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A Review Paper on Robust Model Design for FSO Communication System for Analysing Of Different Parameters

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Abstract*— Communication is an important part of our daily life. The communication process involves information generation, transmission, reception and interpretation. The transmission using high bandwidth can handle vast amounts of information, which can be further improved by reduction in fibre losses, increase in data rates and distances, development of optical sources and detectors compatible with fibres. Today's demand is a communication link with maximum performance and minimum errors. Free Space Optics is a medium with high bandwidth having maximum data rates and security issues favouring its promotion for the present era. Wide bandwidth signal transmission with low delay is a key requirement in present day applications. Optical fibers provide enormous and unsurpassed transmission bandwidth with negligible latency, and are now the transmission medium of choice for long distance and high data rate transmission in telecommunication networks. After studying a lot of research paper some analysis is carried out. We have to see impact of various conditions like atmospheric turbulence, path loss factor, distance and BER. BER is one of most important parameters which should be minimum otherwise distorted information will be received at receiver side and BER increases with distance and other atmospheric turbulence.

Keywords*— Bit Error Rate, FSO, Path Loss Factor, quantization, Intensity, Turbulence, Modulation.

I. INTRODUCTION

FSO is a line-of-sight technology which uses LASERS and Photo detectors to provide optical connections between two points—without the fiber. FSO can transmit data, voice or video at speeds capable of reaching 2.5 Gbps. Products capable of speeds up to 10 Gbps are expected to hit the markets within one year. FSO units consist of an optical transceiver with a laser (transmitter) and a Photo detector (receiver) to provide full duplex (bi-directional) capability [1-2]. FSO systems use invisible infrared laser light wavelengths in the 750nm to 1550nm range. FSO provides point-to-point transmission of communication information through the atmosphere using the Optical signals as the carrier frequencies. It has drawn attention in telecommunication industry, due to its cost effectiveness – easy installation, quick establishment of communication link especially in the disaster management scenario, high bandwidth provisioning and wide range of applications. The range of frequencies where it operates makes FSO communication free from licensing [5].

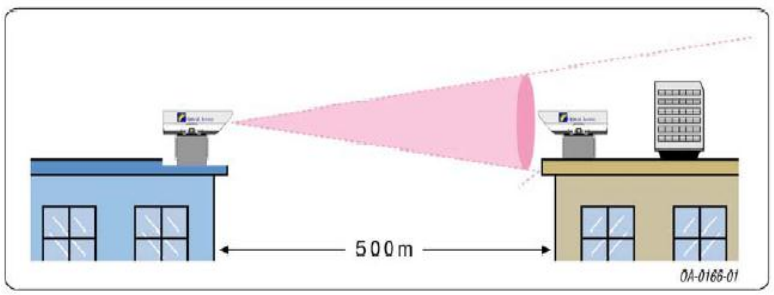

Figure 1 FSO Communication Link

With FSO communication, maximum data transfer rates up to 2.5 Gbps is possible, unlike the maximum data transfer rates of 622Mbps offered by RF communication systems. FSO involves the optical transmission of voice, video, and data using air as the medium of transmission. Transmission using FSO technology is relatively simple [8-9]. It involves two systems each consisting of an optical transceiver which consists of a laser transmitter and a receiver to provide full duplex (bi-directional) capability. Each FSO system uses a high-power optical source (e.g., laser) plus a telescope that transmits light through the atmosphere to another telescope that receives the information. At that point, the receiving telescope connects to a high sensitivity receiver through an optical fiber.

Figure 2 FSO communication between Merrill Lynch Brokerage and Wall Street in New York following the terrorist attack that destroyed normal fiber optic link

II. LITERATURE SURVEY

Over the last two decades free-space optical communication (FSO) has become more and more interesting as an adjunct or alternative to radio frequency communication. This article gives an overview of the challenges a system designer has to consider while implementing an FSO system. Typical gains and losses along the path from the transmitter through the medium to the receiver are introduced in this article [4]. Detailed discussions of these topics can be found in this special issue of the Radio engineering Journal. Its high bandwidth capabilities and low attenuation characteristics make it ideal for gigabit transmission. Fiber optic communication has revolutionized the telecommunications industry. It has also made its presence widely felt within the data networking community as well. Using fiber optic cable, optical communication shave enabled telecommunications links to be made over much greater distances and with much lower levels of losing the transmission medium and possibly most important to fall, fiber optical communications has enabled much higher data rates to be accommodated. Fiber optic systems are important telecommunication infrastructure for world-wide broadband networks. Wide bandwidth signal transmission with low delay is a key requirement in present day applications. Optical fibers provide enormous and unsurpassed transmission bandwidth with negligible latency, and are now the transmission medium of choice for long distance and high data rate transmission in telecommunication networks. Free Space Optics is a medium with high bandwidth having maximum data rates and security issues favouring its promotion for the present era. Turbulent atmosphere affects the performance of the link. Humidity, water vapour, signals absorption, beam scintillation, spreading and wandering are some of the factors which cause laser beam degradation [3]. Maintaining a free space optical link between two junctions is a tough challenge and needs enhancement in its features.

