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Recent Encroachment In Optical Fiber Communication- Visible Light Communication (LI-FI)

Amritpal Kaur
Assistant Professor
Guru Nanak Dev University, Regional Campus, Gurdaspur
dultamrit@gmail.com

***Abstract*: Visible Light Communication (VLC) has been in existence for centuries. Practical use of visible light as a stand-alone transmission media, however, was made possible with the advent of light emitting diodes used for lighting purposes. White-light and other visible LEDs are used in visible light communication. White LED is deemed to be the new candidate for next generation high efficiency/brightness lighting device with power consumption reduced to less than 80%. They replaced high energy consuming light bulbs in private and business homes and even in street lamps.**

***Keywords*:** Visible light communication, Li-Fi, Wi-Fi, RGB

I. INTRODUCTION

Visible light is the form in which electromagnetic radiation with wavelengths in a scrupulous range is interpreted by the human brain.

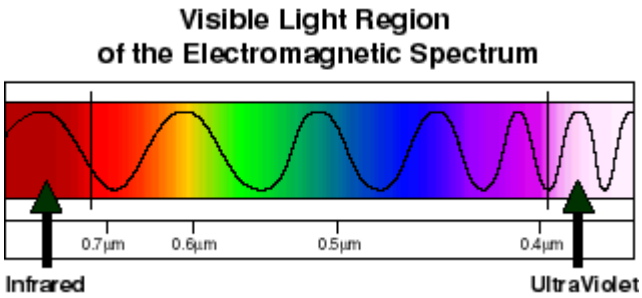

Fig.1: Visible light spectrum

At the lower end of the spectrum there are violet-bluish tones and light at the other end of the spectrum is interpreted to be distinctly red.
Currently there is rapid development in the field of lighting and illumination.VLC technology is one of the advanced optical wireless communication technologies, in which light in the visible region (380nm-750nm) is used as a medium for data transmission and is more secure and achieves high data rates as compared to conventional wireless technologies like Wi-Fi, Bluetooth, Wimax etc., which use radio waves for communication. Till late 1990s infrared spectrum is used for the communication. But in the early 2000s, researches started using visible light from LEDs as the medium for communication. Initially they were able to achieve network speed about 100Kbps. With continuous developments, VLC systems can now achieve about 800Mbps data rate for short range communications. In the 21th century, high speed data transmission will play an important role in our daily life. Li-Fi is the term some have used to label the fast and cheap wireless-communication system, which is the optical version of Wi-Fi. The term was first used in this context by Harald Haas in his TED Global talk on Visible Light Communication. The technology was demonstrated at the 2012 Consumer Electronics Show in Las Vegas using a pair of Casio smart phones to exchange data using light of varying intensity given off from their screens, detectable at a distance of up to ten meters. In today's life we use multimedia services. Practical use of visible light as a stand-alone transmission media, however, was made possible with the advent of light emitting diodes used for lighting purposes. Visible light communication makes use of white LEDs offers the following advantages:

• White LEDs are currently penetrating many areas of our day by day life. They are envisaged to replace high energy consuming light bulbs in private and business homes and even in street lamps. Moreover, they can be used in headlights of planes and trains, front and back lights in cars and trains. • Bandwidth is not limited. •Transmitters and receivers devices are inexpensive, and there is no need for classy RF units. • As light waves do not penetrated opaque objects, they cannot be eavesdropped. It is very intricate for an impostor to (covertly) pick up the signal from exterior the room. •Visible light radiations are undoubtedly free of any health concerns. Therefore, these systems can use in hospitals, private homes, etc.

As a consequence, white LEDs have started to attract attention for use as a data communication means [1]. In addition, white LEDs can offer very high brightness, very low power consumptions and long lifetime. Therefore, a unique feature of white LEDs is that they can serve two purposes at the same time: lighting and high speed wireless data transmission. Adding up, contrasting infrared

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transmission, there are no health convention to restrict the transmit power. Most VLC systems are based on modulating LED's using various schemes.

II. TYPES OF LEDS USED IN VLC

There are two types of LEDs being considered for use today. The first type of LED is called"quasi-white" LED. This type of LED is a blue LED that has had the correct phosphor added to its structure to add a yellow module to the light, resulting in near white light. With correct implementation of the LED design, higher bandwidths can be achieved that are not only apposite for ambient lighting, but can also be modulated at speeds required for network connections.

