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System Performance of Free Space Optics in Underground Moving Train Using Optisystem 14

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ABSTRACT

Free space optical (FSO) communication has been developed as technology for broadband wireless applications, as an alternate to the existing RF technology which offers high date at Gbps on optical wavelength of 1550nm. This project focuses on FSO system model and simulation for the communication in underground trains using OPTISYSTEM 14. An increase in transmission for more than two base stations with range of each at 700m to maximum of about 1400m, whereas recent works were about 180m only. The improvement in data rate of about 4Gbps is achieved with a power of 25dBm. The performance evaluation were made with the variation in ranges for underground as well as overground trains in terms of BER, OSNR, Qfactor and received optical power.

Keywords: Free space optical communications, Bit error rate, Attenuation, Optical transmitters and Optical receivers.

1. INTRODUCTION

Free Space Optics commonly considers light as a medium to transfer data in the form of text, voice, audio and images [1]. The demands in the communication industry towards the need for increase data rate transmission has led to the development of FSO. The FSO system operates at 850nm that cause serious damage to eyes, taking the eye safety into account 1550nm wavelength is prescribed to provide safe laser outcomes to the humans on compared to the 850nm in this work [2]. Moreover, there is always a stable growth in this field on considering about the date rate as regarding Kbps to Mbps for the radio frequency systems [3], but FSO provides it for Gbps which is farthest for RF.

In the proposed work, the Free Space Optics are designed for the underground trains at state of both moving and at when the train is at immotion. A narrow beam of the light to the appreciable covering through the train track with the connection to the passengers inside and the surrounding resident area and public places through the area in terms of 1400meters are tracked for providing the reliable transmission.

2. PROPOSED SYSTEM

The FSO system is designed with the considered range of 1400m, the laser source of wavelength about 1550nm, between more than two base stations in order to connect more passengers inside the long train .The moving train chosen for performance evaluation is underground train. As this provides low attenuation due to various physical design in the track of the train [4].The system consists of various Base Stations (BS) which are positioned along the train track at 700m each with the total of 1400m along the track. At the top of each coach in the train trans-receivers are connected that interact with the main station for the data service over them [5]. Each base station consists of the laser source transmitter that emits a narrow beam of optical rays that communicates between the receiver [6]. The data signals from the train are obtained by the base stations are given to the receiver which is connected to the gateway server. The sever finds the destination address through the network layer and thus transfers the data packets through the Ethernet [7]. The base stations are allocated for the system in the form of linkage of coaches with the trans receivers situated at the top of the train coaches. These base stations on getting the data from the user transmits to the main station through the Ethernet in turn communicates with local area network on sharing data [8].

3. SIMULATION MODEL

The underground train system are designed with review from the works of foot printers in this field [9],[10]. The following Table 1 gives a detail parameters for the designing of the FSO system for underground train

Table 1 Design setup parameters

Parameter	Value
Frequency of CW Laser	193.1 Thz
Operating Wavelength	1550nm
Optical Power	25dBm
Linewidth	10Mhz
Range	600m
Attenuation	25dB/km
Beam Divergence	2mrad
Transmitter aperture diameter	5cm
Receiver aperture diameter	20cm
Transmitter loss	0db
Receiver loss	0dB
Responsivity	1A/W

Based on the design parameters as stated above the simulation was proceeded on construction of prototype in OPTISYSTEM 14 software. The system consists of a narrow beam of the continuous wave laser (CW laser) that connects with the frequency of about 193.1 THz. The source transfers its beam to the MachZehnder modulator that modulates the optical signal with carrier signal as modulating signal. The signals from the PRBS (Pseudo random bit sequence) codes the optical signals as 0's and 1's and transmits to the pulse generator which has its code as NRZ (non-return to zero) .The narrow beam of rays are propagated through the FSO channel with the wavelength of about 1550nm.This signal is passed through the channel that are transmitted to optical receiver to PIN photo detector. The outputs are evaluated for the variation in parameters at the visualizers as shown in the Figure 1.

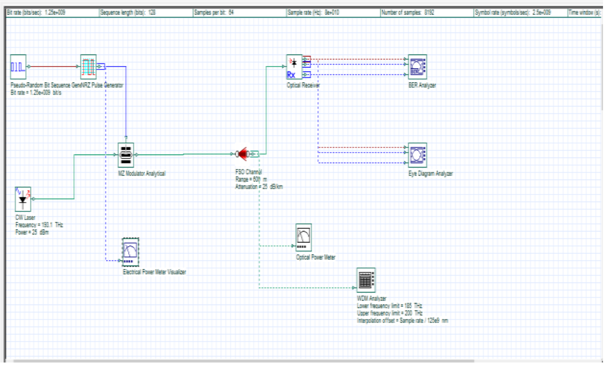

Figure 1 FSO Design

4. SIMULATION RESULTS

Based on the simulation design and model the results were obtained from the visualizers as, WDM Analyzer, BER Analyzer, Optical Power Meter and Eye Diagram Analyzer. The output is obtained for the parameters such as received optical power, BER, OSNR, and Qfactor on varying the range in FSO channel. The following graph were plotted using MATLAB R2011a for the values that were obtained for each parameters on variation of range for both underground and overground trains using OPTISYSTEM 14.