III. PLANNING OF WORK/METHODOLOGY

FSO Link: The transmitter modulates data on to the instantaneous Intensity of an optical beam. We consider intensity Modulated direct detection channels using On/Off Keying (OOK) modulation, which is widely employed in practical systems [10-11]. The received photo current signal is related to the incident optical power by the detector responsivity r.

Received Signal Y=Hr X+N
X=Transmitted Intensity,
H=Channel State
Y= Resulting Electrical Signal
N= Signal Independent AWGN

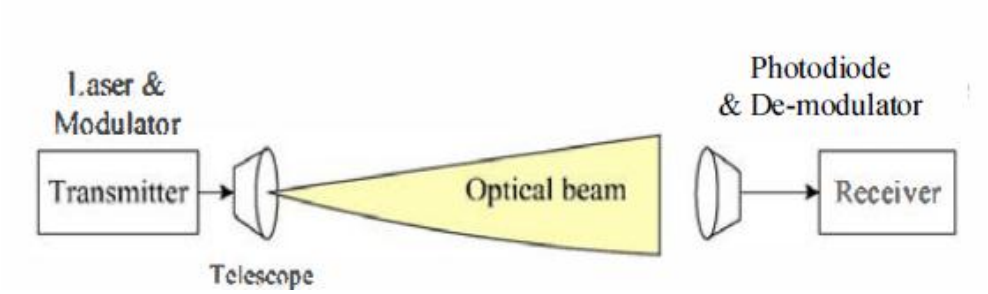

Figure 3 FSO General Block Diagram

Parameters: We evaluated the Bit Error Rate (BER) performance of the proposed system varying with different system parameters such as

Distance
Transmitter Power
Path Loss Factor,
Atmospheric Turbulence
Received Signal Power.

The BER is highly degraded on severe atmospheric turbulence condition ever for a short distance of free space channel. The effect of path loss factor due to dense fog is also severe on the BER even though the turbulence effect and free space distance is short. The optimum transmitted input power and receiver antenna radius at which the BER is minimum, is strongly dependent on free space distance and atmospheric parameters. In FSO there are various parameters which we have to analyse and for it we have to use various blocks from simulation library so that objective can be achieved. During this we have to face various challaneges like pointing error, path loss, attenuation, geometeric spread and atmoshpheric condition

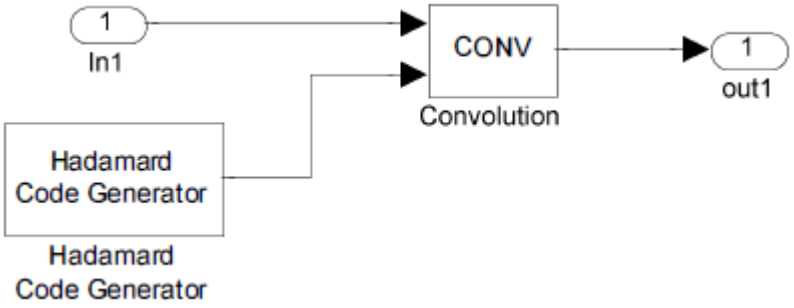

Figure 4 Hadmard Code generator

Free Space Optics (FSO) technology based wireless systems are not without challenges. The fundamental limitation of free space optical communications arises from the environment through which it propagates. Although relatively unaffected by rain and snow, free space optical communication systems can be severely affected by fog and atmospheric turbulence. The main design challenges in free space optical communications are depicted in figure.

Atmospheric Turbulence: For weak turbulence, the intensity fluctuation probability density function is modeled as a log-normal distribution the log-amplitude of the optical Intensity has a Gaussian PDF with log amplitude variance given by

$$\sigma_X^2 \approx \frac{\sigma_r^2}{4}$$

Fog and Free space optics: The main challenge is fog. Fog is vapour composed of water droplets, which are only a few hundred microns in diameter but can modify light characteristics or completely hinder the passage of light through a combination of absorption, scattering, and reflection. This can lead to a decrease in the power density of the transmitted beam, decreasing the effective distance of a free space optical link [13-14].

Scintillation and free space optics: Scintillation is the spatial variation in light intensity caused by atmospheric turbulence. Such turbulence is caused by wind and temperature gradients that create pockets of air with rapidly varying densities and, therefore, fast-changing indices of optical reflection. These air pockets act like lenses with time-varying properties and can lead to sharp increases in the bit-error rates of free space optical communication systems, particularly in the presence of direct sunlight.

