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AN EFFECTIVE AUDIO TRANSMISSION USING VISIBLE LIGHT COMMUNICATION

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Abstract - *This work is based upon the concept of enlightenment and communication using laser. The dependency on wavelength of silicon photodiode (Si PD) used in the optical communication is studied by means of simulation. The sensitivity of the silicon photodiode is compared for three wavelengths corresponding to Red (680nm), green (550nm) and Blue (450nm).The performance of red is high as compare to green and blue at different weather condition. Visible Light Communication is an upcoming field in the communication world. It will provide highest band width, high refuge, efficient power transmission and less spin as compared to all other wireless networks. The major challenge on Visible Light Communication technology is atmospheric attenuation that hampers data transmission of the system by increasing bit error rate. Fog is the distinctive condition which causes highest amount of signal weakening. Signaling rate is taken is 5Gbps, transmitting power is 15 mW and NRZ encoding technique is taken during transmission, transmitter channel is FSO and for reception a PIN photodiode with Bessel filter is taken. This paper primarily describes the effect of bad weather condition on FSO link within 100m range for an attenuation of up to 80 dB/km. Simulation parameter such as Quality factor, minimum BER(bit error rate) and Eye diagram are studied to have the idea of system performance using OPTISYSTEM 12.0 of optical software.*

Keywords *– Optisystem, NRZ encoder, FSO*

I.INTRODUCTION

Wireless communication has gone through several hypothesis shifts starting from the discovery of Electromagnetic (EM) he waves, wireless telegraphy, and the invention of the radio. The EM spectrum as the wavelength decreases, the frequency as well as the energy of the wave increases [1]. The visible light band occupies the wavelength range from 380nm to 750nm and the radio wave occupies the band from 3 GHz to 300 GHz [2]. Radio Frequency (RF) has been the most widely used portion of the EM spectrum for communication purpose, mainly due to little interference in the frequency band and wide area coverage [1]. However, several factors including the rapidly decreasing RF spectrum is driving the needs for an alternative technology. Visible Light Communication (VLC) is emerging as a solution to overcome the crowded radio spectrum for wireless communication system and also its deals with the data congestion problem of radio wave [3]. The Visible Light Communication is the communication technology that utilizes visible light as a transmitting signal, air as a transmission medium and photodiode as a receiver [2].The VLC has more security in communication because the hacker cannot receive the signal instead of Line-of-Sight (LOS) [3]. The luminous efficacy of LED lamps and luminaires is around 100 lm/W (lumen per watt) which is expected to expansion up to 200 lm/W (luman per watt)around in 2025 [2]. A white LED try to implement this effect providing a broad range of wavelengths (red, green and blue) [3].The VLC was first proposed in 2004 by Toshihiki komine and has progressed quickly ever since with the development of solid state light sources, especially light emitting diodes(LEDs) [4]. The great popularity of VLC owes largely to the advantages of LED such as high brightness, low cost, small size, low power consumption, long lifetime and low heat radiation [4]. During the last four decades, the technical progress in the development of LED has been breathtaking [5]. Besides illumination, LED have been finding application in data communication due to their fast switching time. As an optical source for little-range indoor communication visible LEDs are cheap and dependable, offering high data rate capabilities [5]. In VLC, information is transmitted by modulating the intensity of an optical source operating in visible range of the EM spectrum at a rate much faster than the response time of the human eye, which is effectively supposed as a steady glow. An optical wireless communication link using high brightness illumination LEDs has been demonstrated to support a modulation bandwidth of up to 20 Mb/s [5]. In VLC the data are transmitted via light is achieved by having the light source flicker on and off to represented as a logic high and logic low signal respectively. The pulse Width Modulation to provide bandwidth of 6.5 MHz, specifically optimized for composite video and audio signals but equally suitable for any high quality analogue signal [10].

The power loss in VLC system is comparatively lower power than RF communication. So, it desire less amount of power for communication in VLC system which results in a competent communication system between the transmitter and receiver. There are many neurological diseases which are the results of radio frequency (RF) communication. On the other hand, VLC system forges no health hazards and completely qualified for human being [2]. There is another unique property of light that, it cannot pass through the walls. So, it establishes a better protected communication. Also electromagnetic interference (EMI) and radio frequency interference (RFI) are the ultimate limitation of RF communication however they have no repercussion on VLC [3]. Besides wireless connectivity in home environment, combining the function of illumination and transmission is also attractive in specific scenarios where healthy, secured and non-interfered communication is necessary, such as hospital, underground mine, underwater, airplane [4].

