Implementation of FSO Network under the Impact of Atmospheric Turbulences

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ABSTRACT
This work is focused to carry out the investigations of Free Space Optical Transmission System under the impact of different atmospheric attenuation factors. In this work A 10 Gbps data is transmitted through free space optical link of 1 km and the performance is measured in terms of SNR, BER and eye diagrams. Further the role of modulation format is also investigated**.**

General Terms
Free Space Optics, Atmospheric Turbulences, Haze, Fog.

Key Words
Optical Wireless Systems, Modulation Formats, Free Space Optics.

1 Introduction
Now Days, Free Space Optical (FSO) Communication is one of major hot topics in the world of optical & wireless communication. FSO communication is based on optical Communication with only difference that here the light signal which carries the information is not confined in to physical channel such as optical fiber. In FSO communication the optical signal is transmitted in to free space & air or vacuum space act as a channel for signal transmission. This type of cable-less optical communication technology uses a highly directed narrow light beam to transmit data between two points [1]. It can avoid some challenges facing optical fiber communication such as high cost of digging roads, impractical physical communication between transmitter & receiver. Also it can be presented to an alternative or an upgrade for long distance wireless communication system (up to few km's) [2]. Along with higher data transfer rate, a direct Line of sight FSO link offer several advantages compared to conventional wired & radio frequency wireless communication. No need for licensed frequency band allocation, higher bit rate & lower BER, immunity to EMI, very secure due to highly directionally & narrowness of beam are some of the several advantages of free space optics [1,3]. FSO Systems are mounted even within the building or top of the building / roofs. FSO System consists of mainly optical transceiver with a laser transmitter and receiver which allow it to transmit or receive the signal in full duplex mode. It generally looks like a video camera. Along with high power transceiver it also contains the lens which can transmits light through the atmosphere to other lens receiving information. If transmitter source does not produce a sufficiently parallel beam to travel the required distance, the collimation can be done with lens. The receiving lens further connects to high sensitivity receiver via optical fiber. Along with advantages of FSO communication, there are some factors that limit its performance. The main disadvantages of FSO communication system are strict alignment requirement & adverse atmospheric weather condition. Achieving acceptable performance for a practical FSO link requires to overcome some major challenges at the transmitter such as determination of modulation techniques [4,5], suitable light source, transmitting wavelengths and also estimating transmitting power levels[6,7,8] .There are several challenges facing the channel performance such as effect of attenuation due to different weather condition that appears in study dealing with scattering[9,10,11], atmospheric turbulences[12] and scintillations[13].This paper is organised as follow : System Description is mentioned in Section 2, Results are discussed in Section 3 followed by Section 4 which gives the conclusion of this work.

2. SYSTEM DESCRIPTION
There are three main important parts in the FSO System: Transmitter, propagation channel, and receiver. The FSO system is not much different from fibre optical communication where the difference relies in the propagation medium. In the OptiSystem software, the FSO link is modelled between an optical transmitter with 5 cm antenna and optical receiver with 20 cm optical antenna at each end. The transmitter converts the electric signal in to light. The light propagates through the atmosphere to receiver which converts light back in to corresponding electric signal. The FSO link is modeled between an optical transmitter and optical receiver. The attenuation of free space between two connecting FSO nodes is considered as 0.11dB/Km under clear weather conditions, 4 dB/Km & 22 dB/Km under the impact of Haze and Fog respectively [**14]**. The transmitter and receiver gains are 0dB by assuming both the antennas ideal. Also, scintillation and mis-pointing losses are not considered in this simulative work. At transmitting end, a 10-/40-Gbps data is generated by using a Pseudorandom Bit Generator. This data is fed to encoder and further modulated by using MZM modulator. A CW laser diode of line-width of 10MHz with power of 0dBm is used in our proposed hybrid system. At the reception end, the optical signal is received by Photo detector having a dark current of 10 nA as shown in the Fig 1.

