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Visible Light wave Communication (VLC)

Submitted by:

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Remarks

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Abstract

Visible Light Communication (VLC) with Light Emitting Diodes (LEDs) as transmitters and receivers enables low bitrates wireless networking. LED-to-LED VLC networks with VLC devices communicating with each other over free-space optical links typically achieve a throughput of less than a megabit per second at distances of no more than a few meters. LED-to-LED VLC networks are useful for combining a smart illumination with low-cost networking. We present and evaluate a software-based VLC physical layer and a VLC medium access control layer that retain the simplicity of the LED-to-LED approach. The design shows the requirement that LEDs should always be perceived as on with constant brightness. In each VLC device, in addition to an LED, only a low-cost microcontroller is required for handling the software-based communication protocol. The results of our performance measurements confirm recent claims about the potential of LED-to-LED VLC networks as a useful technology for sensor networks, smart and connected consumer devices.

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Chapter 1: Introduction

This chapter is provided for giving a frame work of my project. The chapter is divided into three topics gradually as Motivation, objectives & project outline.

1.1. Motivation

Modern communication system is rising in its peak value. Growth of Visual Light Communication is a new territory of communication sector. Here, as it reduces cost as well as it improves the level of communication. These types of application give us lots of benefits. Such as it doesn’t affect our human body, it doesn’t radiate any types of alpha, beta, gamma rays. So, these types of communication system can be very much helpful to the society & its people [1]. Our traditional communication system creates frequency which is harmful for our heart and nerve system. So, it’s now or never. VLC system is now a crying need of our society.

Though the system has lots of advantages but no system can be perfect in all aspects. VLC system is only applicable to indoor facilities. Long range communications are not available for light wave communication.

Despite all disadvantages it is much more safe & secure. It might open a new door of communication system [2].

1.2. Objective

The main objective of my project is to see how data can be transmitted by light wave. Transmit data over a minimum range of distance. The methodology of transmitting data through light is a big challenge for us. If this project is successful then this system can be applicable as an integrated part of other communication system. Such as security, WLAN, under water diving, airplane etc.

So the main objective of my project is that:

- Communicate over Li-Fi.
- Inventing new criteria for home system communication.
- Facilitate in intercom community.

1.3. Project outline

This project report is structured in such a way that the reader will find no difficulties on reading this. This report deals with all the procedure, steps, outcomes, and difficulties. For the betterment of understanding this report is categories into four (4) chapters.

- **Chapter 1** is provided with a brief introduction of the report. It shows the objectives and outline of this report.

- **Chapter 2** gives a brief introduction about the present condition of my work. All the activities around the world in this prospective are given here.

- **Chapter 3** introduces about the procedure of my project, it's result and all other aspects that I have to face.

- **Chapter 4** gives the conclusion part and review of my total project at a glance.

Chapter 2: Literature Review

Communication is mandatory in our life. It's nothing like a new experience for us. We need to communicate with each other for our own benefits. Now the important thing is that how we communicate, how much faster it could be & how much money we need to spend. Let's take a brief discussion from our ancient stage to modern stage.

2.1. Developing stages

Uses of light wave communication are not entirely new in the field of science. Using smoke signal to transfer messages from one place to another is an old school method. In early 1970 FCC first took the step for building wireless communication system. As for the first time development of wireless mobile was first introduced in 1977 [3]. ***FCC**(Federal Communications Commission (FCC)) authorizes developmental cellular systems launch in Chicago and the Washington [4]. Here a chart is given on the basis of development in this sector.

Timeline	Development
1896	Guglielmo Marconi develops the first wireless telegraph system
1977	FCC authorizes developmental cellular systems
1990	Cellular subscribership surpasses 5 million.
1993	The first smart phone (IBM's Simon) is released to the public

1995	There are more than 33.8 million wireless subscribers
1998	Ericsson, IBM, Intel, Nokia, and Toshiba announce they will join to develop Bluetooth for wireless data exchange between computers or phones
2008	There are more than 270 million wireless subscribers

Table 3: A timeline of wireless communication

2.2. Different Methods of wireless communication

After researching of many years engineers developed many types of wireless communication. People always tried to get something new & of course that must be cost reducing. Here we have a list of effective types of wireless communication. Such as:

- Infrared
- Bluetooth
- Remote Control
- Radio Communication
- Mobile Communication
- Light wave communication

2.2.1. Infrared System

Infrared wireless communication communicates data or information in a device or system through infrared radiation. Infrared is an electromagnetic energy at a wavelength that is longer than that of red light. Infrared system is used for short and medium-range communications and security control [5]. For **IR** communication to work, the systems mostly operate in line-of-sight mode which means that there must be no obstruction between the source and receiver.

