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

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Abstract— The idea of Li-Fi is to provide data communication through fast blinking of light which is not observed by human eye. A better substitute to existing wireless communication is Li-Fi. Li-Fi is a subset of Optical Wireless Communication (OWC) and RF communication which can produce data rates faster than 10 MHZ/sec. Li-Fi is the 5th generation of wireless communication technology. It provides very high speed for communication as compared to other existing communication techniques.

Key words: OWC, Li-Fi, VLC

I. INTRODUCTION

Li-Fi (Light Fidelity) is a VLC (Visible Light Communication) technology in which transfer of data through illumination takes place by taking fiber out of optics & by sending data through a LED light bulb whose intensity keep on varying at a very high speed. As this technology offers a large bandwidth which is unlicensed, so it can be used for many application such as streaming of video and music, connection of internet with moving or stationary devices etc. How exciting it could be if one can get public internet access under a street lamp or can download a movie from the lamp on his desk. This technology could quite literally as well as, 'throw light on' how to meet the ever-increasing demand for high-speed wireless connectivity. Radio waves are replaced by light waves in a new method of data transmission which is known as Li-Fi. In this technology, LEDs must be switched 'ON' and 'OFF' at a faster rate that even human eye cannot detect, this will cause the light source to appear to be 'ON' continuously [1].

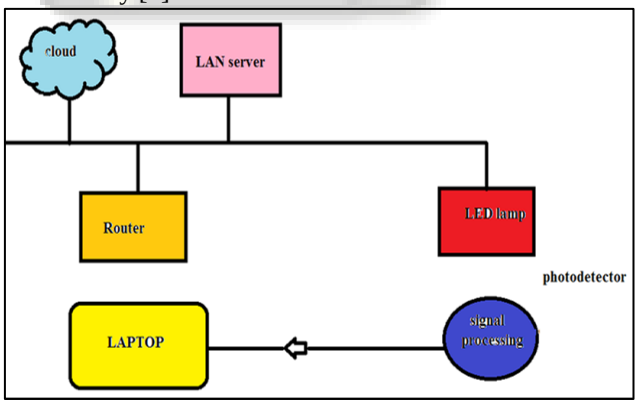

Fig. 1: Architecture of Li-Fi

II. WORKING OF LI-FI

The working of Li-Fi is very easy to understand, In Li-Fi System, there is a light emitter on one end i.e. an LED transmitter, and a photo detector (light sensor) on the other. The data input to the LED transmitter is encoded in to the light (technically referred to as Visible Light Communication) by changing the blinking rate at which the LEDs blink 'ON' and 'OFF' to generate different strings of 1s and 0s. The on- off activity of the LED transmitter which is invisible (Because the LED intensity is modulated very quickly that human eye can't notice, so the light of the LED appears constant to humans), enables data transmission in light form in according to the incoming binary codes: switching ON a LED implies logical '1' is transmitted and switching OFF a LED implies logical '0' is transmitted. By varying the rate at which the LEDs blink 'ON' and 'OFF, the information can be encoded in the light to different combinations of 1s and 0s.

In a typical setup, the transmitter (LED) is connected to the data network (Internet through the modem) and the receiver (photo detector) on the receiving end receives the data as light signal and decodes the information, which is then displayed on the device connected to the receiver. The receiver registers a binary '1' when the transmitter is ON and a binary '0' when the transmitter is OFF. Thus flashing the LED several times or using an array of LEDs (perhaps of a few different colours) will provide data rates in the range of hundreds of Mbps. The Li-Fi working is explained in a block diagram [2] (Fig.2).

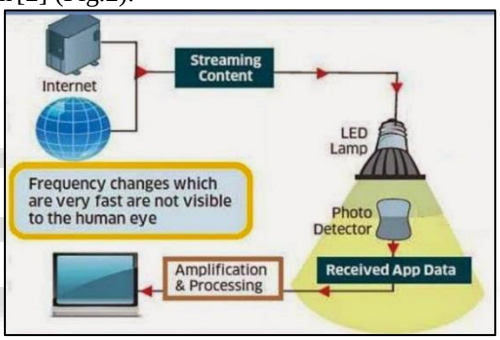

Fig. 2: Block diagram of Li-Fi Sub System

To further get an clear idea of what is said above let us consider an IR remote which sends data stream at rate of 10000-20000 mbps. Now replace the IR LED with a light box containing a large LED array which is capable of sending thousands of such streams at very fast rate. LEDs are found in traffic and street lights, car brake lights, remote control units and countless other applications. So visible light communication not only solves the problem related to lack of spectrum space but also enable novel application because this spectrum is unused and not regulated thus can be used for communication at very high speeds. This method of using rapid pulses of light to transmit information wirelessly, technically referred to as Visible light Communication (VLC) has a potential to compete with Wi-Fi and hence inspired the characterization of Li-Fi[1].