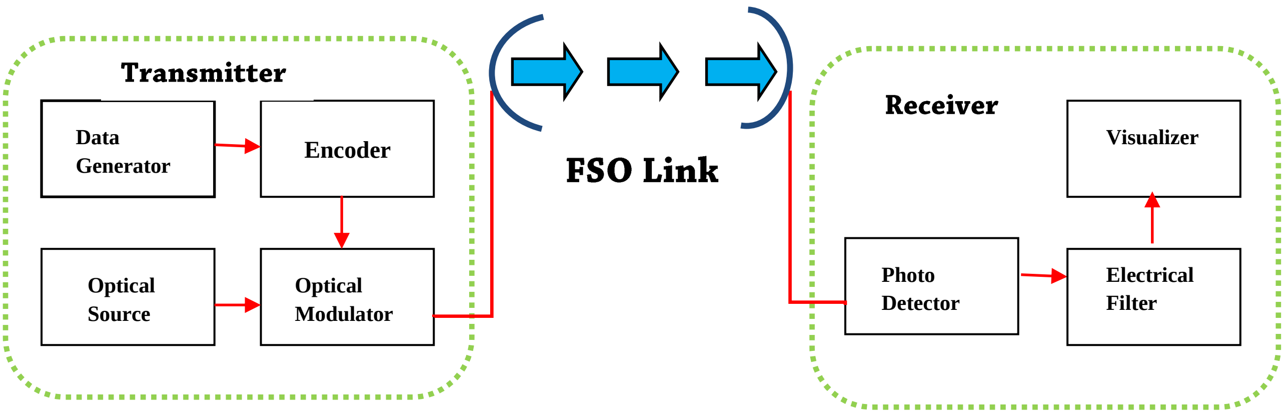


Fig 1 Architecture of Free Space Optical Transmission System

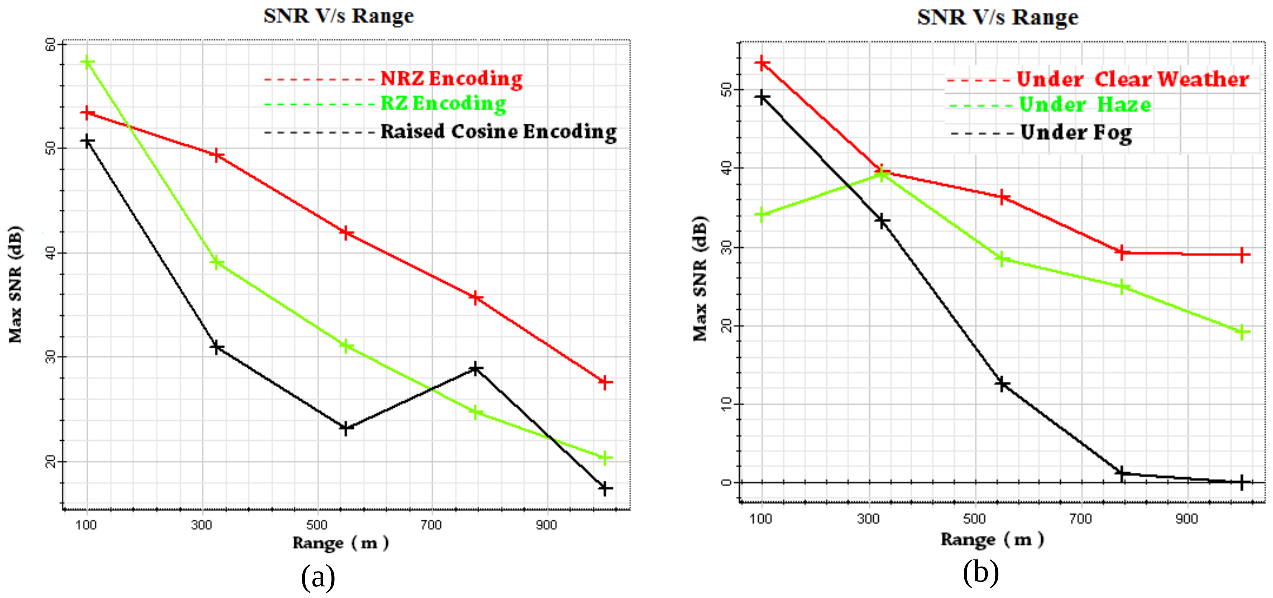
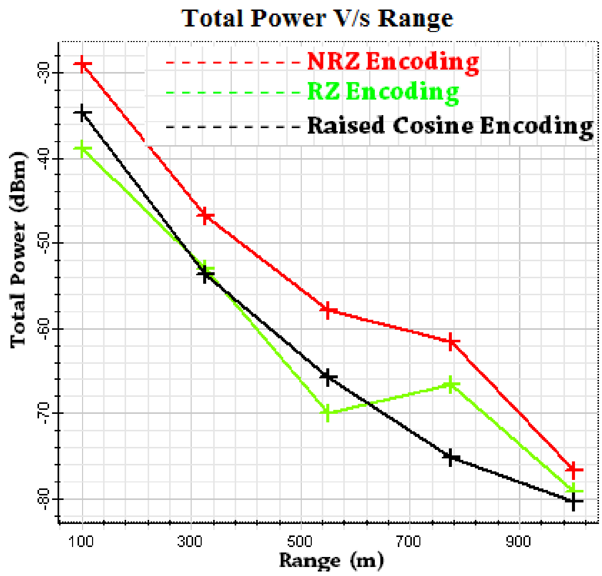
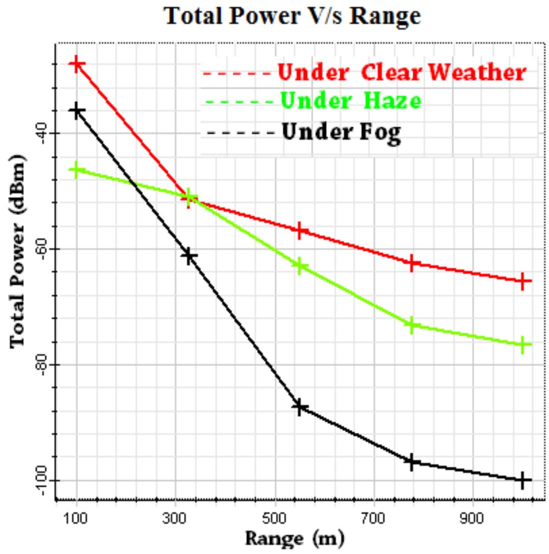


