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Research Article

Effect of Transmitter Pointing Error Angle on InterSatellite Communication

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Abstract

Optical communication fiber link can reach from fibers to the wireless system such as InterSatellite transmission system. InterSatellite communication is used for the communication between two satellites. This paper focused on the effect of the turbulences in InterSatellite communication system using multiple transmitter and receiver for LEO-LEO communication over 2000 km with 10Gbps data rate by using Optisystem 13.0 Software. The effect of transmitter pointing error in OWC at 850 nm and 1550 nm wavelengths are compared and the results are analyzed in terms of total received power and eye diagrams.

Keywords: *Transmitting pointing error, InterSatellite optical wireless communication, multiple transmitter/receiver, free space optical communication, Line of sight.*

1. Introduction

Optical wireless communication has risen with the increase of the bandwidth demand for the future wireless network. Manmade satellites have been developed for various research and communication purpose. Basically there are four orbits i.e. low earth orbit, medium earth orbit, highly elliptical orbit and geostationary earth orbit. These satellites are resides in any one of these orbits. InterSatellite links plays an important role for the communication of the two satellites in same or different orbits. It connects the two satellites directly. In this paper, the communications between two low earth orbit satellites are considered. Lasers are used as a carrier signal for free space optical communication. Free space optical communication is an ultrahigh speed and large capacity communication. The main advantage of the use of laser is having narrow beam width and therefore, it is preferred over RF communication. Some more advantages are reduction in the size of the antenna; offer high bit rate and minimum power is used for the communication. The wireless optical channel concept in terms of received power can be mathematically expressed by the formula:

$$P_R=P_T\eta_T\eta_R(\lambda/4\pi Z)G_TG_RL_TL_R$$

where P_R is received optical power, P_T is the transmitted optical power, η_T is the optical efficiency of the transmitter, η_R is the optical efficiency of the receiver, λ is the signal wavelength, Z is the distance between the transmitter and receiver, G_T is the transmitter telescope gain, G_R is the receiver telescope gain, L_T is the transmitter pointing loss factor and L_R is the receiver pointing loss factor.

In OWC as the distance increases the error will be increases therefore, longer links requires more and advanced recovery, pointing and tracking system. The main requirement of InterSatellite optical wireless communication system is that the transmitter and receiver antenna must be in line of sight. The transmitting pointing and receiving loss factor are mathematically expressed as:

$$L_T=\exp(-G_T\theta_T^2)$$
$$L_R=\exp(-G_R\,\theta_R^2)$$

where, θ_T and θ_R are the transmitter and receiver azimuth pointing error angle.

2. Related Work

In this section the related works based on the effects of turbulences on free space in InterSatellite communication system having multiple transmitters/receivers have been reviewed. (A. H. Hashim, 2010), presented the performance of optical wireless link between LEO-LEO satellites, (A.W. Naji *et al*, 2012, R. Gupta June *et al*, 2014), analyzed the performance of optical wireless link using multiple transmitter/receiver, (S. Chaudhary *et al*, July 2014, S.

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Chaudhary *et al,* 2014), analyzed the performance in free space under different atmospheric effects.

3. System Description

The InterSatellite setup having 4 multiple transmitter/receiver is shown in figure 1 designed by using Optisystem 13.0 Software. The system consists of the transmitter section in which 10Gbps NRZ information is carried and modulated by Mach-Zehnder modulator. The continuous wave laser is used at 193.1 THz and power of 10dBm. The signal is then splitted into 4 signals and again passed it to the 4 forks which again split these signals into 4 signals. After that 4 power combiner are used to combine the respective signals from the forks. The optical signal is transmitted over 2000 km distance through optical wireless channel. The transmitter and receiver each are having the antenna aperture diameter of 50 cm. The mispointing of the transmitter antenna is investigated by varying the transmitter pointing error angle from 0μrad to 3μrad. At the received end these signals are then combine by using a power combiner. Avalanche Photodiode (APD) is used as a photo detector followed by the low pass Bessel filter and 3R regenerator.

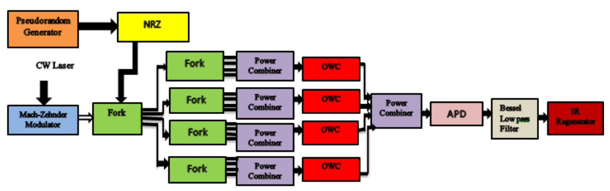


Fig.1 Proposed InterSatellite system

4. Simulation Results

In this section the results of the proposed Is-OWC are discussed.

