

Li-Fi (Light Fidelity) - An Overview to future Wireless technology in Field of Data Communication

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Abstract – The new member of wireless data transmission family is Li-Fi which uses the concept of flickering light faster than human's eye ability for data transmission. As we know speed of light is much more than existing wireless data transmission technique, it is like to achieve speed of fiber optics in wireless communication .Another major concern is security because visible (Visible light) is more secure than invisible (radio waves).we are using light because radio/microwave/ Infrared red techniques have reached the limit same as silicon age is over and we are looking for broader range i.e. nanotechnology. The idea of Li-Fi came out from the mind of Dr. Harald Haas who has been working in this field from 2004 and finally in 2011 he demonstrated of sending video by LED light lamp at speed of 10 Mb/s.

Dr. Gordan, Prof. Harald and Dr. Mostafa from university of Edinburgh named this technique Visible Light Communication (VLC).Li-Fi is now part of VLC PAN IEEE 802.15.7 standard [4].

Index Terms – VLC (Visible Light Communication), LED (Light-emitting diode).

1. INTRODUCTION

In this digital era, we are living in portable and high speed gadget's world. So we need higher spectrum for wireless communication because existing is reaching to limit. Researchers are using Visible Light Spectrum range between 400 THz (780 nm) to 800 THz (375 nm) as for transmission of data because that is untouched yet. We can achieve data rate of more than 1 GB/s using Li-Fi instead of 54-600 megabits per second (Mbps) of Wi-Fi which is must for today's High Definition Digital world [2]. The sending and receiving is simple as we use transceiver-fitted LED lamps for both purposes with ordinary lightening room property but in Wi-Fi we use modems for only data transmission.



Figure 1: Dr. Harald Haas

The main reason to choose light is because of harmless biological and environment effect and widely available as an infrastructure, globally. This technique use conventional binary method of 0 and 1 of data transmission by manipulating light intensity that is beyond the human capability to see.

Teams at the University of Oxford and the University of Edinburgh are focusing on parallel data transmission using parallel formation of LEDs, where individual LED acts as an independent data source. Other groups are using color scheme of computer system that is RGB (red, green and blue) LEDs by which we can be combined these colors to make any color of visible spectrum to get different frequency of visible light, with each frequency encoding a different data channel we can get [1].



Figure 2: Visible Light Communication

The table shows comparison between current and future wireless technologies:

Technology	Data Rate	Reach	Security	Market Maturity
Wireless (current)				
Wi-Fi-IEEE(802.11n)	150Mb/s	Excellent	Good	Adopted
Bluetooth	3Mb/s	Good	Good	Adopted
IRDA	4Mb/s	Good	Good	Outdated

Wireless (future)				
WiGig	7Gb/s	Excellent	Good	Not Fully Adopted
Giga-IR	1Gb/s	Good	Good	Not Fully Adopted
Li-Fi	>1Gb/s	Excellent (As long as we see light)	Excellent	Not Fully Adopted

Table 1 : Comparisons between Current and Future Wireless Transmission technologies

2. SIMPLE ARCHITECTURE OF VLC (VISIBLE LIGHT COMMUNICATION) SYSTEM

The Li-Fi emitter system is made up from four primary parts:

- Bulb
- Radio Frequency power amplifier circuit (Power Amplifier)
- Printed circuit board (PCB)
- Enclosure

The PCB controls the electrical signals of the lamp and microcontroller is used to control the function of lamp. A RF (Radio-Frequency) signal is generated by Power Amplifier and send into an electric field about the bulb. That changes the state of contents of the bulb to a plasma state to the bulb's center; this generates an intense source of light. All of these parts are contained in an aluminum enclosure (as shown in figure) [8].

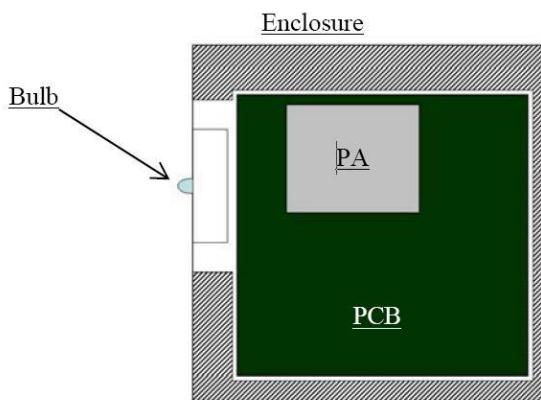


Figure 3: Li-Fi emitter system

The construction of lightning system consists of a bulb in a dielectric material. That (dielectric material) serves two purposes: It acts as a waveguide for the RF energy transmitted by the PA and it also acts as an electric field concentrator that focuses energy to heat the material in bulb to illuminate. [9]