Fig 2 Evaluation of SNR Vs Range of FSO Link (a) Different Modulation Technique (b) Different Atmospheric Conditions

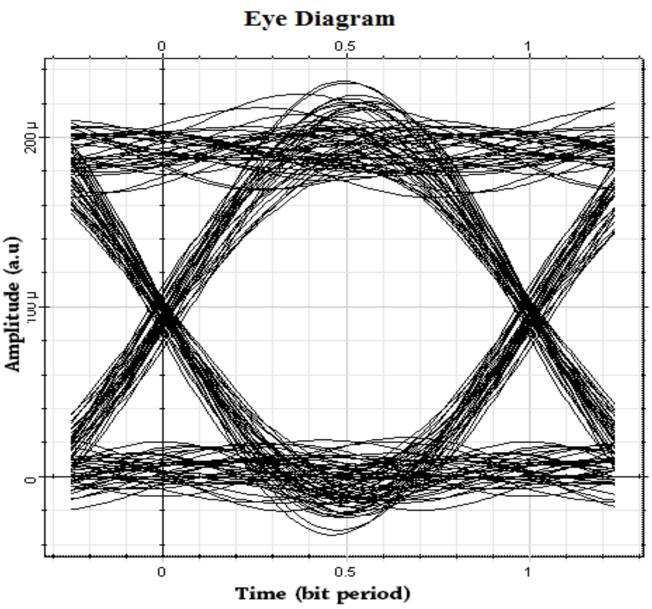


(a)

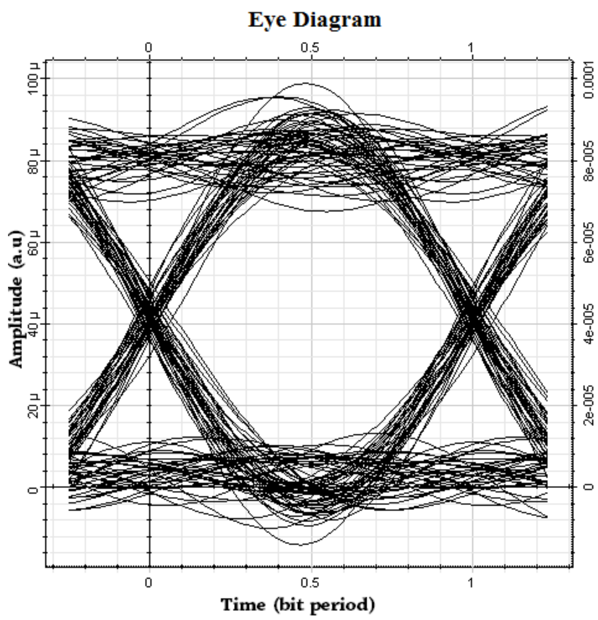


(b)