The most important difference between Fiber Optics and VLC is that VLC is affected by prevailing conditions of environment.

1. Thick fog is one of the most complex forms of interference in Visible Light communication. This occurs because of the moisture in the fog that can reflect, absorb and scatter the signal [11].
2. Absorption and scattering both occur when there is a lot of moisture in air. Absorption of the signal causes a reduction in signal strength. Scattering causes the signal to be dispersed in various directions [11].
3. Physical obstructions, such as trees and even building, can also be a problem.
4. Alignment, the main challenge with FSO systems is maintaining transceiver alignment. FSO transceiver transmits highly directional and narrow beam of light

Table1: Different weather conditions with their attenuations

Conditions	Attenuation in dB/Km
Heavy Fog	80-200
Light Fog	40-70
Snow	20-30
Rain	4-17
Clear Weather	0.2-3

In this paper we proposed the Visible Light Communication system and its performance are measured with a numerical tool for different bit rate through various link distance. Practically measured channel parameters are utilized for VLC system and analysis are carried out for various system condition. Q factor value are measured in detected signal for performance comparison. This paper is organized as follows. Section II describes the experimental setup, Section III, Result and Discussion and finally the conclusion is given in the last section IV.

II. EXPERIMENTAL SETUP

The proposed experimental setup for the VLC system is as in Fig.1.VLC system consists of a transmitter, propagation channel and a receiver. The VLC system is designed with help of OPTISYSTEM 12.0. The FSO (Free Space Optics) components is used for VLC channel. The optical transmitter consists of a message signal generated through sequence generator (in Gbps) which is a pseudo random bit sequence generator (PRBS). The PRBS signal is passed through the electrical pulse generator, viz NRZ (Non-Return To Zero) or RZ (Return To Zero) which converts the bit sequence (in the form of 0 and 1) into an electrical pulse. This NRZ pulse and CW laser source is modulated using a Mach Zender Modulator (MZM).

Mach Zender Modulator is an electro optic modulator. The modulated optical signal is given to the WDM multiplexer. In the optical communication wavelength-division multiplexing is a technology which multiplexes a number of optical carrier signals into single carrier signal by using different wavelengths (i.e., colors) of laser light. The carrier signal is transmitted into the FSO channel through the transmitting antenna. The characteristics of a signal is hindered in this free space channel due to various weather conditions. At receiver the optical signal is received through the receiving antenna. The WDM DEMUX is used to demultiplexing the signal and the signal is given to the corresponding photodiodes. The received optical signal is then converted into the electrical signal using a suitable photo detector. The photo detector used here is PIN photo detector. Then the electrical signal is passed to LPF (Low Pass Filter) pass the low frequency signal and rejects the high frequency signal in the form of noise. The 3R regenerator is used to retime, reshape and reamplify the electrical signal. The performance of a received electrical signal is analyzed using BER analyzer.

Table 2: FSO link parameters

Parameters	Value
Transmission Bit Rate	5 Gbps
Link Distance	300m
Optical Transmitter Power	15mW
Modulation Type	NRZ
Transmitter aperture diameter	0.16
Receiver aperture diameter	0.51
Beam divergence	0.35
Transmitter wavelength	680nm
Signal attenuation	5 dB/km, 20 dB/km, 40 dB/km and 80 dB/km
Photo detector type	PIN photodetector
Dark current	10 nA
Responsivity of receiver	1 A/W