4.1 RANGE Vs QFACTOR

On considering both underground train and overground train, the comparison were made with the variation in ranges and results that were obtained through the "BER Analyzer" shows on the favor of underground trains .

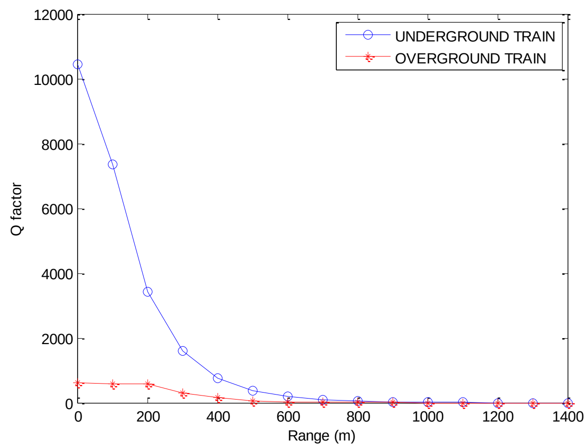

Figure 2 Variation in Qfactor for PIN photodiode at range of 1400m

The Figure 2 gives a clear view that on comparing both trains provide the stable Qfactor of efficiency around 70.4%.

4.2 RANGE Vs BER

On considering the parameter values for both trains, the comparison were made with the variation in ranges and results were obtained from the "BER Aanalyzer" based on favor of underground trains on different BER.

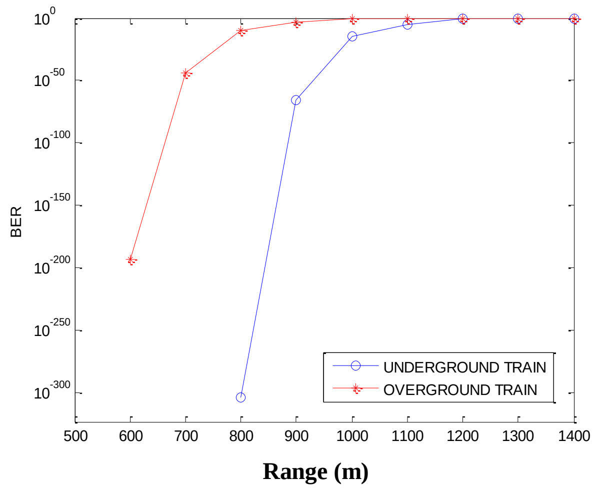

Figure 3 Variation in BER for PIN photodiode at range of 1400m

This graph in Figure 3 gives a clear view that trains have reasonable low BER around the efficiency of 75%.

4.3 RANGE Vs DATARATE

On evaluating both underground train and overground train on the basis of data rates, the comparison were made on variation in ranges and results were obtained "Eye Diagram Analyser" on favor of underground trains.

4.3.1 UNDERGROUND TRAIN

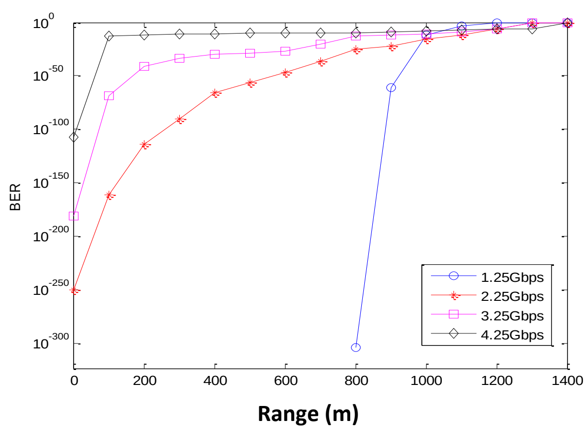

Figure 4 Variation in Data rate for PIN photodiode (underground) at range of 1400m

A BER of efficiency 75% at the transmission range is 800 m for the data rate of 1.25 Gbps and at the transmission range of 1200 m at the data rate of 4.25Gbps is achieved with the efficiency of about 55% for the Figure 4.

