

Li-Fi (Light Fidelity): The Future Technology in Wireless Communication

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Abstract— With the advancement of technology and in this digital age, wireless communication has reached a new level. Internet being now a basic necessity for living, thus the want for faster and more reliable internet has increased over time, as more and more people with their many devices access wireless internet. The German physicist Harald Haas in 2011 has come up with a solution called “data through photons”, which takes the fiber out of the technology of fiber optics and by sending data through LED light bulb with varying intensity faster than we human can follow. Li-Fi provides transmission of data through illumination by sending data through an LED light bulb that varies in intensity faster than human eye can follow. Wi-Fi is useful for general wireless coverage within buildings while Li-Fi is ideal for high density wireless data coverage in confined areas where there are no obstacles. Li-Fi provides better bandwidth, efficiency, availability and security than Wi-Fi. Li-Fi is a wireless optical networking technology that uses light emitting diodes (LEDs) for transmission of data. The term Li-Fi refers to visible light communication (VLC) technology that uses as medium to deliver high-speed communication in a manner similar to Wi-Fi. In this paper we have discussed Li-Fi technology, its advantages and its application. This technology has brought not only greener but safer and cheaper future of communication.

Keywords— Li-Fi, Wi-Fi, LEDs, diode, wireless communication.

I. INTRODUCTION

Li-Fi is transmission of data through illumination by taking the fiber out of fiber optics by sending data through a LED light bulb that varies in intensity faster than the human eye can follow. Li-Fi is transmission of data through illumination using LED light bulbs, this term is used to label fast and cheap communication system which is an advanced version of Wi-Fi or say it the optical version of Wi-Fi. When switched the LED ON, digital 1 is transmitted and when it's OFF, digital 0, thus can be switched on and off very quickly. It is also possible to encode data in light by varying the rate at which the LEDs flicker to produce different strings of 0s and 1s. The intensity is modulated so fast that the human eye can't notice thus the output appearing constant. More advancement could drastically increase the VLC data rate.

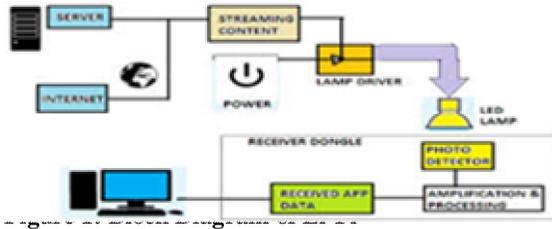
In the near future, the wireless technology is being replaced by drift from Wi-Fi to Li-Fi technologies due to the

disadvantages offered by Wi-Fi over the innumerable advantages proposed by Li-Fi. While Wi-Fi is predicated on the availability of a microwave signal, Li-Fi has the ability to turn any lamp into a network connection operating at much higher frequencies. Li-Fi also offers more privacy than Wi-Fi.

II. WORKING PRINCIPLE OF LI-FI

The working of a Li-Fi is very simple if a LED is ON you just transmit 1 and if it is OFF 0 is being transmitted, thus these LEDs can be switched ON and OFF very quickly thus allowing us to transmit data. So all we require is some LEDs and a controller and code data into the LEDs. All we need to do is just adjust the intensity and vary the rate at which the LED flickers which indeed depends on the data we want to transmit. Modifications and advancement of technologies may bring other changes to this raw technology like using different mixtures of LEDs or an array arrangement and many more. By using different color LED and altering the frequency as every frequency would encode different channel of data. This kind of advancement promise a speed of up to 10Gbps i.e. downloading a full HD video in just 30 seconds. This high speed is not the only reason which gives this technology a future in coming it is also the fact that it just uses light to transmit data and could be used safely in hospitals, aircrafts and other public domains. Since Wi-Fi completely fails underwater this technology doesn't. Radio waves could be easily replaced by the new method of transmitting signals called Li-Fi.

Light emitting diodes known as LED are found everywhere in traffic lights, cars, remote, lamps literally everywhere, these LEDs can be switched ON and OFF quickly so that a human eye can't detect its flickering and use this invisible activity to transmit data using binary code 0 and 1. Data can therefore be encoded by changing the rate at which it blinks thus giving different strings. This method is rather as Visible Light Communication (VLC), this could be used to bring advancement to the basic Wi-Fi to Li-Fi.



III. COMPARISON BETWEEN VARIOUS WIRELESS TECHNOLOGIES:
TABLE 1:

Parameter	Li-Fi	Wi-Fi	Bluetooth	IrDA
Speed	>1Gbps	150	3 Mbps	4 Mbps
Data Density	High	Low	Low	Low
Security	High	Medium	Low	High
Power usage	Low	Medium	Low	low

IV. PROBLEMS IN WI-FI

The following are the basic issues with radio waves:

- a) Capacity: Wireless data is transmitted through radio waves which are limited and expensive. It has a limited bandwidth. With the rapidly growing world and development of technologies like 3G, 4G and so on we are running out of spectrum.
- b) Efficiency: There are 1.4 million cellular radio base stations that consume massive amount of energy. Most of the energy is used for cooling down the base station instead of transmission. Therefore efficiency of such base stations is only 5%.
- c) Availability: Availability of radio waves is a big concern. It is not advisable to use mobile phones in airplanes and at places like petrochemical plants and petrol pumps.
- d) Security: Radio waves can penetrate through walls. They can be intercepted. If someone has knowledge and bad intentions, they may misuse it. This causes a major security concern for Wi-Fi.

