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Li-Fi : Future of Wireless Comunication

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ABSTRACT : Now a day's Wi-Fi is widely used in all the private as well as public areas like home, cafes, hotels, airports. Due to this radio frequency is getting blocked day by day, at the same time usage of wireless data is increasing exponentially every year. Everyone is interested to use wireless data but the capacity is going down. Wireless radio frequencies are getting higher complexities are increasing and RF interferences continue to grow. In order to overcome this problem in future, light –fidelity (Li-Fi) technology came into existence since 2011. Li-Fi is well-defined as the networked, mobile, high-speed VLC solution for wireless communications. It is the same idea band behind infrared remote controls but far more powerful. With this invention can produce data rates faster than 10 megabits per second, which is speedier than your average broadband connection. Li-Fi is distinguished as new ground-breaking technology which aims to provide ubiquitous wireless access for indoor communications, or indeed any, illuminated area. We envision a future where data for laptops, smart phones, and tablets transmitted through the light in a room. Moreover, security would be snap if you cannot see the light, you cannot access the data.

Keywords- Light-Fidelity (Li-Fi), Visible Light Communication (VLC) OSI, Reference Model for VLC, Transmitting and Receiving Element, VLC data flow, Wi-Fi and working of Li-Fi.

I. INTRODUCTION

Li-Fi is a wireless communication system in which light is used as a carrier signal instead of traditional radio frequency as in Wi-Fi. Li-Fi is a technology that uses light emitting diodes to transmit data wirelessly. In other words we can say Li-Fi is a label for wireless communication system which is used to describe visible light communication technology applied to high speed wireless communication. It acquired this name due to similarity to Wi-Fi, using light instead of radio waves. Li-Fi technology uses VLC (Visible light communication). It is similar to Wi-Fi technology with RF communication. So we can say Li-Fi is the optical version of Wi-Fi. The term Li-Fi was first coined by Harald Haas, a German physicist. Li-Fi operates in the range of terahertz and it is free from the spectrum license. LI-FI is implemented using white LED light bulbs which used for illumination by applying a constant current. However the light output can be made to vary at extremely high speeds by fast variations of the current. If the LED is on, it transmits a digital 1otherwise it transmits a digital 0. The LEDs can be switched on and off quickly to transmit the data that can't be detected by a human eye, so the output appears constant.There are also some enhancement could be made, like using an array of LEDs for parallel transmission, or using amalgamation of basic three color's i.e., red, green and blue LEDs as different frequency with each having a different data channel. To further get a grasp of LI-FI consider an IR remote. It sends a single data stream with 10-20 kbps speed. Now if we replace the IR LED with a large LED array then that can be capable of sending thousands of such streams at a very fast rate.

Fig.1: LED Lamp

II.VISIBLE LIGHT COMMUNICATION (VLC)

Li-Fi is a fast and cheap version of Wi-Fi, which is based on visible light communication. VLC is the possible solution to the Global Wireless spectrum shortage. Photo phone was the first experiment of VLC done by Graham Bell in 1880. VLC is a data communication medium using visible light as carrier between 400 THz (780 nm) and 800 THz (375nm) as optical carrier for data transmission and illumination. It is one of the parts of optical wireless communication (OWC). Optical communication becomes cost effective because of the use of light which if freely available everywhere.

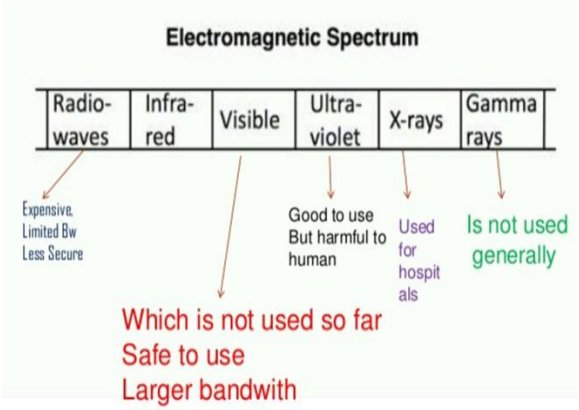


Fig.2 Visible spectrum of light

Light is the source of life. So there has no health hazard. Complexity and cost of VLC is very low as compared to RF communication. VLC provides efficient way of communication due LED which require negligible power and less complexity. It is inexpensive because of the use of already available visible light sources. VLC is very secure because VLC signal is defined closely to lightning area i.e. line of sight communication and other is signals cannot be transmitted through solid things like walls.

