



LIFI TECHNOLOGY: DATA TRANSMISSION THROUGH VISIBLE LIGHT (REVIEW PAPER)

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In a world running out of spectrum, there is a need for a spectrum that has a wide range thus providing data transfer at high speeds. Living in a world already in 5G and steering a course towards 6G and many other technologies that require very high bandwidth, there is a demand for a solution to all this. In such a situation Li-Fi comes to our rescue. Li-Fi referred to as “Light Fidelity” is a technology that uses visible light to transmit data. As we know, visible light has a wide spectrum, therefore data can be transmitted at a higher speed. Li-Fi has already achieved 1Gbps speed during lab testing and it is assumed to achieve 224 Gbps theoretically.

Li-Fi first came into the talk by Professor Harald Haas. He was a professor of mobile communications at the University of Edinburgh and brought this on 12th July 2011 at TED Global Talk (Aditya Manral, 2016). He introduced Li-Fi as a way to transmit data wirelessly via visible light. He used LED as a light source. This is based on VLC (Visible Light Communication) which dates back to the 1880s when (Fig.1) Alexander Graham Bell introduced ‘photophone’ which is a telecommunication device that allows transmission of speech on a beam of light. Li-Fi is considered the future of the internet as it has resolved many issues that Wi-Fi faces. It gives greater capacity, efficiency, security, and a broader bandwidth.



CONSTRUCTION OF LIFI SYSTEM:

LiFi is an optical version of Wifi based on visible light communication between 380 and 700 nm. Here light acts as a data carrier. Data transmission by light requires the following:

- LED which acts as a light source for illuminating and transferring data.
- A silicon photodiode that may detect light pulses and process the data.

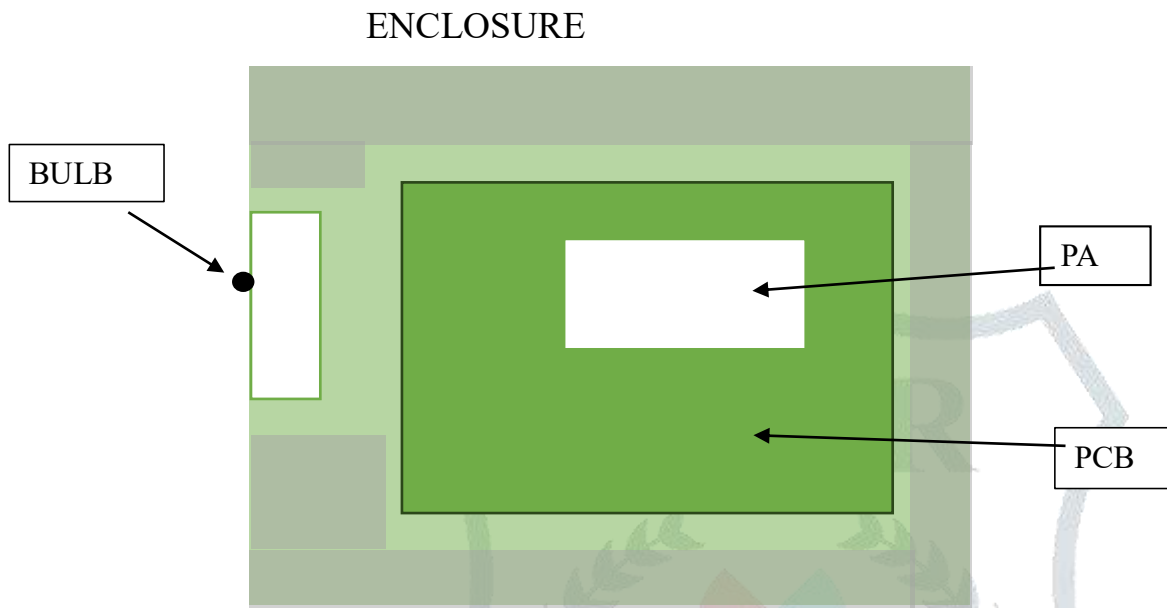
Digital strings of binary 0s and 1s are created and emitted by the light source by continuous flickering of light. But it appears constant to the human eye. The fluctuations being created are controlled by a modifier which sets the intensity of light as per data to be transmitted. The emitter consists of the following:

- Bulb
- RF Power Amplifier Circuit (PA)
- Printed Circuit Board (PCB)
- Enclosure

RF Radio frequency generates a signal which is carried by an electric field to the bulb. PCB controls the inputs and outputs of the emitter circuit and has the controller which controls the light functioning. The electric field of

the bulb ignites the contents present in it which then emit the light. The LED bulb consists of dielectric material which focuses energy in the bulb and waveguides the RF energy.

This is a much better way as it provides light with full efficiency in the full visible region spectrum and light with high brightness and intensity serves as the data carrier (Rahul R. Sharma, 2014) (Aditya Manral, 2016).



(Fig. 2)

WORKING OF LIFI:

LED, light-emitting diode forms the core part of the working LiFi system. LED is used as a source of visible light which transfers data in the form of binary 0s and 1s. This data is received by a photodetector which decodes it and gives us the required information. The LED does not appear to flicker to the human eye but it does. It flickers at a rate faster than the human eye can notice. A logical '1' is transmitted when the LED is on and a logical '0' is transmitted if the LED is off. This continuous on-and-off of LED beams out the data. Therefore, what we require is some LEDs and a controller that can code the whole data into these LEDs (Rahul R. Sharma, 2014) (Jyoti Rani, 2012).

