Determination of Q Factor and Eye Height for Manchester Encoded Input Signal FSO System under Different Atmospheric Conditions for Different Receiver Diameter and Input Power

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ABSTRACT

In this paper FSO system with input as Manchester coded signal is designed and analyzed the performance of FSO channel under atmospheric turbulence for different values of input laser power and receiver aperture diameter. Eye diagrams are constructed by simulating FSO system in OptiSystem tool to find out performance metrics such as Q-factor and eye height. Attenuation is taken as 5dB/Km, 20dB/Km, 40dB/Km and 70dB/Km. All the simulations are performed at 15Gbps data rate and 1550 nm wavelength.

Keyword: *- Mach-Zehnder interferometer, Attenuation, Eye Height, Q Factor*

1. INTRODUCTION

Free space optical (FSO) communication is a leading technology. It is used to handle high data rate and it has big content handling capacity. FSO communication systems are conferred as an available secondary to the fiber optics technology that is able of full duplex sending of information, voice and video in real time applications. Even though light can be competently entered into fiber cables to route the light content, there are many applications where only the free space between the sender and receiver is the only available means to set up a communication link. This free space technique requires only a clear line- of- sight (LOS) path among the transmitter and the remote receiver.

The research in this field has enhanced considerably and commercial use of FSO started after successful trials from 1990s to till date. The images were transmitted among the Waterhouse Centre and the studio during Sydney Olympic Games in 2000. In Japan, JAXA's Optical Inter-orbit Communications Engineering Test Satellite (OICETS) was propelled in 2005, and a laser communication link with advanced relay and technology mission satellite (ARTEMIS) was with success implanted. A German satellite, Terra SAR-X, holding a Laser Communication Terminal (LCT) which permits for optical communications at data rates of up to 5.5 Gbit/s, was founded in June 2007.

For a FSO link to work, it is very crucial that transmitted beam of light should be arranged with the receiving aperture of the transceiver at both end of the link. The adjustment between transceivers gets distressed due to a number of theory like wind effect, and vibration due to sender and receiver stages. Due to conflict of sender and receiver the line of sight link cannot be approved and the received power is heavily reduced or in some cases totally departed. The bigger the receiving aperture is, the moreover scintillation it can conflict. Although, enlarging the size of the receiver aperture region may not be practical, so spatial diversity is used rather huge aperture area.

2. PREVIOUS WORK

In 2017 authors Deeksha Jain and Dr. Rekha Mehra studied the stuff of various atmospheric situations on FSO within 500 m range for several values of attenuation. These simulations are executed for 10 Gbps data rate. Q factor and eye height are determined for each case in Optisystem tool. Their results are mentioned below:

