"A STUDY OF VISIBLE LIGHT COMMUNICATION SYSTEM"

[1]MISS. SNEHAL VILAS CHAUDHARI
Student, Third Year Of Computer Science & Engineering, Hindi Seva Mandal's Shri. Sant Gadge Baba College of Engineering and Technology, ZTC, Bhusawal- 425203
csnehal89@gmail.com

[2]MISS. LAVINA D. PANJWANI
Assistant Professor, Computer Science & Engineering, Hindi Seva Mandal's Shri. Sant Gadge Baba College of Engineering and Technology, ZTC, Bhusawal- 425203
lavina.no1@gmail.com

ABSTRACT: *The Radio Frequency (RF) communication agonizes from interference and high latency matters. Along with this, RF communication needs a separate arrangement for transmission and reception of RF waves. Overwhelming the above limitations, Visible Light Communication (VLC) is a chosen communication technique because of its high bandwidth and insusceptibility to interference from electromagnetic sources. The rebellion in the field of solid state lighting leads to the replacement of luminous lamps by Light Emitting Diodes (LEDs) which further motivates the usage of VLC.*

Keywords: Radio Frequency, Visible Light Communication, Light Emitting Diodes

1. INTRODUCTION

The restricted radio frequency spectrum puts restrictions on the increasing demand for universal connectivity and high capacity. According to CISCO, there will be an 11-fold increase in mobile data traffic in 2018 compared to 2013. The rise in the number of devices retrieving the mobile networks is the primary reason for the radical increase in mobile data traffic. Along with this, the growth of online social services (such as Face book and Twitter) has further increased the mobile data traffic. Apart from the range lack issues in RF wireless communication, interference is a different problem since most wireless devices are electromagnetic. The RF communication suffers from difficulties such as the following. (a) Interference, according to Federal Aviation Administration (FAA) the use of mobile phones on aircraft effects interfering with communication and directional systems. Along with this, mobile phones on aircraft will also affect disturbance with ground system towers as claimed by the Federal Communication Commission (FCC). (b) Regardless of the interference, it is clear that in a wireless communication system that wants very low potential requirements (such as in vehicular communication, safety system), the use of radio frequency is not proper due to its bandwidth restrictions. (c) As RF waves easily pierce the walls, they agonise from security matters. (d) The increase in RF waves, transmission power beyond a certain boundary results in hazards to human health (e) RF communication suffers from power ineffectiveness because we need a separate system for communication of the RF waves. To overwhelm the disadvantages of the RF communication organizations it is imperative to design new communication technologies.
Visible Light Communication (VLC) systems pay visible light for communication that live in the spectrum from 380 nm to 750 nm consistent to a frequency range of 430 THz to 790 THz. The low bandwidth difficult in RF communication is determined in VLC because of the accessibility of the high bandwidth as illustrated in Fig. 1. The VLC receiver only obtains signals if they exist in in the same room as the transmitter, consequently the receivers outside the room of the VLC source will not be able to obtain the signals and thus, it has the insusceptibility to security problems that happens in the RF communication systems. As a visible light source can be used both for enlightenment and communication, therefore, it protects the extra power that is required in RF communication. Keeping in opinion the above benefits, VLC is one of the capable candidates because of its features of non-licensed channels, large bandwidth and low power depletion.