V. ADVANTAGES OF LI-FI

Li-Fi technology is based on LEDs or other light source for the transfer of data. The transfer of the data can be with the help of all kinds of light, no matter the part of the spectrum that they belong. That is, the light can belong to the invisible, ultraviolet or the visible part of the spectrum. Also, the speed of the communication is more than sufficient for downloading movies, games, music and all in very less time.

- a) Capacity: Light has 10000 times wider bandwidth than radio waves. The light sources are already installed. So, Li-Fi has got better capacity and also the equipments are already available.
- b) Efficiency: Data transmission using Li-Fi is very cheap. LED lights consume less energy and are highly efficient.

- c) Availability: Availability is not an issue as light sources are presents everywhere. There are billions of light bulbs worldwide; they just need to be replaced with LEDs for proper transmission of data.
- d) Security: Light waves do not penetrate through walls. So, they can't be intercepted and misused.

VI. LIMITATIONS OF LI-FI

1. Only works if there is direct line of sight (LOS) between the transmitter and receiver.
2. Data transmission can be easily obstructed by opaque obstacles.
3. The use of very high frequencies (400-800THz) limits it to very short distances and point to point communication only.
4. Interference from external light sources like sun light, normal bulbs in the path of transmission will cause interruption in the communication.
5. A high speed moving object and to provide data in a remote area where there are trees and walls is unreliable to use this technology.

VII. APPLICATIONS OF LI-FI

Some of the future applications of Li-Fi are as follows:

- a) **Education systems:** Li-Fi is the latest technology that can provide fastest speed internet access. So, it can replace Wi-Fi at educational institutions and at companies so that all the people can make use of Li-Fi with the same speed intended in a particular area.
- b) **Medical Applications:** Operation theatres (OTs) do not allow Wi-Fi due to radiation concerns. Usage of Wi-Fi at hospitals interferes with the mobile and pc which blocks the signals for monitoring equipments. So, it may be hazardous to the patient's health. To overcome this and to make OT tech savvy Li-Fi can be used to accessing internet and to control medical equipments. This can even be beneficial for robotic surgeries and other automated procedures.
- c) **Cheaper Internet in Aircrafts:** The passengers travelling in aircrafts get access to low speed internet at a very high rate. Also Wi-Fi is not used because it may interfere with the navigational systems of the pilots. In aircrafts Li-Fi can be used for data transmission. Li-Fi can easily provide high speed internet via every light source such as overhead reading bulb, etc. present inside the airplane.
- d) **Underwater applications:** Underwater ROVs (Remotely Operated Vehicles) operate from large cables that supply their power and allow them to receive signals from their pilots above. But the tether used in ROVs is not long enough to allow them to explore larger areas. If their wires were replaced with light say from a submerged, high-powered lamp then they would be much freer to explore. They could also use their headlamps to communicate with each other, processing data autonomously and sending their findings periodically back to the surface. Li-Fi can even work underwater where Wi-Fi fails completely, thereby throwing open endless opportunities for military operations.
- e) **Disaster management:** Li-Fi can be used as a powerful means of communication in times of disaster such as

earthquake or hurricanes. The average people may not know the protocols during such disasters. Subway stations and tunnels, common dead zones for most emergency communications, pose no obstruction for Li-Fi. Also, for normal periods, Li-Fi bulbs could provide cheap high-speed Web access to every street corner.

f) Applications in sensitive areas: Power plants need fast, inter-connected data systems so that demand, grid integrity and core temperature (in case of nuclear power plants) can be monitored. Wi-Fi and many other radiation types are bad for sensitive areas surrounding the power plants. Li-Fi could offer safe, abundant connectivity for all areas of these sensitive locations. This can save money as compared to the currently implemented solutions. Also, the pressure on a power plant's own reserves could be lessened. Li-Fi can also be used in petroleum or chemical plants where other transmission or frequencies could be hazardous.

g) Traffic management: In traffic signals Li-Fi can be used which will communicate with the LED lights of the cars which can help in managing the traffic in a better manner and the accident numbers can be decreased. Also, LED car lights can alert drivers when other vehicles are too close.

h) Replacement for other technologies: Li-Fi doesn't work using radio waves. So, it can be easily used in the places where Bluetooth, infrared, Wi-Fi, etc. are banned.

VIII. CONCLUSION

If this technology can be put into practical use, every bulb can be used something like a Wi-Fi hotspot to transmit wireless data and we will proceed toward the cleaner, greener, safer and brighter future. The concept of Li-Fi is attracting a lot because it offers a genuine and very efficient alternative to radio based wireless. This concept promises to solve issues such as the shortage of radio-frequency bandwidth and boot out the disadvantages of Wi-Fi.

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