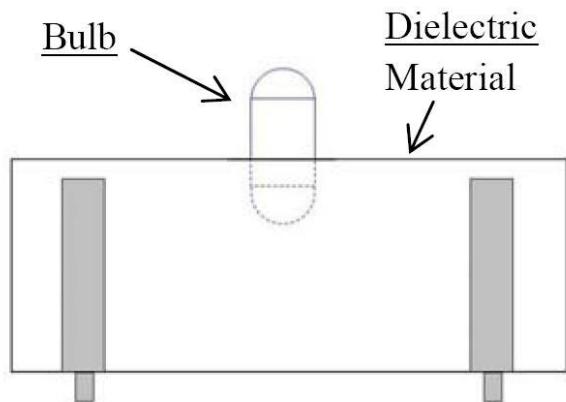


Figure 3: Lightning System

3. WORKING OF VLC (VISIBLE LIGHT COMMUNICATION)

As we know wired network which uses light is working efficiently called Fiber Optics. So our next step is Wireless communication using light which is demonstrated by Prof. Harald Haas. Basic components required for data transmission are:

- Source of light e.g. LED as a source of Data Transmission.
- Silicon photo diode which is visible wavelength region friendly material act as receiving element.

The idea behind concept is very simple like if LED is on which means 1 and 0 means LED is in off state. The LED's can be switched on and off very quickly faster than the reaction rate of human eye, which gives nice opportunities for transmitting strings of logical 0 and logical 1(data in the form of binary code). So what we require at all are some LEDs that act as source of light and a controller that code data into those LEDs in the form of Binary Code. We just have to vary the flickering rate of LED's depending upon the data stream we want to send. A data rate of more than 100 Mbps can be achieved by using array of LEDs with appropriate multiplexing techniques. An overhead lamp fitted with an LED with signal processing technology act as a source, streams data embedded in its beam at ultra-high speeds to the photo detector (receiver). A dongle connected to photo detector that converts the tiny changes in amplitude into an electrical signal. Next Stage is analog to digital conversion and then transmitted the Digital data to a computer and other Digital devices [3].The block diagram below simply represents the working of VLC:

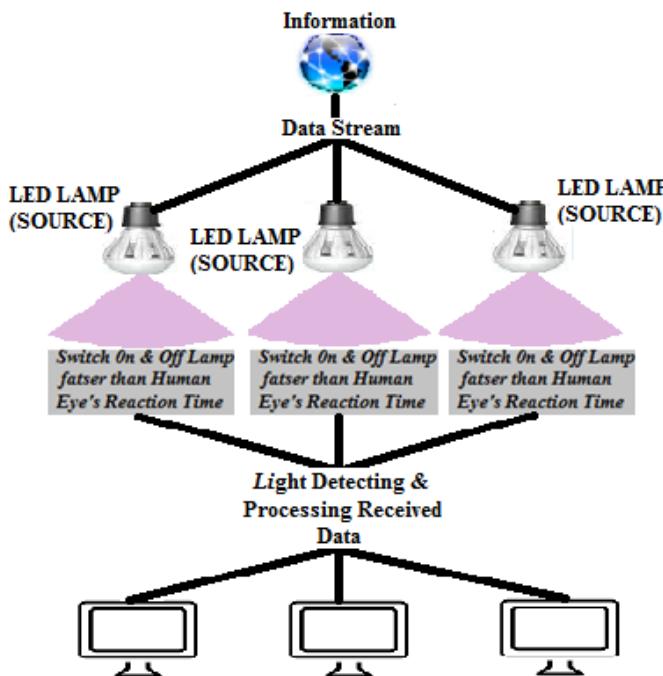


Figure 2: TOP-DOWN Working model of Li-Fi technology

4. APPLICATION OF LI-FI

4.1 Healthcare Field

For a long time, medical technology has lagged behind the rest of the wireless world because radio waves are harmful in operating rooms and also can make interference with medical and other important equipment in hospitals. One solution is Li-Fi Technology which has larger spectrum than Wi-Fi and also harmless and can use existing Light infrastructure.

4.2 Aviation Industry

We all know about Flight-mode in our mobile phones that temporarily switch off our phones because radio waves can interfere with plane's radio waves used for communication but Li-Fi is more reliable and faster than Wi-Fi used in Aeronautical and Aerospace Industry by using reading lamps.

4.3. Chemical Industry

As we know frequencies can be harmful in chemical or petrochemical industries but Li-Fi is transmission technique based on visible light which is used in every industry. So only secure alternate is Li-Fi for transmission.

4.4. More Secure

Radio waves are invisible, so thing that is not visible is difficult to secure. But in Li-Fi, if light is visible then you are online. So Li-Fi is more secure than any other Wireless technology because we know the territory of our network.

4.5 Office and Institute Use

We are presently using Wi-Fi in office and education institute for data transmission and internet access, which is limited in bandwidth. Now we can change this with Li-Fi by using existing Lightening system with little changes and communicate at speed of light without worrying about bandwidth.

5. CONCLUSION

The possibilities are numerous and technology is in its initial stage. We can use existing lightning infrastructure only replacing ordinary bulb with Li-Fi enabled LEDs and each one can act as a Wi-Fi hot spot. As the numbers of user are growing day by day, one day will come when existing Wi-Fi spectrum over same as example of IPv4 and IPv6. Visible light has 10000 times more spectrum space than spectrum of Wi-Fi. So we can use Li-Fi in each and every scenario without worry of spectrum shortage and also where we can't use Wi-Fi connection e.g. hospitals. One of the disadvantages is that it only works in direct line of sight.

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