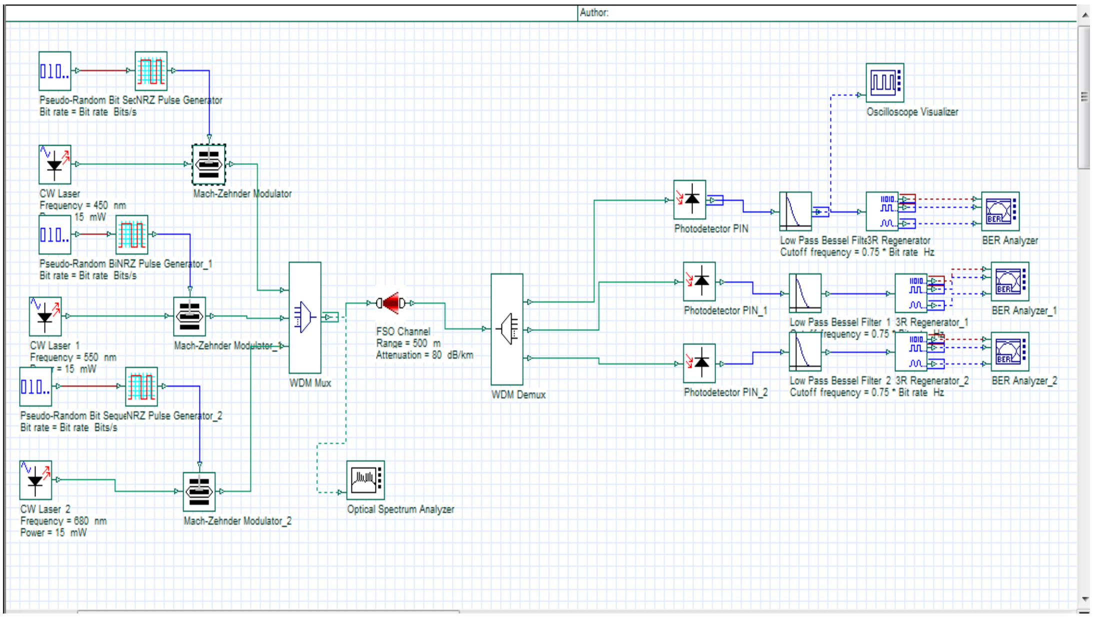


Fig 1: FSO System Model

Table3. Comparison of the proposed work with previous work

Work	source	Modulation Techniques	Attenuation	BER	Q-Factor	Bit Rate
Shaina et al	laser	NRZ-OOK	70 dB/km	0.00153508	2.59	2.5 Gbps
Saru arora et al	laser	NRZ-OOK	20 dB/km	$10e^{-11}$	6	2.5 Gbps
Manivannan et al	LED	RZ-OOK	-	-8.399	8.73	100 Mnps
Deeksha Jain et al	laser	NRZ-OOK	70 dB/km	0.00160863	2.93428	10 Gbps
Proposed work	Laser (visible range)	NRZ-OOK	80 dB/km	$3.4227e^{-027}$	10.7359	5 Gbps

III. SIMULATION RESULTS AND DISCUSSIONS

Bit Error Rate (BER):

Bit Error Rate (BER) corresponding to the maximum error rate present in the reception of bits in the communication systems. For reliable communication, ideally the value of BER is equal to 10^{-9} [12].

BER= (No. of bits in error / Total no of bits sent)

(or)

$$BER = erfc\,(Q/\sqrt{2})/2$$

Quality Factor (Q-Factor):

In optical communication, the common existence of signals are power and noise. That is why SNR is an important parameter for any communication systems. Q-factor is a dimensionless measurement where it simply indicates quality factor of the system whether it is underdamped or overdamped.

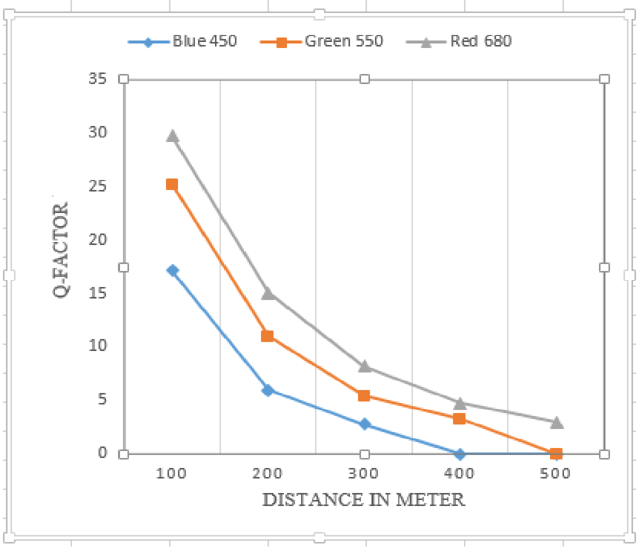
$$Q = \frac{SNR\sqrt{2TBopt}}{1+\sqrt{1+2SNR}}$$