A)Reference Model for VLC communication:

For any communication the two basic parts are sender and receiver. A LED bulb is used for sending data as sender. The sender signal is controlled either by fast ON/OFF switching of LED or by color of light. This flickering is not good for eye safety; hence a dimming scheme LED illumination or modulation is used control brightness. The photo diode is used as a receiver to detect this signal. Following fig. 3 shows open system interconnection (OSI) model for VLC.

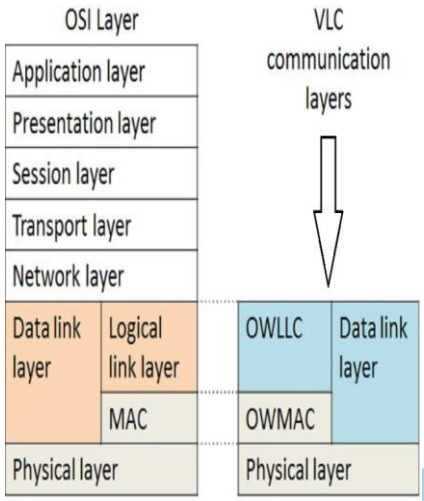


Fig. 3 OSI reference model for VLC communication

The OSI model is the primary architecture model for networks. It describes how data and network information are communicated from an application on one computer through the network media. The vital layers in VLC OSI model is Physical Layer (PHY) and Data Link Layer (DLL). These are important for sending and receiving the light signal. The Media Access Control (MAC) and Physical layers are same for both transmitter and receiver part. The OSI layers for VLC are described as given below:

The Physical Layer:

Physical layer defines the electrical and physical specifications of hardware used. In VLC this layer functions same as in the OSI model. The communication on Physical layer is done with small units of data called as packets. According to the data rates the physical layer is categorized as,

PHY 1: It is low data rate (12 to 267 kbps) physical layer. It is used for outdoor operation.

PHY 2: It have moderate data rate of 1.25 to 96 Mbps. It is used for indoor applications.

PHY 3: It is with high data rate of 12 to 96 Mbps. It is used for lightning sources and detectors.

The Data Link Layer:

This layer uses the services of physical layer to send and receive data bits over communication channel. According to the architecture used in IEEE 802.15.7 project this layer is divided into two sub-layers as given below:

1.) Optical Wireless Logic Link Control (OWLLC):

It confirms and controls the logical links between devices on a network. With DLL it allows the interconnection of other technologies and provides services to network layer.

2.) Optical Wireless Media Access Control (OWMAC):

The media of communication may be simplex, half duplex or full duplex, OWMAC confirms the control over it. With the use of OWMAC protocol working terminals and connected devices are controlled.

B) Transmitting Element and Receiving Element:

Elements which are used for transmission purpose in VLC are visible light LED and fluorescent lamp can also be used. But when fluorescent lamp will be used the transmitting speed will be very slow so it's not a good idea to use. LED light intensity is modulated by controlling its current. The technology uses fluorescent lamps to transmit signals at 10bit/s, or LED's for up to 500 Mbit/s. Here we should note that fluorescent lamp can't be used. Because fluorescent lamp will not give say like a LED which can be used for transmission of data.