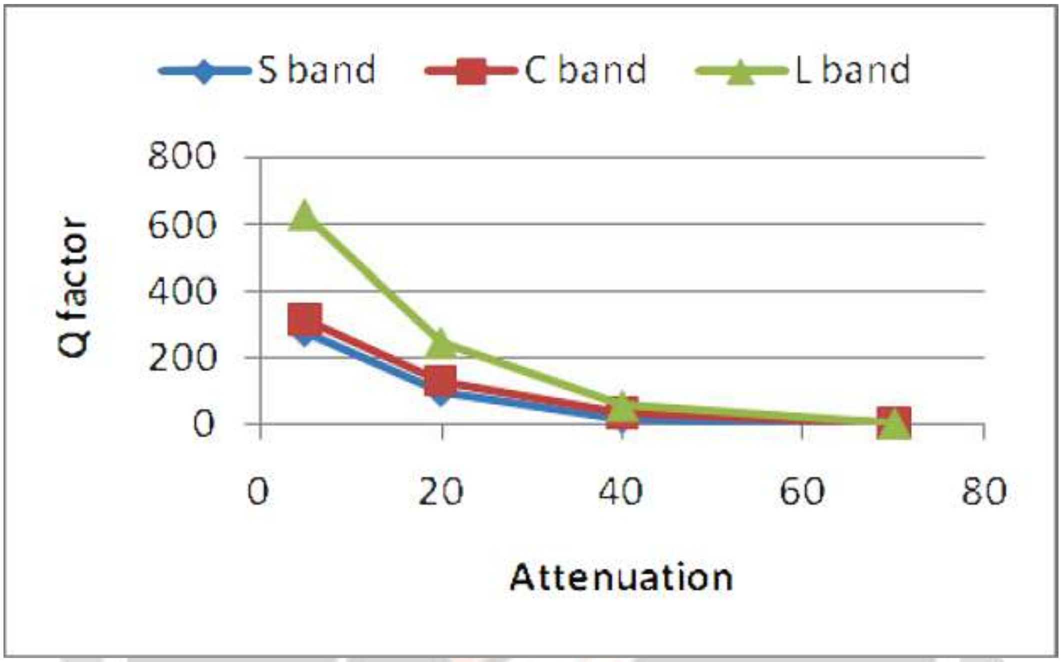

Fig 1 Q factor versus attenuation for NRZ for different frequency

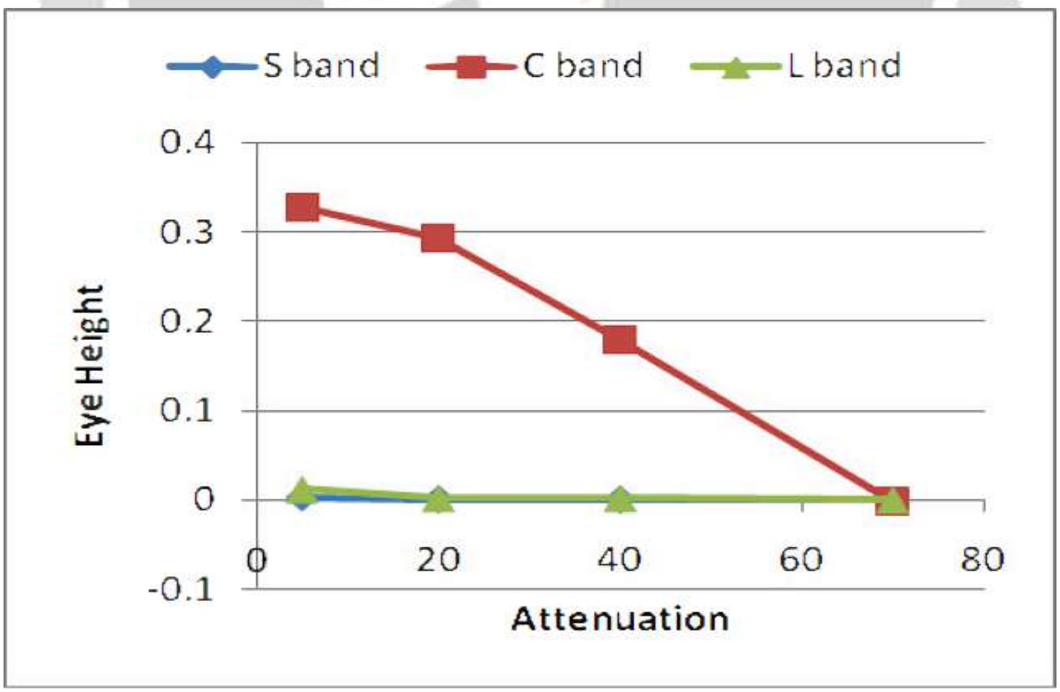

Fig 2 Eye height versus attenuation for NRZ for different frequency

3. PROPOSED DESIGN

In Fig.3 initially a user defined bit sequence generator having 15 Gbps data rate is used to generate user defined bit pattern also called data (110011). One more user defined bit sequence generator having 15 Gbps data rate is implemented to generate a clock signal (101010).

