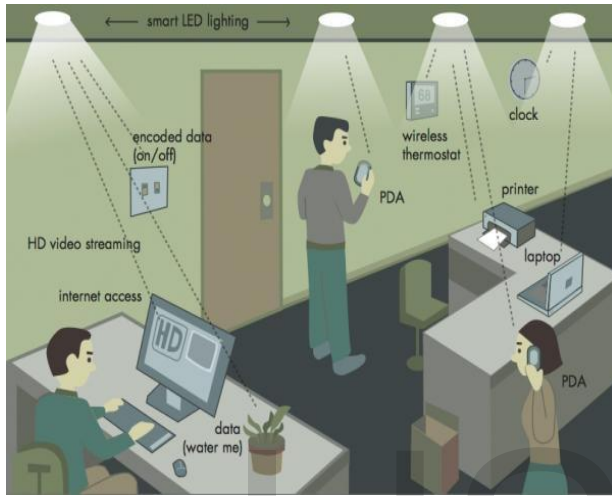


Figure. 1: Use of Wi-Fi Technology [4]

2. WORKING PRINCIPLE OF LI-FI

The Light-Fidelity (Li-Fi) technology is based on the Visible Light Communication (VLC) which uses the visible light source for data communication. The VLC technology use a source of illumination that in turn use by Li-Fi, which produce both illumination and also performs data transmission using the same light source. The VLC technology is the source of illumination along with communication.

Working of Li-Fi as shown in the figure 2 according to key points:

- Firstly, Li-Fi is implemented using white LED light bulbs at downlink transmitter.
- As the speed of light is very fast and the current is always varying, optical output can be made to vary at extremely high speeds.
- An overhead lamp is fitted with an LED bulb. This is done along with signal processing technology where data streams are embedded in its beam with ultra-high speeds to the photo diodes.
- At the receiver side, a receiver dongle makes the tiny changes in amplitude into an electrical signal; these signals are again converted into a data stream & further transmitted to the devices such as computer or mobile [5].

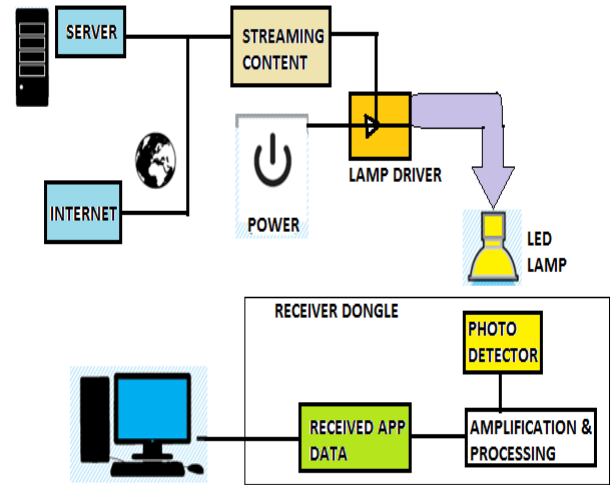


Figure 2: Working principle of Li-Fi

3. VISIBLE LIGHT COMMUNICATION (VLC)

1. Light Fidelity (Li-Fi) technology is faster and much cheaper version of traditional Wi-Fi, which is based on visible light communication (VLC) technique. The visible light communication is a kind of data communication technique which works by using visible light. The VLC uses its visible light as an optical carrier in the range between 400 THz and 800 THz for data transmission [6].

2. The radio-waves and other rays such as, Gama rays, X-rays, Ultra violet rays are mostly harmful for the human body as we all knows that.

3. The Infrared rays as they seems are mostly support to low power transmission they are also dangerous. These rays can penetrate through many parts of human beings. Another thing is it can only be used with low power.

Radio waves are also less secure for any living thing. Hence we are left with only the visible - light spectrum not harmful for any living [8], as light is our daily need and does not harm to any sensitive living thing.

4. ADVANTAGES OF LI-FI OVER WI-FI TECHNOLOGY

Wi-Fi	Li-Fi
A. TRANSMISSION SECURITY:	
From the security point of view, Wi-Fi is less secure as radio waves can penetrate through walls. They can be traced if someone has bad intentions, they can misuse it. This create a major security issue.	Li-Fi is based on data transmission through visible lights. Li-Fi is secure as light rays cannot penetrate through walls. They are not so much easy to be misused and traced by other People, for misusing it.

B. NETWORK CAPACITY:	
Wireless data which is transmitted through radio waves are mostly limited and expensive. It has to face with the problem of or limited amount of bandwidth.	The bandwidth capacity of Light is 10000 times wider than radio waves. Hence using the visible light technology Li-Fi has much better capacity compare to Wi-Fi.
C. RANGE AVAILABILITY:	
Wi-Fi networks offers the transmission for the limited range. For Example, a typical Wi-Fi home router might have a range of 45m (150ft) indoors and 90m (300ft) outdoors.	The range availability is not an issue in Li-Fi technology as light sources are available everywhere. For Example, there are billions of light bulbs across worldwide, they just need to be replaced with LEDs and one can enjoy the benefits of data transmission.
D. COST and EFFICIENCY:	
It is much costly than Li-Fi. It contains many radio base stations which consume more heat also. It is also less efficient.	It is not costly as the LED lights sources consume less energy. It is much more efficient source than Wi-Fi.

