CHARACTERIZATION OF LOW-LEVEL MODULATION TECHNIQUES FOR INDOOR VISIBLE LIGHT COMMUNICATION (VLC) SYSTEM

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UNIVERSITI TEKNIKAL MALAYSIA MELAKA

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DEDICATION

I dedicated this thesis to my beloved parents who have been alongside with me all the time. Their caring and patience have made me who I am today. They flourished my life with unconditional love and support, giving guidance toward success and protecting me along the thorny path. Their attitude and kindness have affected me from young. Thanks for everything that my parents have done to me and I am much appreciated it.

ABSTRACT

Technology is another expression of industrial art which comprise of skills, techniques, methods and processes to develop or manufacture a product or provide service to help the life of human getting easier. During the past recent years, we have encountered a bombastic advancement in technology especially in wireless communication system. We are now on the road to the fifth generation of wireless system that would definitely change the way we communicate currently. Optical Wireless Communication (OWC) has risen to become a reliable replacement to the current radio frequency transmission. Visible Light Communication (VLC) is one of the key technologies that falls within the category of OWC and indicate the dawn of 5G. This technology has been proposed for the past decade and the research and development (R&D) keep going until today in order to achieve a better objectives. Such objectives are higher transmission speed, larger capacity and security improvement. Modulation techniques are important to achieve those objectives and some of the them will be discussed in detail. This project is mainly focused on low-level indoor VLC system so the modulation schemes are limited to the certain techniques such as pulse position modulation. Most of their properties and both advantages and disadvantages will be listed out to make comparison among various modulation techniques. At last, the modulation technique with the highest transmission speed will be chosen as an ideal method for future prototype.

ABSTRAK

Teknologi adalah satu sektor perindustrian yang mengandungi kemahiran, teknik, kaedah dan proses untuk membangun, menghasilkan produk atau menyediakan perkhidmatan untuk membantu kehidupan manusia menjadi semakin senang. Sepanjang tahun-tahun kebelakangan ini, kita telah mengalami kemajuan besar dalam teknologi terutamanya dalam sistem telekomunikasi tanpa wayar. Kita sedang berada di atas jalan yang mengarah ke generasi kelima dalam sektor komunikasi tanpa wayar dan ini akan mengubah cara kita berkomunikasi pada masa kini. Optical Wireless Communication (OWC) telah meningkat sebagai salah satu pengganti yang boleh dipercayai selain daripada frekuensi radio yang digunakan semasa. Sistem Visible Light Communication (VLC) adalah salah satu teknologi penting yang dapat menunjukkan kedatangan 5G. Teknologi ini telah dicadangkan sejak sedekad lalu dan penyelidikan dan pembangunan (R&D) terus berjalan hingga hari ini untuk mencapai objektif yang lebih baik. Objektif tersebut adalah kelajuan transmisi yang lebih tinggi, peningkatan kapasiti dan peningkatan keselamatan. Teknik modulasi adalah penting untuk mencapai objektif tersebut dan akan dibincang secara terperinci. Projek ini akan memberi tumpuan kepada sistem VLC dalaman yang bertahap rendah, oleh itu, skema modulasi adalah terhad kepada beberapa teknik tertentu. Kebanyakan sifat mereka dan kedua-dua kelebihan dan kelemahan akan disenaraikan untuk membuat perbandingan antara pelbagai teknik modulasi.

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LIST OF SYMBOLS AND ABBREVIATIONS

AM	:	Amplitude modulation
BER	:	Bit error rate
IoT	:	Internet of things
IR	:	Infrared
LED	:	Light emitting diode
OFDM	:	Orthogonal frequency division multiplexing
OOK	:	On-off keying
OWC	:	Optical wireless communication
PAM	:	Pulse amplitude modulation
PPM	:	Pulse position modulation
PWM	:	Pulse width modulation
RF	:	Radio frequency
UV	:	Ultraviolet
VLC	:	Visible light communication

CHAPTER 1

INTRODUCTION

1.1 Project Background

In the past decades, the world's telecommunication technology has shown a dramatic improvement in both wired and wireless field. The increasing demand for high-speed internet has bombarded the market and lead to the need for further innovation, research and development in new emerging technologies which capable to deliver ultra-high data rates to the users. This rapid growth resulted in traffic congestion which can be seen clearly from wireless communication. The increasing demand has overflowed with the limited bandwidth and such situation arise in high-density areas such as airport and commercial office. In order to overcome this situation, visible light communication (VLC) is one of the preferred solutions due to its universality and performance [1].

VLC has many advantages over the other technologies such as infrared (IR) and ultraviolet (UV). Example of the advantages are radio frequency (RF) interference-free, no side effect to human health and has higher security [2]. All these advantages have pushed the development of VLC as an alternative choice to replace or work together with other wireless communication technologies.

This technology has been proposed a few years ago but facing some commercial problems due to the lack of reliable lighting source. This problem has seen to be solved after the use of light emitting diode (LED) become so common. LED has chosen to be the ideal light source due to its high flickering and longer life-time than the other conventional lighting devices such as fluorescent lamps and incandescent bulbs. LED used for illumination purpose are simultaneously used for wireless data transmission [3].

Data transmission rate is getting more vital when more people are demanding higher quality internet services. Visible light occupies the spectrum from 380nm to 750nm which corresponds to the frequency spectrum of 430THz to 790THz. The deficiency of bandwidth in RF communication can be solved by the VLC system because of its large bandwidth [5].

VLC can be a very good communication fabric for the Internet of Thing (IoT) with a LED enhanced with photodiodes. In this situation, the LED light source can act as both transmitter and receiver. This shows that VLC is a sustainable and green technology with the potential to revolutionize approaches to how we are going to use lights in the future [4].