IN CAMPUS COMMUNICATION SYSTEM USING OPTICAL PRINCIPLES AND TECHNIQUES (RECEIVER)

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DEDICATION

This thesis is dedicated to my family and friends who have shared countless hours helping me in the process completing this report.

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ABSTRACT

Free space optics (FSO) is an emerging technology that has found application in several areas of the short-and long-haul communications space. From inter-satellite links to inter-building links, it has been tried and tested. As with any technology, FSO has worked much better in some applications than in others. Free space optical systems do face a lot of problems especially from atmospheric disturbances as the signal travels in free space. Rain and snow attenuate the signal and hence decrease the range of reliable communication. Fog being composed of water droplets, can completely hinder the passage of light through a combination of absorption, scattering and reflection. Physical obstructions such as flying birds cause temporary interruption in the received signal. Nonetheless, free space optical communication systems is a viable alternative, given its optical base, bandwidth scalability, speed of deployment, re-deployment and portability, and cost-effectiveness.

ABSTRAK

Optik ruang bebas (FSO) adalah satu teknologi mula membangun yang telah diaplikasikan di beberapa kawasan untuk ruang komunikasi jauh dan singkat. Daripada sebagai penghubung antara satelit kepada penghubung antara bangunan, ia telah diaplikasi dan diuji. Dibandingkan dengan teknologi sedia ada, FSO terbukti lebih baik dalam beberapa faktor. Sistem optikal ruang bebas ini bagaimanapun tetap mempunyai kekurangan kerana isyarat dipancarkan ke ruang bebas banyak menghadapi gangguan terutmanya dari atmosfera itu sendiri. Hujan dan salji menggangu isyarat dan oleh itu mengurangkan julat komunikasi untuk bekerja. Kabus yang terhasil juga boleh menghalang isyarat yang dipancar dari diterima. Halangan objek fizikal seperti burung juga mendatangkan masalah kerana boleh menghalang isyarat untuk satu jangkamasa yang singkat. Namun banyak kelebihan sistem ini seperti menjimatkan kos, mengambil masa yang singkat untuk dipasang, penghantaran yang laju menjadikan ia satu pilihan.

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LIST OF ABBREVIATION

FSO	-	Free Space Optic
WDM	-	Wavelength Division Multiplexing
RF	-	Radio Frequency
LD	-	Laser Diode
LED	-	Light Emitting Diode

CHAPTER 1

INTRODUCTION

1.1 Project introduction

The increasing demand for higher bandwidth in communication networks has led to the rise in the use of optical communication systems for transmitting voice, video and data. Optical communication can be either guided as in fiber optic wave guides or unguided as in free space optical systems. Fiber optic systems are the most reliable means of providing optical communications. But the digging, delays and associated costs to lay fiber often make it economically prohibitive. Moreover, once fiber is deployed, it becomes a "sunk" cost and cannot be re-deployed if a customer relocates or switches to a competing service provider, making it extremely difficult to recover the investment in a reasonable timeframe. Free space optical communication system on the other hand, is a line of sight technology that uses air/free space as the medium of transmission and is relatively simple. Unlike radio frequencies, the technology requires no spectrum licensing. It is easily upgradeable, and its open interfaces support equipment from a variety of vendors. Further, it enables optical transmission at speeds up to 2.5 Gbps and in the future up to 10 Gbps using WDM. This is not possible using any fixed wireless/RF technology existing today.

1.2 Project objectives

- To design a communication system that sent data in light beam through atmosphere.
- To offer system that overcome the problems or disadvantage in recent wireless communication such as microwave.
- Provides system with no federal communication commission or frequency allocation requirement.
- Provides system that useful where the physical connection of the transmission and receiver location is difficult.
- Provides system that portable and quickly deployable (ideal for temporary installation).
- Provides an economic system because no cabling cost, low power consumption and save space.
- Provides system that is secured because of laser’s narrow beam detection and interception are difficult.
- Design a moderate speed FSO data link with transfer rates up to 100Kbps.
- Operating distances 100 to 300 meter
- Much Cheaper as compared to the commercially available equipment.

- Design using readily available, cheap and indigenous components instead of expensive, specialized components.
- Excellent up-time and good reliability.
- Very less setup times.