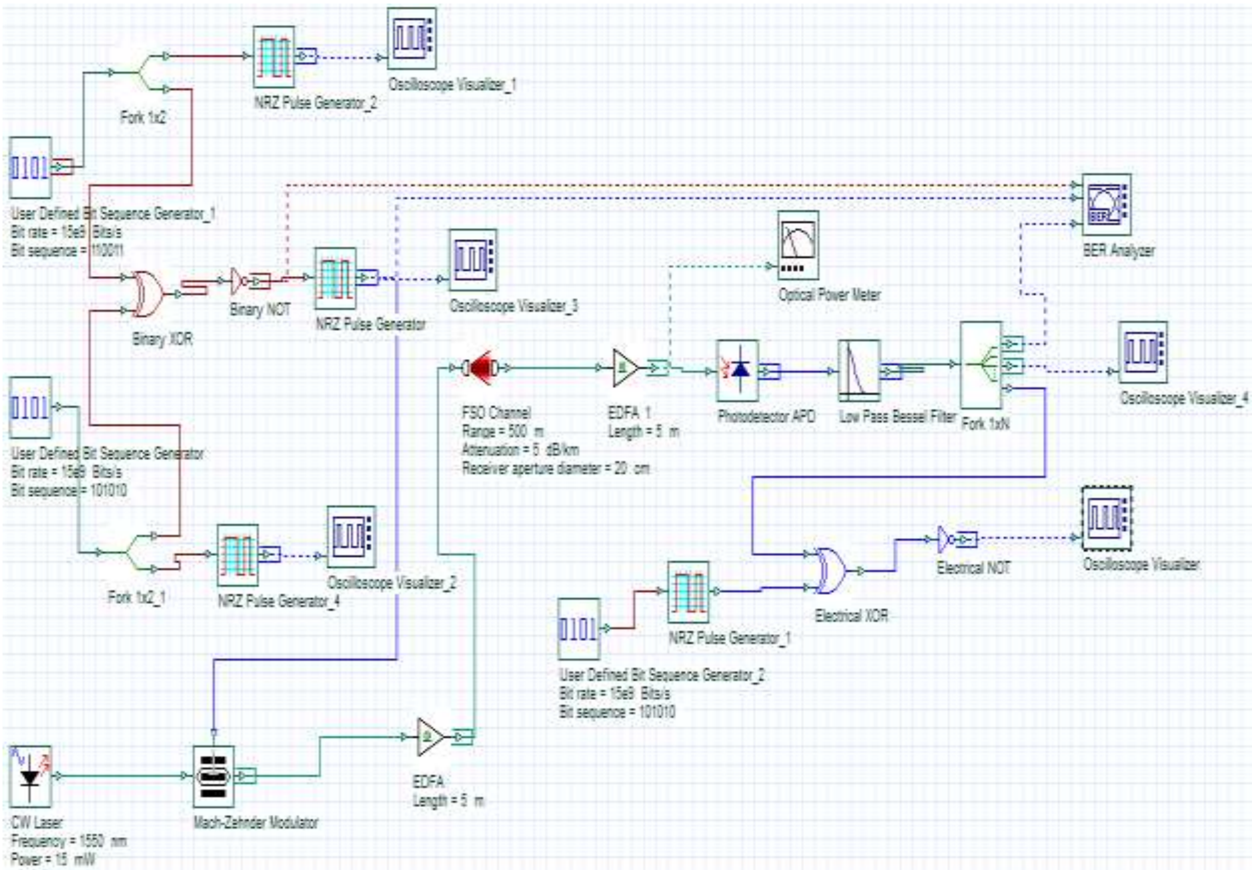

Fig 3 FSO system with Manchester Encoding

4. EXPERIMENTAL RESULTS

All FSO systems are simulated at 15 Gbps data rate to determine Q factor and eye height for different receiver aperture diameter at different values of attenuation for 1550nm frequency. In this analysis range is kept constant at 500 m. Proposed results are shown below:

Table 1 Simulation results for 30 cm receiver diameter

Input power = 15mW, Range = 500 m, Wavelength = 1550 nm		
Attenuation (dB/Km)	**Q-factor**	**Eye Height**
5	517.39	0.348
20	277.51	0.319
40	108.69	0.249
70	16.61	0.029