Table 4. Comparison table for q-factor vs weather condition

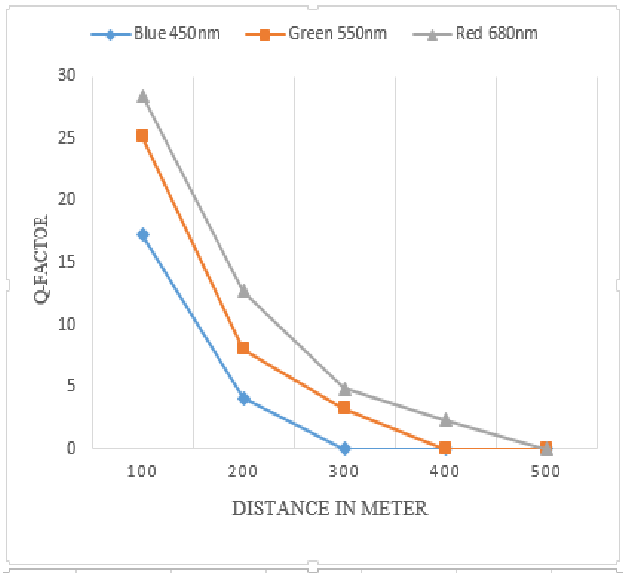
DATA RATE	DISTANCE	Q-FACTOR	WEATHER CONDITION
5Gbps	300m	8.19072	0.2 dB/km
	200m	12.6778	8 dB/km
	200m	6.12043	25 dB/km
	100m	20.2646	40 dB/km
	100m	10.7359	80 dB/km

3.1 Analysis for better Wavelength:

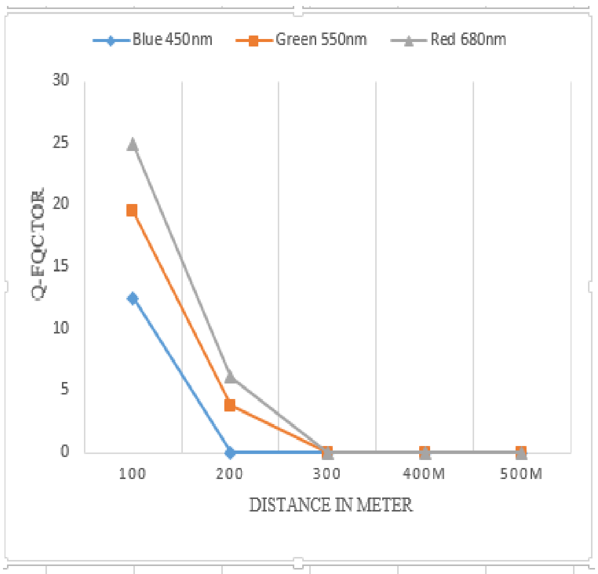
In this analysis, 5 GB data is transmitted for different wavelength ranges at different atmospheric ranges to the distance of 100 m, 200 m, 300 m, 400 m and 500 m. For the better understand red wavelength of 680 nm, green wavelength of 550 nm and blue wavelength of 450 nm is taken into account. The simulation results are discussed below.