1.3 Scope

- Due to financial constraints we have implemented this technology at an elementary level. Availability of more funds will help us implement the circuit for higher speeds of the order Mbps to Gbps and also widen its communication range from meters to kilometers.
- The system implemented is basically a one to one bi-directional communication system. It can be modified into one to many multichannel systems.
- One of the limitations of the above system is its inability to operate with efficiency in presence of fog, heavy rain or snow.
- As the range of communication of the system increases certain de-coherence limiting measures are needed also, the swaying of buildings certain adjustments need to be done.
- When line of sight communication is not possible then the system can be implemented by the use of reflection and deviation mirrors.

1.4 Problem statement

Fiber optics provides an excellent solution for high bandwidth, low error requirements and can serve as the backbone for the internet infrastructure. Most of the recent trenching to lay fiber has been to improve the metro core (backbone). Carriers have spent billions of dollars to increase network capacity in the core, of their networks, but have provided less lavishly at the network edges. This imbalance has resulted in the "last mile bottleneck." Service providers are faced with the need to turn up services quickly and cost-effectively at a time when capital expenditures are constrained.

From a technology standpoint, there are several options to address this "last mile connectivity bottleneck" but most don't make economic sense.

- Fiber Optic Cable: Without a doubt, fiber is the most reliable means of providing optical communications. But the digging, delays and associated costs to lay fiber often make it economically prohibitive. Moreover, once fiber is deployed, it becomes a "sunk" cost and cannot be re-deployed if a customer relocates or switches to a competing service provider, making it extremely difficult to recover the investment in a reasonable timeframe.

- Radio frequency (RF) Wireless: RF is a mature technology that offers longer ranges distances than FSO, but RF-based networks require immense capital investments to acquire spectrum license. Yet, RF technologies cannot scale to optical capacities of several gigabits. The current RF bandwidth ceiling is 622 megabits. When compared to FSO, RF does not make economic sense for service providers looking to extend optical networks.

- Wire and Copper-based technologies**:** Although copper infrastructure is available almost everywhere and the percentage of buildings connected to copper is much higher than fiber, it is still not a viable alternative for solving the connectivity bottleneck. The biggest hurdle is bandwidth scalability. Copper technologies may ease some short-term pain, but the bandwidth limitations of 2 megabits to 3 megabits make them a marginal solution.

Providing last mile connectivity is extremely difficult and expensive. In metropolitan areas, an estimated 95 percent of buildings are within 1.5 km of fiber-optic infrastructure. But at present, they are unable to access it. Connecting them with fiber require high cost, with 85 percent of the total figure tied to trenching and installation. Street trenching and digging are not only expensive, they cause traffic jams (which increase air pollution), displace trees, and sometimes destroy historical areas.

CHAPTER 2

BACKGROUND STUDY

2.1 Introduction

Free Space Optics, the industry term for “Cable-free Optical Communication Systems”, also called Free Space Photonics (FSP) or Optical Wireless refers to the transmission of modulated visible or infrared (IR) beams through the atmosphere to obtain optical communications. In other word, it is a line of sight optical technology in which video and data are sent through the air (free space) on low-power light beams at speeds of megabytes or even gigabytes per second. A free-space optical link consists of 2 optical transceivers accurately aligned to each other with a clear line-of-sight. Typically, the optical transceivers are mounted on building rooftops or behind windows.

These transceivers consist of a laser transmitter and a detector to provide full duplex capability. It works over distances of several hundred meters to a few kilometers.

Like fiber, Free Space Optics (FSO) uses lasers to transmit data, but instead of enclosing the data stream in a glass fiber, it is transmitted through the air. Free Space Optics (FSO) works on the same basic principle as Infrared television remote controls, wireless keyboards or wireless Palm devices.

2.1.1 History of Free Space Optics (FSO)

The engineering maturity of Free Space Optics (FSO) is often underestimated, due to a misunderstanding of how long Free Space Optics (FSO) systems have been under development. Historically, Free Space Optics (FSO) or optical wireless communications was first demonstrated by Alexander Graham Bell in the late nineteenth century (prior to his demonstration of the telephone!). Bell's Free Space Optics (FSO) experiment converted voice sounds into telephone signals and transmitted them between receivers through free air space along a beam of light for a distance of some 600 feet. Calling his experimental device the "photophone," Bell considered this optical technology and not the telephone, his preeminent invention because it did not require wires for transmission.

Although Bell's photophone never became a commercial reality, it demonstrated the basic principle of optical communications. Essentially all of the engineering of today's Free Space Optics (FSO) or free space optical communications systems was done over the past 40 years or so, mostly for defense applications. By addressing the principal engineering challenges of Free Space Optics (FSO), this aerospace/defense activity established a strong foundation upon which today's commercial laser-based Free Space Optics (FSO) systems are based.