2. HISTORY OF VISIBLE LIGHT COMMUNICATION SYSTEM

In early times, light was used to transfer messages using approaches such as fire and smoke signals. The Roman used refined metallic plates for sunlight reflection to carry out long distance signaling. Semaphore lines created optical communication (OC) systems were established in the 1790 s. The first pictorial telegraphy system was established by the Claude Chappe in 1792 in France [2]. A sequence of towers (shown in fig.1) armed with semaphores were used for data transmission between the cities. Heliograph, a wireless solar telegraph established by the US military in the later 1800 s was based on Morse code flashes of reflected sunlight by a mirror. The flashes were established by either one disruption of the beam with a shutter or momentary mirror pivot. In 1880, Graham Bell introduced his photo phone that was created on conveying voice signal on a light beam. The voice signal is predicted near a mirror which reasons vibrations on the mirror. The mirror was then bounded by sunlight and thus, the vibrations are caught by the sunlight. At the receiver side the sunlight was received and converted back to a voice signal. The major drawback of this system is that it does not work well in cloudy weather. Optical communication did not achieve much popularity till the development of Light Amplification by Stimulated Release of Radiation (LASER). In 1970, Corning Incorporated positively established optical fibres for profitable purposes with low reduction. The GaAs semiconductor laser was also established at that time for use in optical fibre cables for long distance communication. The creation of the in-fibre Bragg grating (1990) and optical fibre (OF) amplifier (1980) was the basis of the rebellion in the area of telecommunication in the late 20th century. VLC is a type of optical communication that uses the range of frequencies from 430THz to 790 THz. In 2003, the Nakagawa Laboratory at Keio University, Japan, transmission of information was delivered out using LEDs.

Figure 1: Semaphore towers in Nalbach, Germany

3. Architecture of VLC

The two essential parts of the VLC system: the transmitter and receiver usually consist of three common layers. They are the physical layer, MAC layer and application layer. The mention model of the VLC communication system is shown in Fig. 2. There only two layers (such as PHY and MAC) are well-defined for straight forwardness.

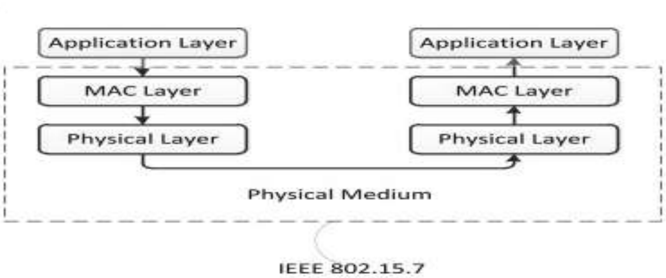

Figure 2: Layered Architecture of VLC

3.1. MAC layer

The chores finished by Medium Access Control (MAC) layer contain:

(1)Mobility support
(2)Dimming support
(3)Visibility support
(4)Security support
(5)Schemes for mitigation of flickering
(6) Colour function support
(7)Network inspirations generation if the device is a coordinator
(8)VPAN disassociation and association support
(9)Providing a dependable link between peer MAC entities

The topologies maintained by the MAC layer are peer-to-peer, broadcast and star. The communication in the star topology is accomplished using a single centralized controller. All the knots interconnect with each other through the centralized supervisor. The part of the coordinator in the peer-to-peer topology is done by one of the two nodes involved in communication with each other.

3.2. Physical layer

The Physical layer offers the physical requirement of the device and also, the bond between the device and the intermediate. Fig.3. shows the block diagram of the general physical layer implementation of the VLC system. First of all, the input bit stream is passed by the network encoder (optional). Linear block codes, Convolutional codes and the state of the art turbo codes can be used to enhance the performance of the VLC system. Then, the network encrypted bit stream is passed through the line encoder to yield the encrypted bit stream. After line encrypting, inflection (such as ON–OFF keying, PPM and PWM, etc.) is performed and finally, the data is fed to the LED for transmission through the optical channel. In, dissimilar implementations of the visible light communication systems are given. In, a full-duplex bi-directional VLC system using RGB LEDs and a commercially available phosphor based LED in downlink and uplink, are planned respectively. Wavelength division multiplexing (WDM) and subcarrier multiplexing (SCM) are used to accomplish the bi-directional communication. Furthermore, orthogonal frequency division multiplexing (OFDM) and Quadrature Amplitude Modulation (QAM) were appointed to rise the data rate. The rapidity of the VLC system in was enlarged to 3.75vGb/s as equated to that in which was 575-Mb/s downlink and 225-Mb/s uplink. At the receiver side, the receiver (such as a silicon photo diode and PIN photodiode) received the optical signal. After demodulation and line decrypting, the bit stream passed through the channel decoder to yield the output bits.