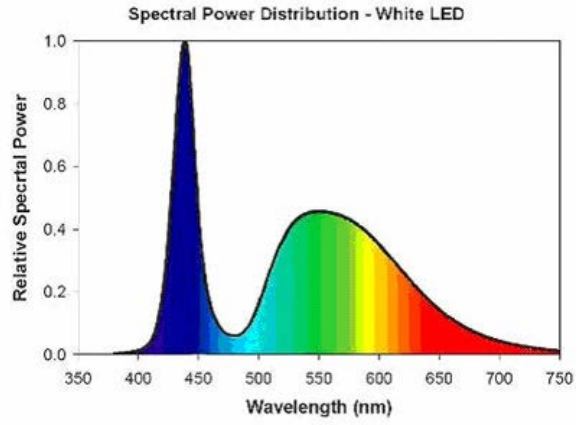

Fig. 2: Relative Spectral Power of Quasi-White LED. Source

A second type of LED is referred to as a RGB LED. RGB stands for RED, GREEN, and BLUE and can theoretically offer higher bandwidth than a quasi-white. It is, however, more expensive than the quasi-white adaptation of LED. As it has three separate spectral distributions, it also could be used in concurrence with WDM modulation schemes, resulting in a privileged bandwidth.

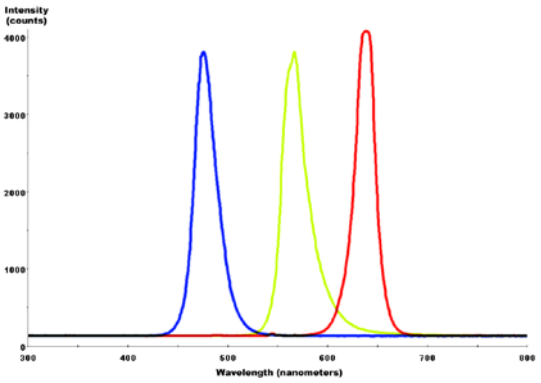

Fig. 3: Relative Spectral Power of RGB LED

Either of these LED technologies can be used to put into operation a VLC system.

III. VLC APPLICATIONS

VLC has potential applications in a number of areas.

III. a. Visual Signaling and communication

Colored signal lights are widely used in marine, automotive and other applications. In this case the color provides a signal to the observer, such as 'red for danger and augmenting this with data communications might improve safety and other aspects of traffic management. Due to their reliability, LEDs are used in these applications, and there have been several demonstrations of data transmission by modulation of these sources. In [2] data is transmitted from a traffic signal to a car, and in [3] a scheme for parallel communication is presented. An EU research project [4] examined car-to-car communication using white-light headlights.

III. b. Visible light information broadcast system

Information of products at a supermarket is obtained by a visible light receiver that is installed in a shopping cart.

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Fig. 4: Visible light communication system

III. c. Three dimensional position measuring system using visible light communication [5]

Objects can be measured by receiving and detecting the direction of visible light signal with an image sensor. The error of position for a 100 meter object such as a bridge in the photo is about 5mm.

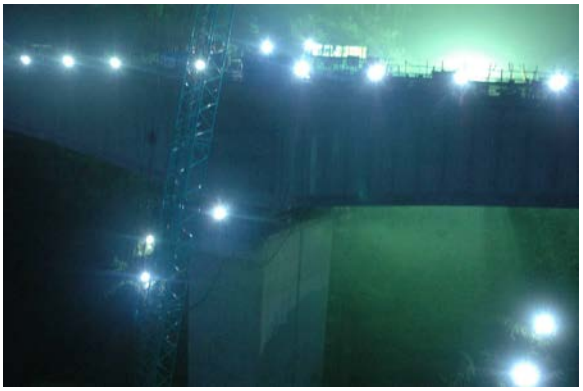

Fig.5: LED lights attached to a highway bridge under construction

When an object in located in the 40 meter by 40 meter area, this technology is able to measure three-dimensional position of the object in several millimeter accuracy.

IV. Features and Value of VLC Systems

VLC systems have several features which can make them worthy of consideration for next generation communication systems.