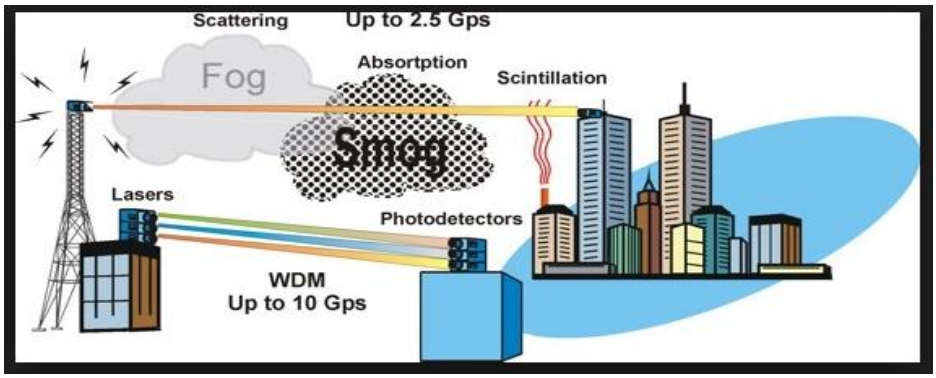

Figure 5 Atmospheric effects on FSO Link

Beam Wander and free space optics: Beam wander arises when turbulent wind current (eddies) larger than the diameter of the transmitted optical beam cause a slow, but significant, displacement of the transmitted beam [15]. Beam wander may also be the result of seismic activity that causes a relative displacement between the position of the transmitting laser and the receiving photo detector.

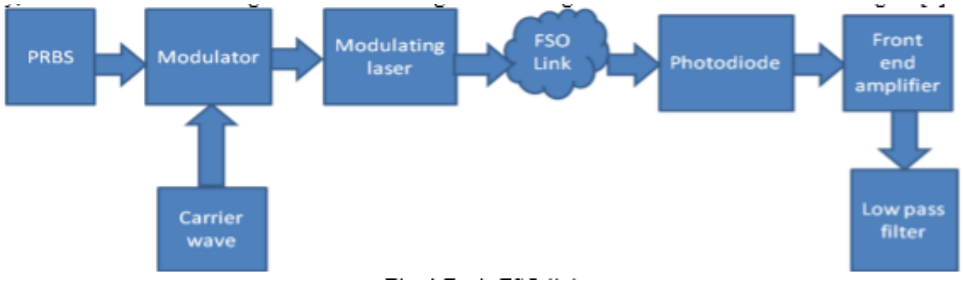

Figure 6 FSO Transmitter and receiver viva FSO Link block Diagram

IV. SOFTWARE USED AND SIMULATION RESULT

Software: MATLAB Version R2015a: It is powerful software that provides an environment for numerical computation as well as graphical display of outputs. In MATLAB the data input is in the ASCII format as well as binary format. It is high-performance language for technical computing integrates computation, visualization, and programming in a simple way where problems and solutions are expressed in familiar mathematical notation.

- Acquisition, Data Exploration, Analysing &Visualization
- Engineering complex drawing and scientific graphics
- Analysing of algorithmic designing
- Mathematical and Computational functions
- Modelling and simulating problems prototyping
- GUI (graphical user interface) building environment.

Using MATLAB, you can solve technical computing problems very easily and time saving as compared to traditional programming languages, such as C, C++, and FORTRAN.
The name MATLAB stands for matrix laboratory.

MATLAB Features

- MATLAB is a high-level language used for numerical computation, visualization, and application development
- It create very friendly environment for iterative exploration, design, and problem solving
- Mathematical functions for solving ordinary differential equations, Fourier analysis, linear algebra, statistics, filtering, optimization, numerical integration
- Development tools for enhancing code quality and maximizing performance
- Tools for building applications with custom graphical interfaces (GUI)
- Functions for integrating MATLAB based algorithms with external applications and we can able to generate code in hex file, c, embedded etc.

CONCLUSION

After studying various research papers we will analyse the impact of various parameters like atmospheric turbulence, path loss factor and pointing error on the performance of free space optical communication system. To obtain our goal we will simulate a model of free space communication system in MATLAB using Simulink. From transmitter to receiver we will use various block which can provide us better result means to say when we transmit data from transmitter then it is propagated viva wireless channel and definitely various parameters like fog, attenuation factor, rain and atmospheric turbulence affect our data so that at receiver side we got distorted data it means BER will be there and to reduce it is our main objective. Besides this another important factor is power that must be minimum. Then the BER is evaluated by varying the several parameters such as distance, transmitter power, path loss factor, received signal intensity and atmospheric turbulence. Path loss factor is severe in presence of dense fog. The effect of atmospheric turbulence was also observed at maximum turbulence condition the BER is also approximately 12-28. In research our main focus will be to analyse the impact of various parameters on data transmission

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