The data to be transmitted can be modulated by controlling the flickering rate which could be done by using an array of LEDs, different colored LEDs, or by just controlling the flickering rate. We can disseminate the data as different strings of 0s and 1s are transmitted. LEDs are used because they can be modulated rapidly and accurately to transmit data (Anurag Sarkar, 2015) (R.Karthika, 2015).

ADVANTAGES OF Li-Fi OVER Wi-Fi:

In the upcoming years, this world will become more data-centric thus requiring a medium to transmit data in larger amounts at higher speeds. Current and coming technologies have daunting demands that could be fulfilled by LiFi for the following reasons.

1. **Capacity:** Wi-Fi uses radio waves to transfer data while Li-Fi uses visible light which has greater bandwidth which implies that more of the data can be transmitted.
2. **Efficiency:** Radio waves are sent from radio base stations which consume a major part of the energy only to cool the stations. This reduces its efficiency to only 5% (Rahul R. Sharma, 2014).
3. **Security:** Li-Fi is more secure than Wi-Fi because it works in direct line of sight while radio waves can penetrate through walls thus it is important to note that someone with malicious intentions can obtain your personal information without your knowledge or consent, which can potentially lead to negative consequences.
4. **Availability:** Visible light is available everywhere, even in airplanes, gas stations, and hospitals where radio waves are prohibited. So, the lights around us can not only provide illumination but may carry information in a way much safer to mankind.

5. **Traffic-free:** In today's hyper-connected world, denser network environments can pose a significant challenge to network speed, resulting in frustrating latency. But this is not the case when we use Li-Fi.
6. **Speed:** Li-Fi offers transmission at a rate much faster than Wi-Fi of about 1Gbps which is beyond WIFI's range.

DISADVANTAGES OF Li-Fi:

There are two sides to every coin. So, we just can't do justice to this review paper without mentioning the cons of Li-Fi. Li-Fi cannot make our lives easier without finding a solution to the below-mentioned points.

- Li-Fi works in direct line of sight between the source and the receiver. If any obstacle is introduced, no data could be transmitted. Even a person walking in front of the light source can cause interruption. In the case of wi-fi, it could penetrate objects and reach the receiver.
- Output obtained depends on the presence of light. So, this restricts its working in the areas that lack light.
- If the VLC system is installed outdoors sunlight can interfere with the information transmission speed.
- We use LEDs everywhere but those cannot transmit data until the infrastructure is improved i.e. the introduction of VLC systems. This is not at all as cost-efficient as the transmission of data is. So, a whole new fabrication is required (Sambhav, 2020) (Anurag Sarkar, 2015).

A SOLUTION to the major problem is creating certain modulating elements or controllers that could manage and amplify the intensity of the incoming data and modify it in a way required by the users instead of changing the whole infrastructure which could be highly expensive. A few patents have already lightened the path this way.

APPLICATIONS OF Li-Fi:

Li-Fi can be introduced to many fields where Wi-Fi has not given many benefits. Some are mentioned below.

1. In Hospitals: Wi-Fi is allowed in hospitals only in certain areas because it is interrupted by other signals and may damage medical equipment. Therefore, Li-Fi could be used in such situations as visible light has no health issues as well as will not damage any apparatus (Anurag Sarkar, 2015).
2. In Petrol Pumps: Wi-Fi is not permitted in gas stations to reduce the potential risk of ignition of flammable particles by radio waves. In such places, visible light communication could be used.
3. Underwater Communications: Underwater ROVs use a tether to carry the signal to the pilot on the surface so that he can control it and explore the world out there. Radio waves are very rapidly absorbed by water thus eliminating underwater communications. But a tether limits the movement of ROVs. This could be overcome by using light to communicate between the pilot and the ROV. Their headlamps can also be used to communicate with each other and process data autonomously (Anurag Sarkar, 2015) (Aditya Manral, 2016).
4. In traffic management: Headlights and tail lights use LED lights which offers developing a network between cars which can decrease accident risks as cars could communicate via Li-Fi. Traffic lights can offer information regarding traffic rules and regulations. LED lights in subways, train stations, and other transport stations can keep us in touch with a lot more information than we merely thought about.
5. Security: High-security areas such as military bases can use Li-Fi to transmit confidential information with high reliability as light could not pass obstacles and there would be no breach.

RECENT ADVANCEMENTS IN LIFI:

Researchers at the Heinrich Hertz Institute in Berlin, Germany reached a speed of 500 megabytes per second by using a standard white light. At the Consumer Electronic Show in Las Vegas in 2012 Casio smartphones were used to demonstrate this technology by using a light that could be detectable at up to 10 meters with varying intensity. In 2011 a group of companies came together to work on the progress of Li-Fi by forming a consortium called 'Li-Fi Consortium'. This made us believe that Li-Fi could achieve a speed of 10 Gbps which is beyond the

thought of WiFi. University of Strathclyde in Scotland has professors working in the direction of upgrading this technology and finding solutions in a way to move forward in this (Rahul R. Sharma, 2014).

CONCLUSION:

As addressed in my review paper there are a plethora of possibilities to take this technology to a level where it can help mankind. Although there is a still long way to go, we will reach our destiny where every light source may act as a hotspot for the internet. This market is expected to grow especially if we get a solution to the fabrication of LiFi systems. Few patents have already lighted us the path, the only need is to walk on it. A high-speed data transmission is the need of the hour which is the major plus point of this technology. A significant number of companies and groups are already working in this direction. Harald Haas started Pure LiFi which provides access to this technology. LiFi is a revolutionary technology that will no doubt provide its users an efficient and high-speed data. As the research is going on we will overcome many problems shortly and LiFi may collaborate with WiFi to provide us with a safer networking world.

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