1. Not affected by EMI – the systems can work where Wi-Fi cannot.
2. Secure – Signals cannot pass through walls making rooms or buildings completely immune from unauthorized signal reception.
3. None of the health risks associated with Wi-Fi or laser based systems – Since they do not rely on
the part of the electromagnetic spectrum that has, in some studies, shown an adverse effect on human health, they are completely safe to humans in any system.
4. These systems can be designed to operate with existing Wi-Fi infrastructure.
5. The available bandwidth is well in excess of that available in RF systems, on the order of 100 THz
6. With proper design, VLC can provide one-way communication to mobile platforms and handheld devices.

V. VLC Links

A VLC link consists of a transmitter, the propagation channel and a receiver. Each of these is described in the following sections.

V. a. Sources

White-light LEDs either use red, green and blue LEDs that mix to provide the desired color, or a single LED (usually blue) that excites a yellow phosphor to create an overall white emission. The 'triplet' approach allows the color to be altered by varying the color to the LEDs, and allows different data to be sent on each device. However, maintaining color balance can be challenging and the devices are complex.

V. b. The VLC channel

A communication terminal might be placed on a desk anywhere within the room, and a channel exists between the lights and the terminal. The channel consists of a number of line of sight paths from the units to the terminal, together with a diffuse channel formed by the light from the source reflecting off multiple surfaces within the room.

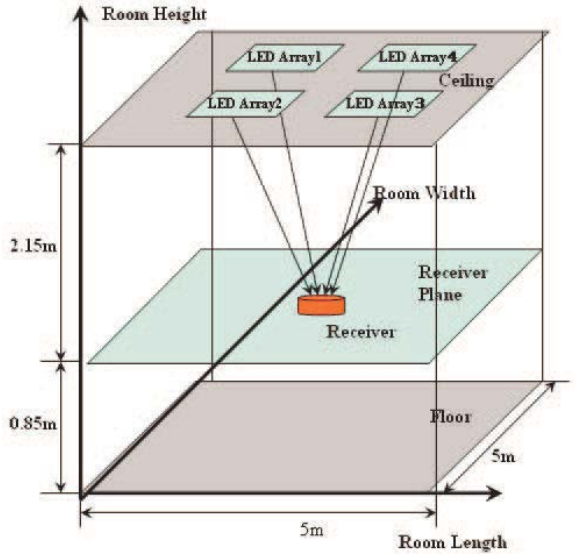

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Fig.6: Typical VLC indoor lighting configuration

V. c. Receiver

The receiver consists of an optical element to collect and concentrate the radiation onto the receiver photodetector. This converts the radiation into photocurrent, which is then pre- and post-amplified before data recovery. The most common choice of receivers are photodiodes which turn light into electrical pulses. The signal retrieved in this way can then be demodulated into actual data.

V . d. MODULATION

In order to actually send out data via LEDs, such as pictures or audio files, it is necessary to modulate these into a carrier signal. In the context of visible light communication, this carrier signal consists of light pulses sent out in short intervals. .First type of modulation scheme that is used is called subcarrier pulse position modulation. The second modulation scheme to be used is called frequency shift keying referred to as FSK.

VI. WHERE DOES THIS TECHNOLOGY ROBUST

VLC technology is protocol agnostic. It can be deployed in any number of physical implementations. The simplest way to think of how VLC is used is to simply replace the standard "Wi-Fi" transmitting modem with a LED. The LED serves as the transmission "antenna" and the optical receiver serves as the receiving antenna. In typical office settings, the standard lighting infrastructure is comprised of rows of fluorescent light fixtures set at various intervals. LED lighting is clearly the next wave in room lighting for several reasons. LED's are more proficient, saving electricity, using 6 to 10 times less energy for the same light output. They also last longer than the either fluorescent lights. The typical lifespan of LED lighting is about 6 times longer than fluorescent lights. as designers and architects move toward inclusion of LED lighting in the infrastructures of new buildings, they will have the opportunity to include networking infrastructure as part of the lighting system. This presents the building owner with several advantages arising from the selection of VLC technology including increased security, the ability to connect anywhere in the building and a lower potential impact on the health of employees in the offices.

VII. CONCLUSION

VLC offers the advantage of a communications channel in an unregulated, unlicensed part of the electromagnetic spectrum. In applications where a visible beam is desirable for security it can provide high data rates. There are many applications that can be realized using visible light communication. VLC is a promising technology with a wide field of prospective applications. An ever-growing interest in VLC throughout the world can be expected to lead to real-world applications in the future. In some fields of application it poses a favorable alternative to conventional solutions (infrared, WLAN etc.). The main goals for the future are increasing the transmission rate and improving standardization.

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