Journal of Theoretical and Applied Information Technology
31st January 2024. Vol.102. No 2

ISSN: 1992-8645 www.jatit.org E-ISSN: 1817-3195

HYBRID MODULATION TECHNIQUE TO IMPROVE RECEIVER SENSITIVITY FOR FSO LINK PROPAGATION

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ABSTRACT

Free space optical (FSO) communication is now become a main communication due to the ability of propagation channel to operate up to Terabit per sec (Tbs) and can support high number user. The FSO suffer when experience severe weather condition. Apart from that FSO also facing threshold problem especially related with Amplitude Shift Keying - Onn Off Keying (ASK-OOK) when dealing poor signal and the biggest effect is high noise presence at receiver which led the signal to deteriorate. In this research proposed new development of transmitter and receiver design in order to reduce the impact of atmospheric attenuation and increase receiver sensitivity. In this paper focus on the analysis performance related bit rate which will compare with conventional amplitude shift keying (ASK) approach. Simulation result will be used to measure the performance and comparison between conventional and new proposed modulation double transmission balance receiver (DTBR) will also be presented. It was anticipated that proposed technique which offer a simple and inexpensive procedure capable of increasing received power, receiver sensitivity, and decreasing bit error rate would be used. The measurement of result will involve the effect of geometrical loss, data bit rate and distance propagation. Four level of synchronous transport module (STM) which is STM1(155Mbps), STM4(622Mbps), STM16(2.5Gbps) and STM64(10Gbps) will be compare the performance of bit rate. Meanwhile two different distances will test to measure the ability system extend the range transmission. From the result, the DTBR can increase 25% improvement as compare to conventional ASK.

Keywords: *Free Space Optical, Conventional ASK, Geometrical Loss, Bit Error Rate*

1. INTRODUCTION

The Free Space Optics (FSO) can be defined as an optical communication technology that uses light which usually uses a LASER source and propagate via free space to transmit data between two points [1]. This technology has the same characteristic with the fiber optic communications but only distinguished in term of medium propagation. The data of optic fiber communication are transmitted by modulated laser light in cable, while FSO data are transmitted in a narrow beam through the atmosphere. Light travels through air faster than it does through glass, so it is fair to classify FSO as optical communications at the speed of light [2].

In terms of advantages of FSO technology communication over fiber communication, the FSO is not requiring the licensing from the Federal Communications Commission (FCC). Unlike the RF communication need the licensing for frequency allocation due to RF use the frequency that less than 300 GHz. Apart from that the FSO can support the bandwidth up to 2.5Gbps if compare to RF limited to 622Mbps. The further study has successfully tested 160Gbps in laboratories and speed could potentially be able to reach Terabit range [3]. The FSO also has an attractive alternative to the excessively high cost of digging the street to lay the fiber and requiring permission from authorities for installation. This technology transmission only needs a place on a roof or behind a window to set up a transceiver. The duration of installation can be made over within a few hours or one day.

Behind the advanced of this technology, the obvious limitation in FSO is vulnerable to weather condition. This led this technology not applicable

for long distance in terrestrial FSO. This technology also needs a line of sight (LOS) transmission to operate. Any blocking over the laser light will cause the receiver not received the signal and drag to loss of communication data [5]. For instance, the flying bird across the laser beam propagation is most normal cases that block the laser light. Moreover, the building movement also can impair the link performance. This is because the arising of pointing error in FSO system [6].

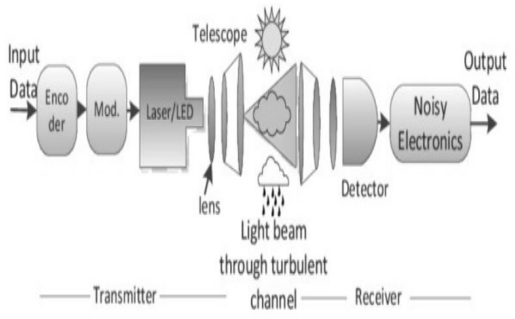

Figure 1. Basic of FSO communication system

(a)

(b)

Figure 2. Example difference visibility of FSO facing by FSO transmission due to foggy and haze weather

Atmospheric scintillation is attributed to temperature inhomogeneity, as reported by [18]. When the optical beam travels through the atmosphere, it encounters both constructive and destructive interference, which may weaken the signal. When the distance between transmitter and receiver is more than 1 km, scintillation may drastically reduce FSO connection availability and performance.

The typical ASK - OOK modulation method is a common basic modulation technique that is now employed in commercially available terrestrial FSO systems [19]. Nevertheless, when turbulence is present, the received signal level fluctuates, and the threshold detector must watch this variation in order to find the best decision point. As a consequence, a considerable design challenge will be required, since channel noise and fading will need to be continuously monitored for the OOK in FSO to work ideally. Ignoring the signal fluctuation and allowing the OOK FSO system to function with a constant threshold level will result in an increase in detection inaccuracy.

Because of the background noise, dark current dominates the detection of weak signals in FSO transmission. FSO is encountering significant hurdles in limiting the presence of undesired signal (noise) in the receiver. This is because the laser beam is transmitted straight through the air, with varying contributions from atmospheric effects (pie cite). As a result, the optimum receiver design must condense the presence of noise.

In the past, substantial research on optical communication in free space has been conducted in optical technology. Compared to other mediums, such as microwave, radio frequency, and others, this technology is particularly alluring and promising. As end-user demand for wireless communication increases in terms of speed, data capacity, and number of users, the free space optical system is the optimal solution. Nonetheless, there is still need for improvement in order to create a reliable and efficient performance system.

Reported in [15,16,17], this researcher has developed RoFSO system based on BCH and RS coded BPSK OFDM for 5G applications in smart cities. It applies the hybrid system using radio frequency and free space optical communication. The system embedded with OFDM coded. However, it cost complicated over the system and involve very complex development if convert in real implementation. There also reported in [20] some researcher explores in Deep Learning (DL)