Figure 5: IR communication work

2.2.2. Bluetooth System

Bluetooth technology is a wireless communications technology that is simple, secure, and can be applicable everywhere [6]. The key features of Bluetooth technology are low power, and low cost. Connections between Bluetooth enabled electronic devices allow these devices to communicate wirelessly through short-range of area. Bluetooth technology operates in the unlicensed industrial, scientific and medical **(ISM)** band at 2.4 to 2.485 GHz.

Figure 6: Application of Bluetooth

2.2.3. Radio Communication

Radio wave Communication transmits music, conversations, pictures and data invisibly through the air, often over millions of miles. It happens every day in thousands of different ways [7]. Even though radio waves are invisible and completely undetectable to humans, they have totally changed society. All the radios of present time use continuous sine waves to transmit information. The reason that we use continuous sine waves today is because there are so many different people and devices that want to use radio waves at the same time. It has the bandwidth of around 3 kHz to 300 GHz. When the range is in 30-300KHz then it is called as low radio frequency. [8] In the range of 3-30MHz it is known as high radio frequency & within 3-30GHz it called as supper high radio frequency.

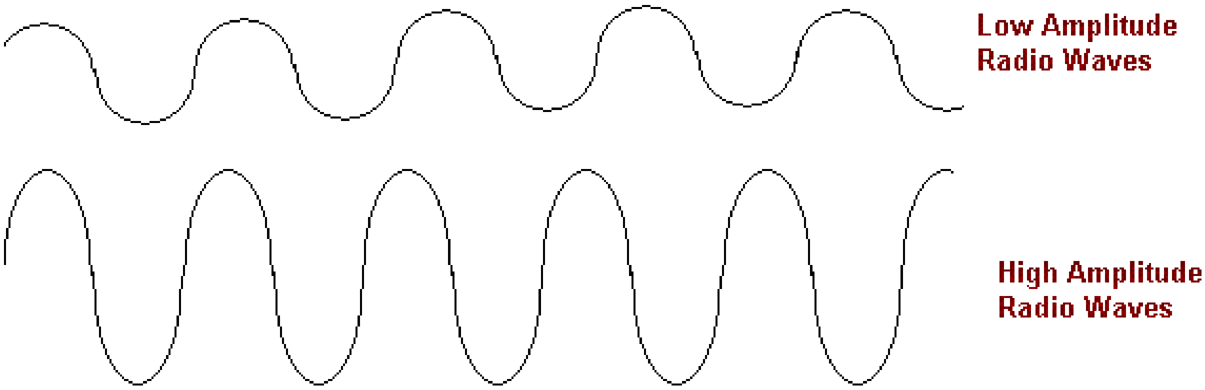

Figure 7: Continuous Sine wave for radio frequency

2.2.4. Mobile Communication

A basic mobile phone is nothing more than a combined radio transmitter and receiver. Quite similar to a walkie-talkie or **CB radio(Citizens Band radio)** [9]. In order to remain portable, mobile phones need to have relatively compact antennas and use a small amount of power. This means that mobile phones can send a signal over only a very short range, just like a walkie-talkie. But improving the receiver tower and developing in bandwidth now-a-days mobile communication is in great run. More than 100million people are now using mobile to communicate with each other. 824-896 MHz commonly termed as 800 MHz is the bandwidth of mobile phone [10].

2.2.5. Light wave Communication

The particular data is modulated through our general rule pulse position modulation or, phase shift keying. After the modulation it is transmitted through light wave [11]. The receiver receives data from light wave then the demodulator demodulates the coded data.

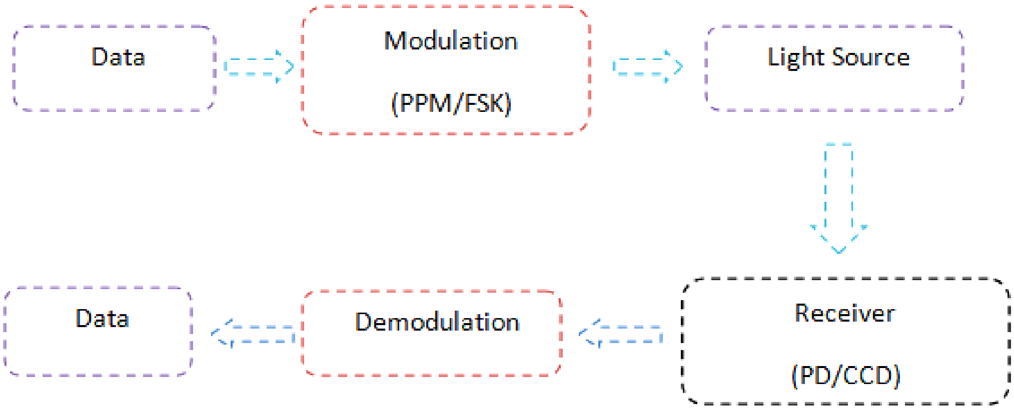

Figure 8: Light wave communication

Chapter 3: Methodology

3.1. Equipments

The components that are used for this project is given in the table. All the equipments are mentioned with their ratings.