4.3.2 OVERGROUND TRAIN

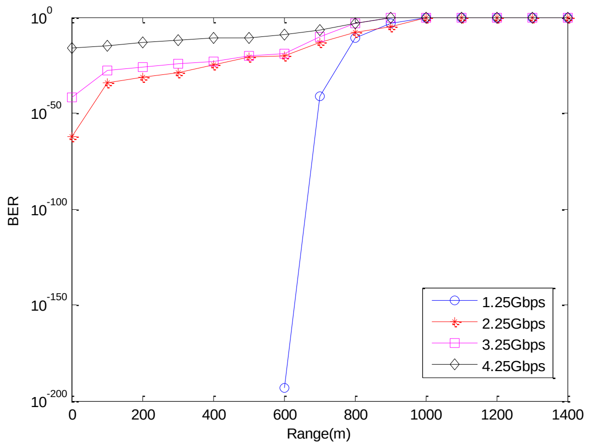

Figure 5 Variation in Data rate for PIN photodiode (overground) at range of 1400m

An efficiency of about 50% at the transmission range is 600 m for the data rate of 1.25 Gbps and at the transmission range is 800 m the data rate of 4.25Gbps is achieved with the efficiency of 34% for the Figure 5.

4.4 RANGE Vs RECEIVED POWER

The graph is curved with values from "Optical Power Meter" for both the trains without variation in modulator, since the power meter are connected with FSO channel and not with the optical receiver

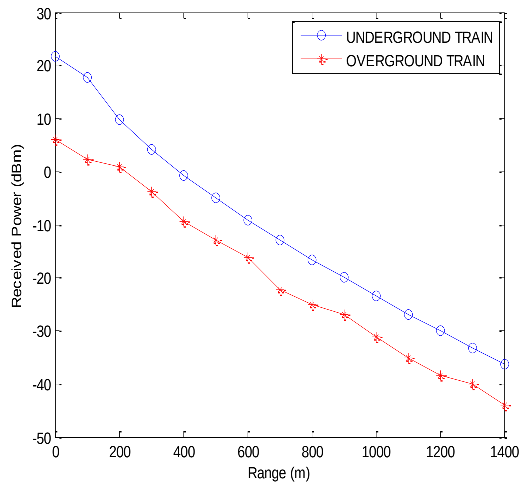

Figure 6 Variation in received power (dBm) for both trains at range of 1400m

The variation in plots for the Figure 6 prove that the efficiency of 82% is good among trains.

4.5 RANGE Vs OSNR

The graph is drafted with values from "WDM Analyser" for both the trains without variation in modulator, since the analyzer are connected with FSO channel and not with the optical receiver.

The variation in plots for the Figure 7 prove that the trains are good with the efficiency of 80% that satisfies with the default values.

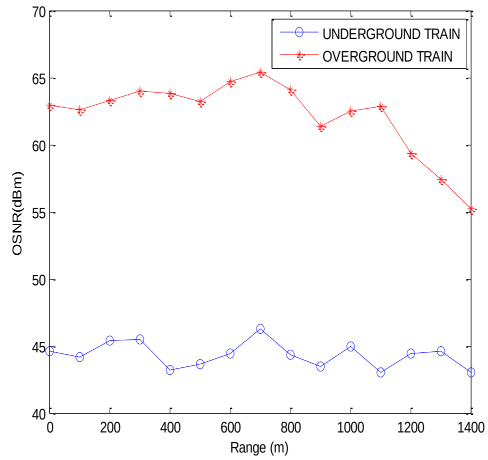

Figure 7 Variation in OSNR for both trains at range of 1400m

5. CONCLUSION

In this work, different parameter designs are implemented to enhance the performance of the underground train using OPTISYSTEM 14 between laser transceivers have been presented. The received power, the *Q*-factor, OSNR, BER and data rates for variation in ranges were analysed along that track. The measured and predicted results along the track was shown a good agreement with the underground train. The Power decreases as the length increases along the range of the train increases that covers longer distances. Based on the results from the Qfactor the system is evaluated along various ranges with results satisfy with the default values of the design. The obtained outcomes of the OSNR provide that system is stable with the more optical signal ratio than the noise ratio of the range. An improved performance with a BER at range of 800m is obtained for PIN photodetector. The data rates variation gives the declared result that propagation of the signals at Gbps with esteemed ranges, the reliable transmission is provided for 1.25Gbps with the PIN as the photo detector. The efficiency on overall performance of the system is obtained as 75% for the PIN photodector is obtained on increased range about 1400m.Thus the proposed design for the underground moving train was simulated and the results were shown as the improved in the optical performance of the system. The further works will be on modulation and coding techniques to ensure reliable links through the FSO channel.

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