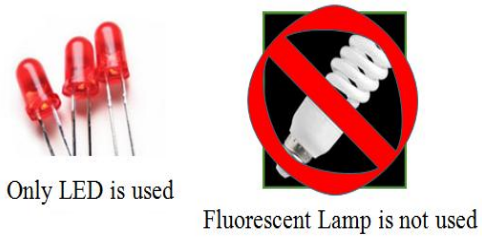
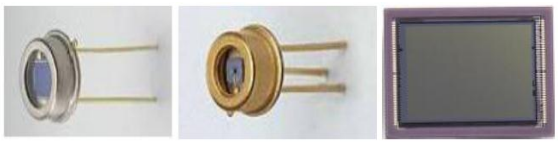


Fig. 4: Transmitting Element LED Light

For reception purpose in visible light communication are pin photodiode, Avalanche photodiode and Image sensor as shown in figure 5. Pin photodiode is used for high speed reception up to 1Gbps. In case of very sensitive reception avalanche photodiode will be used and Image sensor will be used for simultaneous image acquisition and data reception.



(a) Pin photo diode (b) Avalanche photodiode (c) Image sensor

Fig.5 Photodiode and Image Sensor

C) Flow of Data in VLC

Visible light communication is a data communication medium using visible light as carrier. It is one of the parts of optical wireless communication (OWC). Optical communication becomes cost effective because of the use of light which if freely available everywhere. The visible light communication is done with LED. As shown in fig. 6, the intensity of light is modulated such that a human eye can't follow it. A light detector with interference prevention from other source is used. It is acting as receiver which can demodulate the light signal into electronic signal. It difference from infrared (IR) and ultra violet (UV) as light used for lightning is also used for communication. Visible light is constant beam of photons emitted from light source when constant current is applied. When the current varied at

very high speed, light output varies accordingly which is detected by photo detector. These variations in light are impossible to follow by human eyes. Hence we feel constant lightning from light source. VLC is much simpler than complex RF communication like IR, which is limited in power because of its hazardous effects.

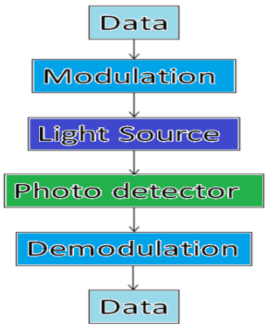


Fig. 6 VLC data flow

III WORKING OF THE LI FI SYSTEM

As in Li-Fi LED Bulb is used which is able to transmit data from one device to another using transmitting and receiving element so a Li-Fi network will be establishing in a localized environment. The system block diagram to be used for Li-Fi system is shown in Fig.7.

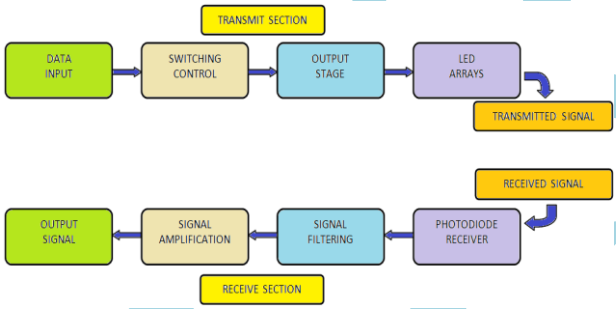


Fig.7 System Block Diagram

The system architecture consists of a transmit section and a receive section. Working of the Light Fidelity system can be understood easily using above block diagram. The transmit section consists of the data input which is then fed into a switching control system. Based on the data, the switching control generates a stream of 1s and 0s thereby encoding the data in binary. The output of this control is given to the array of LEDs which turn OFF and ON at extremely high speeds. This ON-OFF modulation of the LED light transmits the data. LED is the choice for light source since it consumes very less power when compared to fluorescent lamp or a light bulb. It consumes about one-tenth the power when compared to conventional methods of lighting

Also, the lifetime of a typical LED bulb is several tens of thousands of hours. LEDs are also fast switching with good visibility. Thus, LEDs are ideal for use as the downlink transmitter. For the uplink transmitters, Infrared (IR) can be chosen to be the uplink transmitter for user convenience. This avoids fitting an LED light source on or next to the mobile devices. The receive section consists of a photodiode, e.g. silicon photo detector, pin photodiode or an Infrared germanium cylindrical detector. The photo detector demodulates the incoming received signal based on the sequence of 1s and 0s. The demodulated signal is then sent to a filter to remove unwanted noise. This filtered signal is then amplified using signal amplification mechanism. The filtered and amplified signal is then given to an output device such as an LCD display or a speaker.