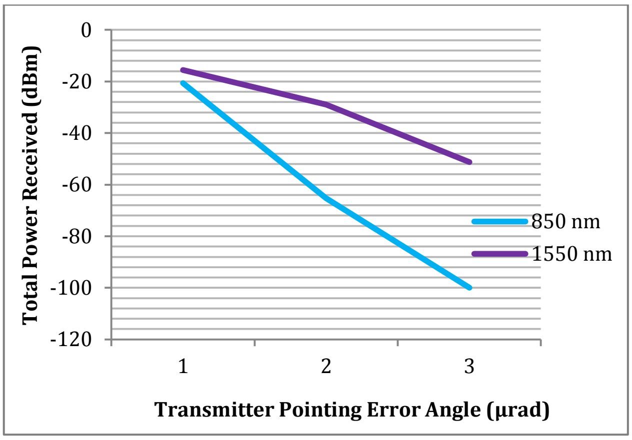
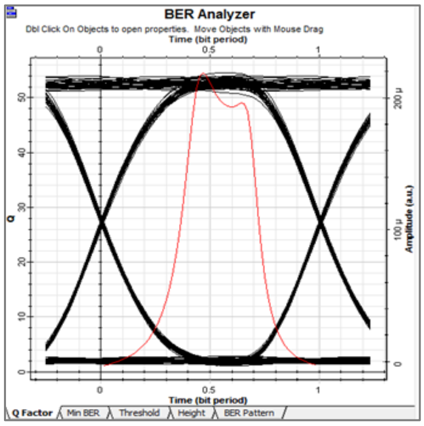
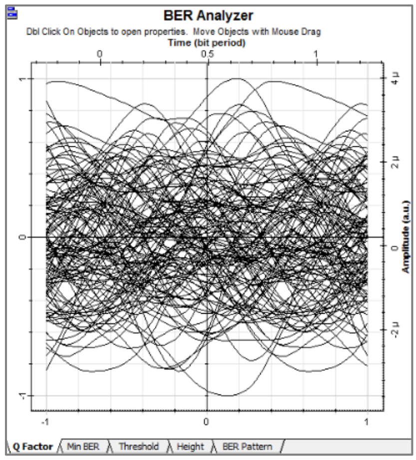


Fig. 2 Total power received vs. transmitter pointing error angle (μrad) at 850 nm and 1550 nm

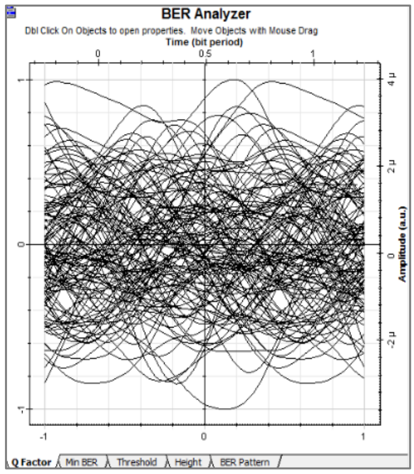
The effects of the transmitter pointing error angle are analyzed for two operating wavelengths 1550 nm and 850 nm in terms of eye diagram and power received. It is analyzed from the eye diagram at 850 nm that when the transmitter pointing error angle reaches to 2μrad the eye diagram gets distorted due to the high bit error rate as compared to the 1550 nm. Figure 2 shows the total power received vs. transmitter pointing error angle at different wavelengths i.e. 850 nm and 1550 nm. It is noticed that at 850 nm and 1550 nm the total power received degrades as the transmitter pointing error angle reaches at 3μrad.



(a)

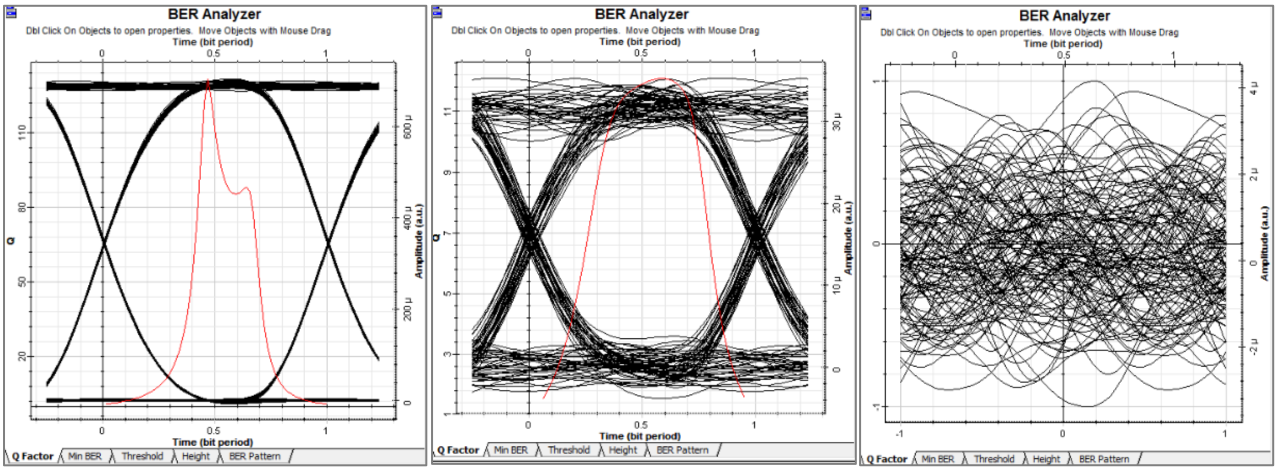


(b)



(c)

Fig. 3 Eye diagram at transmitter pointing error angle at 850 nm (a) 1μrad (b) 2μrad (c) 3μrad



(d) (e) (f)

Fig. 4 Eye diagram at transmitter pointing error angle at 1550 nm (d) 1μrad (e) 2μrad (f) 3μrad

Conclusion

In this paper the InterSatellite system setup having high data rate of 10Gbps through an Optical Wireless Channel over 2000 km is transmitted between two satellites under the effect of transmitter pointing error angle is designed using Optisystem 13.0 Software. Therefore, it is concluded from the simulation results that the performance of Optical Wireless link at 2000 km distance is better at 1550 nm as compared to 850 nm.

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