Table 2 Simulation results for 25 cm receiver diameter

Input power = 15mW, Range = 500 m, Wavelength = 1550 nm		
Attenuation (dB/Km)	**Q-factor**	**Eye Height**
5	432.94	0.341
20	255.23	0.313
40	95.36	0.227
70	11.28	0.018

Table 3 Simulation results for 20 cm receiver diameter

Input power = 15mW, Range = 500 m, Wavelength = 1550 nm		
Attenuation (dB/Km)	**Q-factor**	**Eye Height**
5	420.69	0.333
20	194.14	0.304
40	63.22	0.194
70	9.41	0.011

All FSO systems are simulated at 15 Gbps data rate to determine Q factor and eye height for different receiver aperture diameter at different values of attenuation for 1550nm frequency. In this analysis range is kept constant at 500 m and receiver diameter at 20 cm.

Table 4 Simulation results for 25 mW input power

Wavelength = 1550 nm, Range = 500 m, Receiver diameter = 20 cm		
Attenuation (dB/Km)	**Q-factor**	**Eye Height**
5	440.84	0.334
20	204.99	0.306
40	68.84	0.200
70	9.73	0.012

Table 5 Simulation results for 20 mW input power

Wavelength = 1550 nm, Range = 500 m, Receiver diameter = 20 cm		
Attenuation (dB/Km)	**Q-factor**	**Eye Height**
5	434.75	0.334
20	217.26	0.305
40	76.06	0.197
70	9.25	0.011

Table 6 Simulation results for 15 mW input power

Wavelength = 1550 nm, Range = 500 m, Receiver diameter = 20 cm		
Attenuation (dB/Km)	**Q-factor**	**Eye Height**
5	420.69	0.333
20	194.14	0.304
40	63.22	0.194
70	9.41	0.011

5. COMPARISON WITH PREVIOUS RESULT

All the simulation results are compared with the results of previous literature and found that our results are better than those results.

Table 7 Q factor comparison between proposed and previous work for 1491 nm wavelength

Input power = 15 mW, Range = 500 m		
Attenuation (dB/Km)	**Q Factor**	
	Proposed Work	**Ref [11]**
5	267.38	277.38
20	145.76	97.51
40	63.77	17.47
70	7.82	0

Table 8 Eye height comparison between proposed and previous work for 1491 nm wavelength

Input power = 15 mW, Range = 500 m		
Configuration	**Eye Height**	
	Proposed Work	**Ref [11]**
5	0.0047	0.0026
20	0.0016	0.0005
40	0.0003	0.00003
70	0.0019	0

Table 9 Q factor comparison between proposed and previous work for 1531 nm wavelength

Input power = 15 mW, Range = 500 m		
Configuration	**Q Factor**	
	Proposed Work	**Ref [11]**
5	400.23	316.94
20	214.83	131.25

40	68.48	34.85
70	8.67	2.84

Table 10 Eye height comparison between proposed and previous work for 1531 nm wavelength

Input power = 15 mW, Range = 500 m		
Configuration	**Eye Height**	
	Proposed Work	**Ref [11]**
5	0.334	0.328
20	0.314	0.294
40	0.269	0.180
70	0.068	-0.001

6. CONCLUSION

We have successfully performed analysis of FSO communication system designed with Manchester encoded signal as an input signal. This system is analyzed under different values of atmospheric attenuation such as 5 dB/Km, 20 dB/Km, 40 dB/Km and 70 dB/Km. FSO system is simulated at all attenuation factors for different wavelength, receiver aperture diameter and input power. In previous work at 1491 nm wavelength, Q factor for attenuation 5, 20, 40 and 70 dB/Km is 277.38, 97.51, 17.47 and 0 respectively whereas our results are 267.38, 14.76, 63.77 and 7.82 which is better than previous results. In previous work at 1531 nm wavelength, Q factor for attenuation 5, 20, 40 and 70 dB/Km is 316.94, 131.25, 34.85 and 2.84 respectively whereas our results are 400.23, 214.83, 68.48 and 8.67 which is better than previous results.

7. REFERENCES

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