5. ADVANTAGES AND DIS-ADVANTAGES OF LI-FI

5.1. Advantages of Li-Fi

The Light – Fidelity (Li-Fi) technology is very much more beneficial for many of us. This technology emerges as a result of vast amount of license-free and secure electromagnetic spectrum. This spectrum consists of infrared and visible light regions [10] which work faster, easier and in effective manner. The key advantages are highlighted as follows:

- Li-Fi enhanced wireless infrastructures can do better by providing an additional layer of small cells called as ‘attocells’.
- Li-Fi does not make use of the radio frequency spectrum which increases the capacity up to 10,000.
- This technology enables very high peak data rates of about (10 Gbps). As it uses only visible lights which completely eliminates the health security issues.
- This makes significant enhancement in the security of wireless communication and reduced interception of signals that is often happened in case of radio-waves.
- The use of Visible Light Communication technique enhanced energy-efficiency by combining data communication and illumination. So, it helps in 100 times energy reduction.

5.2. Some Limitations of Li-Fi

Despite of many advantages of Li-Fi, like any other technology it also has some limitations and disadvantages [11], as enumerated below:

- As light is unable to pass through any object, and if in case the source is blocked by any kind of disturbances then the signals are stopped and receiver will be unable to get any data source.
- The Reliability and network coverage are found to be the major issues by the companies in case of VLC services. Some kind of interference from external light sources like sunlight, normal bulbs and can also become the source of disturbance in both the source of light and data transmission.
- The cost of installation of the systems can be complemented by large-scale implementation of VLC and it will reduce further operating costs like electricity charges, maintenance charges, etc.
- We still need Wi-Fi as our Li-Fi is unable to bear with the disturbances. Our light bulb does not provides data to a high-speed moving object and not in the remote area where there are trees, walls and obstacles and interferences.

6. APPLICATIONS OF LI-FI

The Light – Fidelity system has variety of uses in many fields of our daily lives as it is based on LED visible-light source. It is useful from the access of internet by the general public using street lamps and in another case with the auto-pilot cars which communicate through their headlights. In spite of this, the areas such as healthcare and aircrafts where Wi-Fi is harmful/ useless, where Li-Fi is the alternative which provide faster data access rate.

Some of the applications are listed as below:

6.1. Healthcare Industries

The Wi-Fi emits radio waves which are very harmful for the patients. And in the deadly case they can interpret the medical instruments also. Thus, we can use internet in operating rooms by Li-Fi technology which makes only use of visible light which is not harmful to anyone. For this reason only, now medical technology would lag behind the use of wireless internet from the rest of wireless world. Till now operating rooms did not allowed Wi-Fi overradiation concerns, this healthcare industry can use Li-Fi as the source to access internet.

6.2. Airlines

In Airlines, passengers have to pay extra money to make use of the dial up service in the aircraft. Li-Fi could be able to introduce "high-speed" transmission service. This service would be interruption free and possibly differs from other wireless in the aircraft system also.

6.3. Underwater applications

Underwater ROVs (Remotely Operated Vehicles) is not long enough to allow them to explore larger areas. If their wires system were replaced with our LED light that is from a submerged and high powered lamp, then they would be much free to explore themselves for another use. These headlamps can also be used to communicate with each other [12]. In underwater appliances, Li-

Fi can work underwater where radio-waves fails here completely. So, Li-Fi provides opportunities for underwater military operations.

6.4. Natural Disaster Management

In times of natural calamities like earthquakes, Li-Fi serves as a powerful means of communication efficiently. As the Li-Fi uses light which is not obstructed by such environment or physical condition. The Wi-Fi technology lags here as RF waves are obstructed by walls or other such kinds of things.

7. RESENTTRENDS WITH LI-FI

7.1. Li-Fi for smart cities

The simplicity of the li-fi technology using LED light bulbs to transmit data along with transmission of light source at the same time. This includes high speed data connections that might be possible to be given by the street lights that could add additional benefits to the emergence of smart cities.

7.2. Li-Fi technology as enabler of (IoT) and everything:

Researchers at one of the Li-Fi center, At the University of Edinburgh stated that, The Li-Fi nodes are along with strong communication and capabilities of networking. The Li-Fi has the optical carrier for wireless transmission and this is present above TCP/IP layers for connecting things on everything, any-time, everywhere basis. Along with very minimal capital expenditure (CAPEX) and operationexpenditure (OPEX) [14].

7.3. In the future, Topology is important

Researchers published guidelines worldwide which show that the future network will work faster but capacity problems still remain unavoidable. It reveals that the 'topology' is the makeup of transmitters providing network signal.

7.4. Reliable communication and improved networking

The Li-Fi technology we are discussing is the high-speed, fully networked and supporting broadband wireless and aimed at relieving the existing Wi-Fi technology. A Li-Fi access point can serve multiple users simultaneously within the area of its coverage.