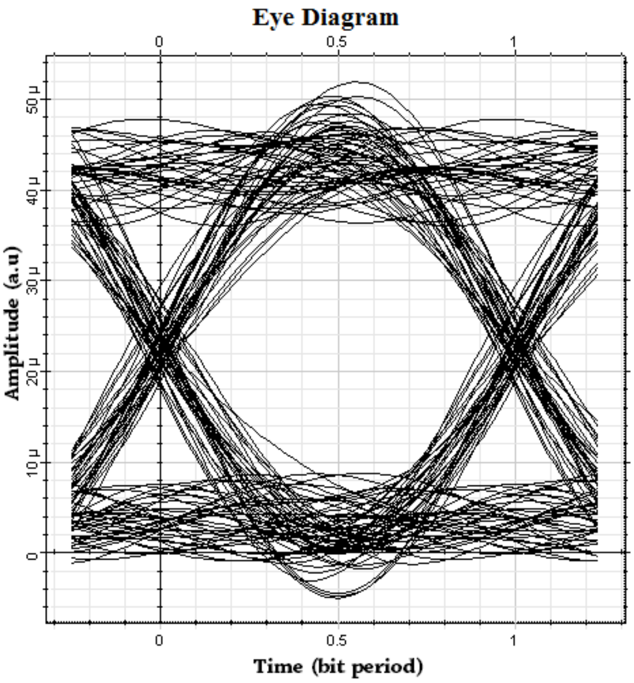
Fig 3 Evaluation of Total Power Vs Range of FSO Link (a) Different Modulation Technique (b) Different Atmospheric Conditions



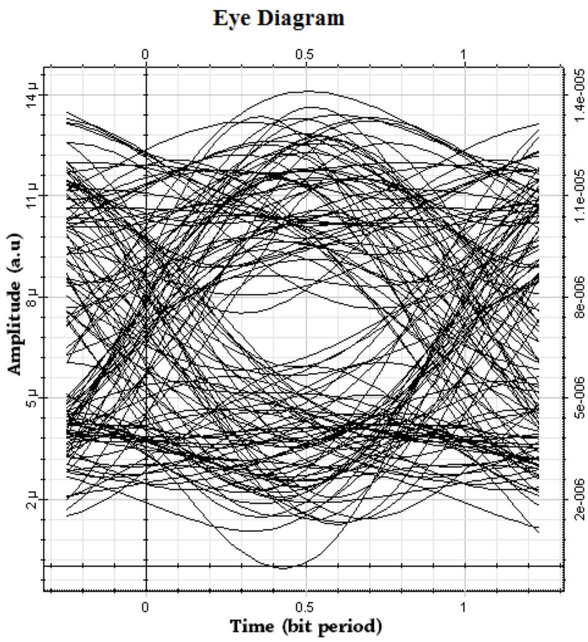
(a)



(b)



(c)



(d)

Fig 4 Evaluation of Eye Diagram at (a) Under Clear Weather Conditions after 1 Km b) Under haze after 1 Km (c) Under Fog after 550 m (d) Under Fog after 750 m

3. RESULTS AND DISCUSSION

As data rates increase, FSO channels are better to be described as slow fading channels. So, according to information theory, any given transmission rate cannot be supported by such channels. Consequently, in many practical situations, where delay constraints prevent using of an extended codeword and averaging over deep fade channels realizations is not possible, an appropriate measure of capacity is the probability that the channel can support a given transmission rate. SNR is the required parameter to support a rate R and the probability of outage parameter can be expressed in terms of SNR. Further, it can be expressed in terms of the cumulative distribution function CDF of the SNR. Hence, in this work, we have discussed the results in terms of SNR by transmitting 10 Gbps signals via FSO link using different modulation technique and different atmospheric conditions. It is revealed from the Fig 2 (a) that an improvement of 8 dB in SNR after 1 Km is computed in case of NRZ encoding scheme as compare to RZ & Raised Cosine schemes. Fig 2 (b) reveals that FSO Link prolongs to 1 Km with the acceptable SNR of 30 dB & 20 dB in case of under clear weather conditions and under haze whereas in case of under fog conditions it prolongs to only 500 m with the acceptable SNR of 20 dB. Consequently, the total power received at photo detector is revealed from Fig 3. Similarly the eye diagram is evaluated for different atmospheric attenuations in Fig 4. The eye is clearer in case of clear weather conditions and under the impact of haze after 1 Km FSO link as shown in Fig 4 (a) & (b). Further when the attenuation is increased to achieve fog condition the eye is distorted after 500 m & 750 m as shown in Fig 4 (c) and (d).

4. CONCLUSIONS

In this article, 10 Gbps data of three modulation format is transmitted through free space optical link under three different atmospheric conditions and the performance is measured in terms of SNR, total power and Eye diagrams. It is concluded from the results that NRZ format is better as compared to RZ & Raised Cosine modulation formats. Under Clear weather conditions the FSO Transmission link is prolongs to 1.3Km. Under the impact of Haze the link prolongs to 950 m where as under Fog conditions the link prolongs to only 480 m with acceptable SNR and BER.

5. REFERENCES

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