3.3. Transmitter

The growth of LEDs has made the solid state lighting an developing field. LEDs have exceeded the luminous light sources in terms of dependability, power requirements and luminous efficiency. The effectiveness of LEDs is 20lm/W larger than the luminous lamps proficiency. LEDs and Lasers are used as transmission bases for VLC. The LED should be used when both communication and illumination have to be done using a single device. The white light based on LEDs and wavelength converters is one of the attractive applicants for being used as the VLC source. There are different latent spectra in which white light is created by the LEDs. The Tetra-chromatic, dichromatic and tri-chromatic modes used for generation of white light. The furthermost generally used methods for generation of white light using LEDs are trichromatic (such as red, green and blue). The benefit of using an RGB LED for white light generation is the high bandwidth and thus, high data rates. The downside of the RGB LED is their great related complexity and problems in modulation. The appropriate LED is selected based on the channel model.

3.4. Receiver

The classic VLC receiver consists of an extension circuit, optical filter and optical concentrators. The beam deviation that occurs in LEDs due to enlightening large areas results in reduction so the optical concentrator is the device that is used to recompense this type of reduction. In the VLC receiver, the light is sensed using a photodiode and then transformed to photo current. The parameter requirement of the VLC will be different from that of the infrared communication because of the changed wavelengths [6]. The silicon photodiode, PIN diode and avalanche photodiode are used for VLC. The avalanche photodiode has a greater gain than a PIN photodiode but at the expenditure of the high rate. The VLC is susceptible to interfering from other sources such as sunlight and other radiance; therefore, optical filters should be designed to alleviate the DC sound components present in the received signal. In a VLC receiver, the photodiode is normally used for reception of the VLC signals. It is superior to use a photodiode in the case of a stationary receiver; however, the imaging sensor is employed in its place of a photodiode because of the greater FOV in the case of flexibility. Operating imaging sensors is energy expensive and slow. Therefore, a trade-off should be made between the cost, speed and complexity while considering photodiode and imaging sensors.

4. APPLICATIONS OF VLC

VLC communication must be used in underwater communication systems. The Un Tethered Remotely Operated Vehicle (UTROV) is additional application of the VLC inherent features of VLC include greater bandwidth, no health threat, low power consumption and non-licensed channels that made it attractive for practical use. Different applications setups using VLC are as follows:

4.1. Li-Fi:

In 2011, Harald Haas was the first to invent the term Light Fidelity (Li-Fi) [3]. Li-Fi is a high speed bi-directional fully connected, visible light wireless communication system and is equivalent to Wi-Fi, which uses radio frequency for communication. The areas that are penetrating to electromagnetic radiation (such as aircrafts) Li-Fi can be a well solution. A Li-Fi also offers support to the Internet of Things (IoT). A speed up to 10Gbits/s is found using Li-Fi, which is 250 times extra than the speed of super-fast broad band.

4.2. Underwater communication:

RF waves do not travel finely in sea water because o underwater communication. The different works that can be performed using UTROV contain observatory preservation of the oceans and deployment occasion from the ships. Fig. 5 outlines the operation of the UTROV. The right pane displays the communication of the UTROV using the optical channel to a static infrastructure on the sea floor [5]. In the center, the communication is accomplished by UTROV using an optical channel with a ship based convey infrastructure. The left most pane displays the communication of the UTROV using short bandwidth underwater communications

4.3. Visible light ID system:

Visible light can be used as an ID scheme in different places such as houses and subways. For example, if we are standing in room 12 in assured building. A visible light ID system can be working for recognizing the room number and its building. Similarly a visible light ID system can be working in subways, hospitals and airports.

4.4. Wireless local area networks (WLANs):

LED based VLC can be used in setting up LANs. In [4], an ultra-high speed full duplex, LAN based on star topology architecture using LED visible light communication is proposed to offer a speed of more than 10-Gb/s and tested for immense users. The schematic diagram of the high speed LAN[4]. The purpose for the design of the network using a star topology is to offer support for immense users. Fibre is used in connection with each lamp directly. The hybrid contact protocol is used in the offered LAN such as time division multiplexing (TDM) for bidirectional VLC broadcast and frequency division multiplexing (FDM) for uplink and downlink fibre transmissions [6]. The results of the proposed LAN exposed its potential power of proposing high speed access for huge users. In, a 10 Mbps VLC wireless LAN system was planned using white LEDs. The lighting system was used for downlink and infrared light was used for up-link. The VLC wireless LAN has the latent to be used in office buildings and hospitals, which need a high level.