III. ADVANTAGES AND DISADVANTAGES OF LI-FI

Although Li-Fi is a blessing to fulfill today's ever increasing demands but still this blessing have some drawbacks. In this section we will discuss its advantages and disadvantages.

A. Advantages of Li-Fi

In Li-Fi technology, communication takes place through LEDs and other light sources, which makes overall system of low cost.

The transmission of data can be done by using all kinds of light, it is not dependent on the spectrum that they exist [3].

1) Capacity

Light has10000 times broad bandwidth than radio waves. Also light source are formerly connected.

2) Efficiency

Data transmission in Li-Fi is very cheap as LEDs are used. Light absorb less and are highly efficient.

3) Availability

Availability is not a concern as Light sources are available in every direction. To implement Li-Fi, the existing light sources i.e. bulbs need to be replaced with LEDs for effectual transmission of data.

4) Security

As light waves do not access through walls so they cannot be blocked and misused.

B. Disadvantages of Li-Fi

- It is a unidirectional network which allows only downloading but no uploading from the connected device [4].
- The Light can't access through walls and has a fixed field of process [4].
- Other light sources except used in Li-Fi architecture like LEDs, can restrict the speed of data transmission.
- Just particle to particle communication is available.
- This works only with Horizontal/ direct line of view [5].

IV. APPLICATIONS OF LI-FI

There are numerous applications of Li-Fi technology, from public Internet access through existing lighting (LED) to auto-piloted cars that communicate through their headlights (LED based). Applications of Li-Fi can extend in areas where the Wi-Fi technology lacks its presence like aircrafts and hospitals (operation theatres), power plants and various other areas, where electromagnetic (Radio) interference is of great concern for safety and security of equipments and people. Since Li-Fi uses just the light, it can be used safely in such locations or areas. In future with the Li-Fi enhancement all the street lamps can be transformed to Li-Fi connecting points to transfer data. As a result of it, it will be possible to access internet at any public place and street.

Some of the future applications of Li-Fi could be as follows:

1) Education systems: Due to the high speed of LI-FI, it can replace WI-FI in educational institutions as well as in companies. By implementing Li-Fi, all the people of that area can make use of internet with the same speed as it is intended for that particular area[6].
2) Medical Applications: Operation theatres (OTs) do not allow Wi-Fi due to radiation concerns. Usage of Wi-Fi at hospitals interferes/blocks the signals for monitoring equipments. So, it may have hazardous effect to the patient's health, due to improper working of medical apparatus. To overcome this and to make OT tech savvy Li-Fi can be used to access internet and also to control medical equipments [7]. This will be beneficial for conducting robotic surgeries and other automated procedures.
3) Cheaper Internet in Aircrafts: The passengers travelling in aircrafts get access to low speed Internet that too at a very high price. Also Wi-Fi is not used because it may interfere with the navigational systems of the pilots [8]. 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.
4) Underwater communication: Radio waves are quickly absorbed in water, preventing underwater radio communications, but light can penetrate for large distances. Therefore, Li-Fi can enable communication from diver to diver, diver to mini-sub, diver to drilling rig etc. [9].
5) Disaster management: Li-Fi can be powerful means of communication in times of earthquakes [10]. Li-Fi bulbs could provide economic high speed Web access to every street corner.
6) Applications in sensitive areas: Power plants need fast, inter-connected data systems so that grid integrity and core temperature (in case of nuclear power plants) can be monitored [11]. The Radio communication interference is considered to be bad for such sensitive areas surrounding these power plants. Li-Fi can offer safe, abundant connectivity for all areas of these sensitive locations. Also, the pressure on a power plant's own reserves will be lessened.
7) Traffic management: In traffic signals Li-Fi can be used to communicate with passing vehicles (through the LED lights of the cars etc) which can prove beneficial in managing the traffic and can also help in reducing the accidents numbers [12]. Also, LED car lights can alert drivers when other vehicles are too close
8) Mobile Connectivity: Mobiles, laptops, tablets, and other smart phones can easily connect with each other [13]. The short-range network of Li-Fi can yield exceptionally high data rates and higher security.

V. CONCLUSION

This paper provides a complete knowledge of what Li-Fi technology is, how it works and related advantages & disadvantages of the system. The possibilities are numerous and can be explored further. If this technology can be put into practical then every bulb can be used something like WI-FI hotspot to transmit wireless data and which will proceed towards the cleaner, greener, safer and bright future.

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