IV CHALLENGES FOR LI-FI

As Li-Fi has many advantages over Wi-Fi but Li-Fi technology is facing some challenges. One of these shortcomings is that it works in direct line of sight and hope it can be sorted out someday.. Another challenge is how the receiving device will transmit to the transmitting device. One cannot shift the receiving device in case of indoor arrangement of the apparatus as light cannot penetrate through walls and is easily blocked by somebody simply walking in front of LED source. There has been a lot of early hype, and there are some very good applications.

V COMPARISON OF TECHNOLOGIES

Li-Fi technology is based on LEDs for the transfer of data.

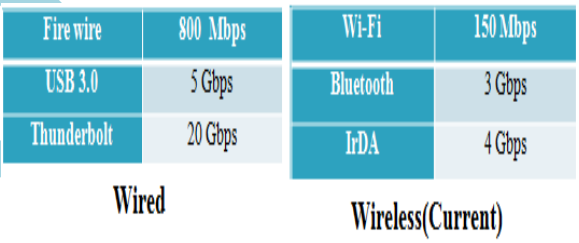


Fig.8 Currently technologies

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 internet is incredibly high and you can download movies, games, music etc in just a few minutes with the help of this technology. Here in figure 8 is shown that technology we are using currently.

Fig.9 Future of wireless with speed

This technology removes limitations that have been put on the user by the Wi-Fi. You no more need to be in a region that is Wi-Fi enabled to have access to the internet. You can simply stand under any form of light and surf the internet as the connection is made in case of any light presence. There

cannot be anything better than this technology. In figure 8 shown that in future we will use this wireless technology.

VI BENEFITS AND APPLICATION OF LI FI

- Higher speeds than Wi-Fi, as high as 500mbps to 30GB per minute.
- Li- Fi uses light rather than radio frequency signals and 10000 times the frequency spectrum of radio.
- More secure because data cannot be intercepted without a clear line of sight.
- Instant start-time.
- Does not create interference in sensitive electronics.
- Better for use in environments like hospitals and aircraft.
- This technology could enable greater area of coverage than a single Wi-Fi router
- Security is another benefit, he points out, since light does not penetrate through walls.
- VLC could be used safely in aircraft
- Integrated into medical devices and in hospitals as this technology does not deal with radio waves, so it can easily be used in such places where Bluetooth, infrared, Wi-Fi and internet are banned. In this way, it will be most helpful transferring medium for us.
- Under water in sea Wi-Fi does not work at.
- There are around 19 billion bulbs worldwide, they just need to be replaced with LED ones that transmit data. We reckon VLC is at a factor of ten, cheaper than WI-FI.
- In streets for traffic control. Cars have LED based headlights, LED based backlights, and Car can communicate each other and prevent accidents in the way that they exchange Information. Traffic light can communicate to the car and so on.
- By implementing the Technology worldwide every street lamp would be a free access point.
- Li-Fi may solve issues such as the shortage of radio frequency bandwidth.

VII.CONCLUSION

Li-Fi is certainly not useless, but it has certain inherent limits for the technology. The possibilities are numerous and can be explored further. If his 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 currently attracting a great deal of interest, not least because it may offer a genuine and very efficient alternative to radio-based wireless. As a growing number of people and their many devices access wireless internet, the airwaves are becoming increasingly clogged, making it more and more difficult to get a reliable, high-speed signal. This may solve issues such as the shortage of radio- frequency bandwidth and also allow internet where traditional radio based wireless isn't allowed such as aircraft or hospitals. One of the shortcomings however is that it only work in direct line of sight. LI-FI may solve issues such as the shortage of radio-frequency bandwidth and is aimed at creating new communication channels with the use of existing equipment.

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