5. ADVANTAGES OF VLC

Visible light communication has numerous advantages: Visible light communication is visible (in compare to invisible radio communication), so it is easy to conclude who can listen to (or receive) a message. Furthermore, light communication did not use electromagnetic waves, and there are environments or societies that may value this feature. A side effect is that light communication does not need portion of the (limited) radio spectrum and can therefore be seen as a appropriate allowance in bandwidth-limited situations. And (visible) light is present in many places, so there is the chance to combine light communication with lighting design to let Visible Light Communication(VLC) co-exist with(or even benefit from)the lighting format present in many offices, homes, or organizations [7]. The VLC principle is a moderately new approach for optical free space uses. However, it has been so distant considered mainly for Internet access or home grids, but more imaginative use cases are achievable. For example, VLC can be employed for toy cars or may permit a magic stick to control light effects on a dress [1], [2].

6. CONCLUSION

In this rapidly developing world of data communication, VLC presents a steady, easy and a faster technique of data communication. VLC takes a different method as related to other forms of data communications by using light which is obtainable richly everywhere and makes use light's two most straightforward and most effective properties its speed and reach. Though the VLC still in its primeval stages of development, it can revolutionise the data communication field, if it's potential is efficiently selected. With dramatic growth in LED technology and rare spectrum resources, there has been a rising interest in VLC, which can be named as a positive step in this direction. But to progress in this technology convinced disadvantages much be acknowledged, such as range, energy effectiveness and cost to appliance, and to find solutions to overwhelmed these restrictions. Visible light communication is an outstanding method of communication and has the probable to be the major mode of communication in the near future.

The features of high bandwidth, non-interference with the radio waves in electromagnetic delicate areas and non-hazardous to fitness has complete visible light communication an striking technique for future communication. Li-Fi is 250 times quicker than its equivalent Wi-Fi, which uses radio frequency for communication. Potential applications of VLC contain Li-Fi, visible light ID system, underwater communication and traffic communication systems. All of these applications have made VLC an attractive part of study.

7. ACKNOWLEDGEMENT

I would like to thank the almighty God to shower his blessings on me. I would also like to thank our honourable Principal, Dr. R. P. Singh, Head of Department of Computer Science & Engineering, Prof. D. D. Patil. My special thanks to my guide, Prof. L. D. Panjwani & sincere thanks to all teaching faculties of Department of Computer Science & Engineering, Hindi Seva Mandal's, Shri Sant Gadge Baba College of Engineering & Technology, Bhusawal. My special thanks to my parents for their continuous encouragement, blessings and support. At last, I would like to thank all the writers of reference papers that are referred by me.

8. REFERENCES

[1] "Cisco Visual Networking Index: Forecast and Methodology", 'Cisco', 2013–2018, June 10, 2014.

[2] G. J. Holzman, B. Pehrson, "The Early History of Data Networks", ''IEEE Computer Society Press', United States (1995).

[3] Anurag Sarkar, Shalabh Agarwal, Asoke Nath, "Li-Fi Technology: Data Transmission Through Visible Light", 'Int. J. Adv. Res. Comput. Sci. Manag. Stud.', 3 (6) (2015).

[4] Y. Wang, N. Chi, Y. Wang, L. Tao, J. Shi, "Network Architecture of a High-Speed Visible Light Communication Local Area Network", 'IEEE Photonics Technol. Lett.', 27 (2) (2015), pp. 197–200.

[5] P.H. Pathak, X. Feng, P. Hu, P. Mohapatra, "Visible Light Communication, Networking, and Sensing: A Survey, Potential and Challenges", 'IEEE Commun. Surv. Tutor.', 17 (4) (2015), pp. 2047–2077.

[6] JEITA, JEITA Visible Light Communication Standards, Information on http://www.jeita.or.jp/cgi-bin/standard_e/list.cgi?ateid=1&subcateid=50. (Accessed 26/6/2015).

[7] Komine and M. Nakagawa, "Fundamental Analysis for Visible Light Communication System using LED lights", 'IEEE Trans. on Consumer Electronics', vol. 50, pp. 100-107, 2004.