Names	**Purpose**
Battery	9V, power source
Microphone	The microphone module translates sound into the electronic language
LED	Transmitting data
Light sensor	The light sensor measures duration of it. It has two modes ‘1’ and ‘0’.
DC Motor	The DC motor rotates a shaft when light is send to it.
Speaker	Generates sounds from LED
Cable	Connecting between data & LED

Table 4: Use of equipments

3.2. Technology procedure

Transmitters

Every kind of light source can theoretically be used as transmitting device for VLC. However, some are better suited than others. For instance, incandescent lights quickly break down when switched on and o frequently [12]. The simplest form of LEDs are those which consist of a bluish to ultraviolet LED surrounded by phosphorus which is then stimulated by the actual LED and emits white light. This leads to data rates up to 40 mbps [Won et al. 2008]. RGB LEDs do not rely on phosphorus any more to generate white light. They come with three distinct LEDs (a red, a blue and a green one) which, when lighting up at the same time, emit light that humans perceive as white. Because there is no delay by stimulating phosphorus rust, Data rates of up to 100 mbps can be achieved using RGB LED. In recent years the development of resonant cavity LEDs (RCLEDs) has advanced considerably. These are similar to RGB LEDs in that they are comprised of three distinct LEDs, but in addition they are titled with Bragg mirrors which enhance the spectral clarity to such a degree that emitted light can be modulated at very high frequencies. In early 2010, [13] Siemens has shown that data transmission at a rate of 500MBit/s is possible with this approach.

Receivers

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. In more complex VLC-based scenarios, such as Image Sensor Communication, even CMOS or CCD sensors are used (which are usually built into digital cameras).

MODULATION

In order to actually send out data via LEDs, such as pictures or audio less, 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. How these are exactly interpreted depends on the chosen modulation scheme, two of which will be presented in this section. At rest, a scheme called subcarrier pulse position modulation is presented which is already established as VLC-standard by the VLCC. The second modulation scheme to be addressed is called frequency shift keying, commonly referred to as FSK.

3.3. Difficulties

Even though VLC can lead to many interesting applications, as shown in the previous sections, the technology is not entirely free of certain drawbacks which shall be addressed shortly in this section.

First of all, to successfully transmit data, there has to exist a line of sight between sender and receiver, because visible light cannot penetrate solid items or objects. Apparently, this is not always a problem, but might even be a desired property when it comes to location estimation in closed rooms.

Another problem that may arise consists in interference which is, admittedly, not a VLC specie problem. There can be no interference with other electromagnetic waves in the non visible spectrum, such as WLAN or mobile phone radiation, but additional light sources may vastly impact data transfer.

A severe disadvantage of VLC in the medical field is that it is sometimes imperative during surgery to switch background illumination

Chapter 4: Conclusion

It has been shown that even though most existing efforts are still in a very early stage, VLC is a promising technology with a wide edge 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.

Completing standardization is challenging in that technical requirements and other regulations, such as eye-safety and illumination constraints, have to be combined.

Reference

1. visiblelightcomm.com
2. Dominic C. O'Brien, Lubin Zeng, Hoa Le-Minh, Grahame Faulkner, Joachim W. Walewski, Sebastian Randel.
3. wirelesshistoryfoundation.org/wireless-history-project/wireless-history-timeline
4. wirelesshistoryfoundation.org/wireless-history-project
5. engineersgarage.com/articles/wireless_communication?ui=desktop
6. bluetooth.com/Pages/Basics.aspx
7. electronics.howstuffworks.com/radio3.htm
8. en.wikipedia.org/wiki/Radio_frequency#As_a_weapon
9. physics.org/article-questions.asp?id=82
10. criterioncellular.com/tutorials/bandsandfrequencies.htm
11. Low-Complexity Visible Light Networking with LED-to-LED Communication, Domenico Giustiniano, Nils Ole Tippenhauer, Stefan Mangold
12. Visible Light Communication. Christian Pohlmann
13. Punith P. Salian, Sachidananda Prabhu, Preetham Amin, Sumanth K.Naik, Dr. M.K. Parashuram
14. 'Li-fi' via LED light bulb data speed breakthrough (http:/ / www. bbc. co. uk/ news/ technology-24711935), BBC News, Matthew Wall, 28 October 2013