7.5. Li-Fi Access nodes its inherent Programmable features

The Quantum mechanics used to develop systems for the controlling of number of photons from a simple LED light bulb by changing the frequency of the light sources. This makes it the most perfect carrier for wireless transmitting of data in the smallest cell of network among 5G wireless communication networks [13].

7.6. Light brings users super-fast wireless internet

With the fast advancing world Lights in shop windows, cars etc. should be able to access the wireless internet. Li-Fi could prove to be seventimes faster than Wi-Fi and enable to download an entire HD movie in a couple of seconds.

8. CONCLUSION AND FUTURE SCOPE

Li-Fi is an emerging technology and it has vast potential in today's advanced world. A lot of research can be conducted in this field as it is based on the LED visible lights. This technology, is invented by Harald Haas, and now it becomes one of the major technologies for use today. This technology can be used efficiently, works like the Wi-Fi hotspots available from the light bulb. It will be cleaner and greener and the future of mankind will be safe as it does not use the radio-waves. The Li-Fi technology can solve the crisis of the amount of limited available bandwidth. As the radio-waves uses the airwaves that are becoming increasingly clogged, and making it more and more difficult for getting a smooth and high-speed signals.

The future of Li-Fi is Gi-Fi. The Gi-Fi or *gigabit wireless*. This system refers to wireless communication supporting the data rate more than one billion bits (gigabit) per second. In 2008 researchers at the University of Melbourne demonstrated the speed and working of the transceiver that is integrated on a single IC- chip that operated at 60 GHz on the CMOS process. With this technology it is possible to transfer about 5 gigabits per second using wireless technology. It is ten times faster than the present rates with the wireless techniques available with us.

REFERENCES

- [1] Ravi Prakash, Prachi Agarwal "The New Era of Transmission and Communication Technology: Li-Fi (Light Fidelity) LED & TED Based Approach", *International Journal of Advanced Research in Computer Engineering & Technology (IJARCET) Volume 3, Issue 2, February 2014.*
- [2] 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.*
- [3] Shubham Chatterjee, Shalabh Agarwal, AsokeNath, "Scope and Challenges in Light Fidelity (LiFi) Technology in Wireless Data Communication" *International Journal of Innovative Research in Advanced Engineering (IJIRAE) ISSN: 2349-2163, Issue 6, Volume 2 (June 2015).*R. Nicole, "The Last Word on Decision Theory," *J. Computer Vision*, submitted for publication. (Pending publication)
- [4] BEST FIVE BENEFITS OF LI-FI TECHNOLOGY [ONLINE] AVAILABLE: [HTTP://WWW.TECHNEWSPAPER.NET/WPCONTENT/UPLOADS/2013/11/FONCTIONNEMENT-LIFI.JPG](http://www.technewspaper.net/wpcontent/uploads/2013/11/FONCTIONNEMENT-LIFI.JPG)
- [5] Lee, s. C. J., randel, s., breyer, f., and koonen, a. M. J., "pam-dmt for intensity-modulated and direct-detection optical communication systems," *ieee photonics technology letters* 21, 1749-1751 (dec. 2009).
- [6] Tsonev, d., sinanovic, s., and haas, h., "Novel Unipolar Orthogonal Frequency Division Multiplexing (U-Ofdm) For Optical Wireless," *In Proc. Of The Vehicular Technology Conference (vtc spring)*, (may 6-9 2012).
- [7] Khalid, a. M., cossu, g., corsini, r., choudhury, p., and ciaramella, e. "1-gb/s transmission over
- [8] [Http://www.scribd.com/doc/88340668/seminar-report-on-lifi](http://www.scribd.com/doc/88340668/seminar-report-on-lifi)
- [9] Nitika Bansal, Abhishek Bhardwaj, "Li-Fi Technology- Next Generation Wireless Technology", *International Journal of Latest Trends in Engineering and Technology (IJLTET)*, Vol. 5 Issue 3 May 2015.
- [10] Benefits of Li-Fi [Online] available: <http://www.lifi-centre.com/about-li-fi/benefits-of-li-fi/>
- [11] AsokeNath, "Li-Fi Technology: Data Transmission through Visible Light", ARTICLE in *IJARCSMS · JULY 2015.* [Online] available:

<http://www.researchgate.net/publication/279530585>

- [12] N. Kumar, D. Terra, N. Lourenço, L. N. Alves, and R. L. Aguiar, "Visible light communication for intelligent transportation in road safety applications", in *Proc. 7th Int. Wireless Commun. Mobile Comput. Conf.*, pp. 1513–1518, 2011.
- [13] LI-FI (LIGHT FIDELITY)-THE FUTURE TECHNOLOGY IN WIRELESS COMMUNICATION [Online] available: <http://caledonianmercury.com/the-futures-bright-the-futures-li-fi>
- [14] Subarna Panda, MdSoyaib, Dr. A. Jeyasekar, "Li-Fi Technology –Next Gen Data Transmission through Visible Light Communication", *International Journal of Innovative Research in Science, Engineering and Technology (IJIRSET)*, An ISO 3297: 2007 Certified Organization Volume 4, Special Issue 11, September 2015.

IJSER