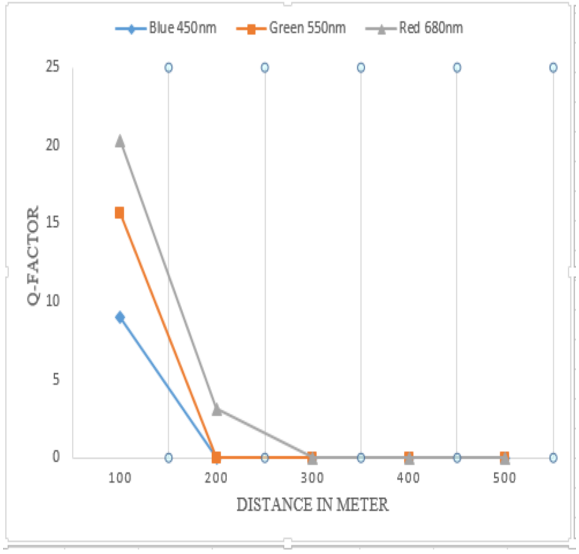
(a) 0.2 dB/km



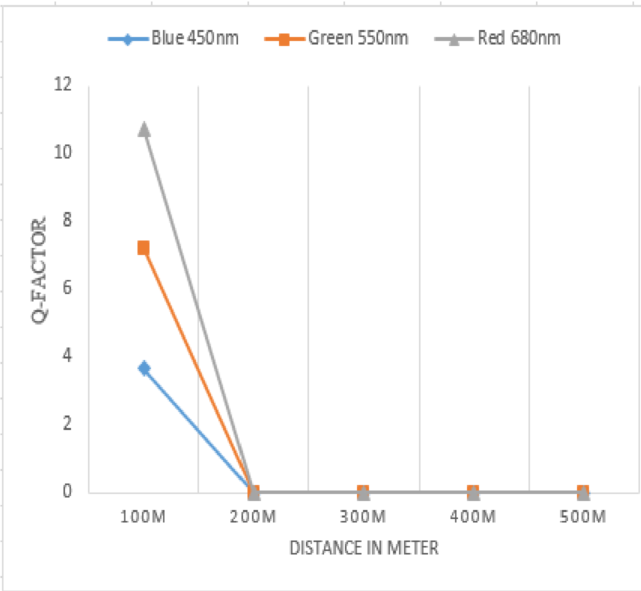
(b) 8 dB/km



(c) 25 dB/km



(d) 40 dB/km



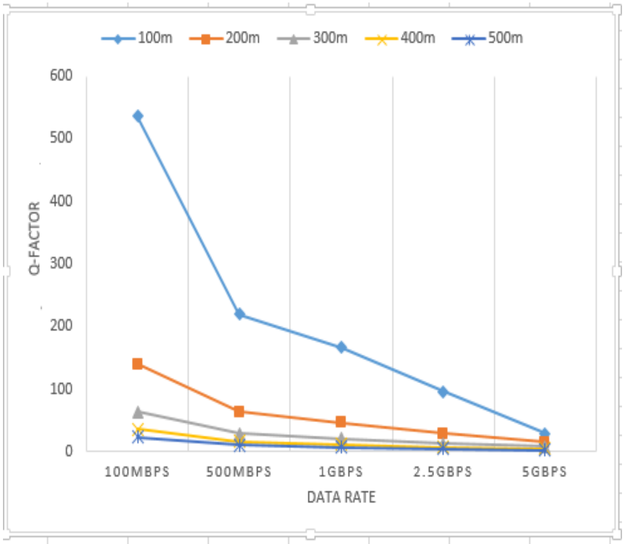
(e) 80 dB/km

Fig 2: Different wavelength at 5Gbps in (a) 0.2 dB/km, (b) 8 dB/km, (c) 25 dB/km, (d) 40 dB/km, (e) 80 dB/km

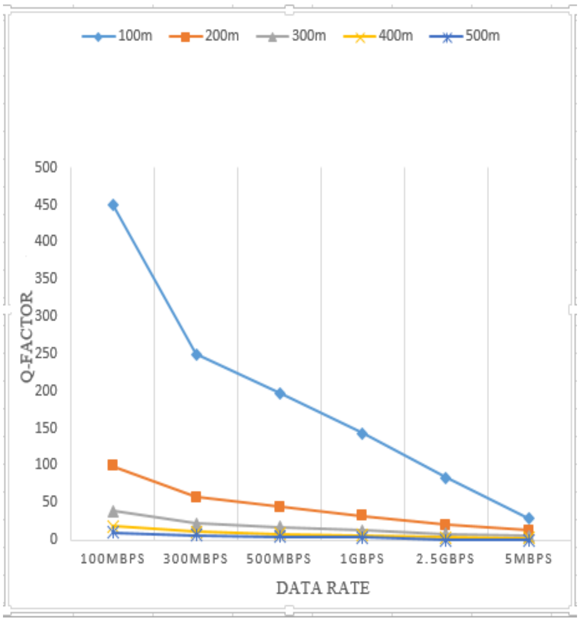
After analyzing the graphs (a), (b), (c), (d) and (e) the Red wavelength laser (680nm) having the better performance than other two laser. So that Red laser is used for data communication for one place to another place by using air medium. In case of visible light, waves of shorter wavelength/high frequency travel less (blue) and those with larger wavelength / low frequency travel longer (red light) distance. The red laser have the larger beam diameter than the green laser because of the beam diameter red laser uaually have better divergence. Many higher powered red laser are available with an adjustable focus.

3.2: Audio Transmission using Red Wavelength Laser at different atmospheric conditions

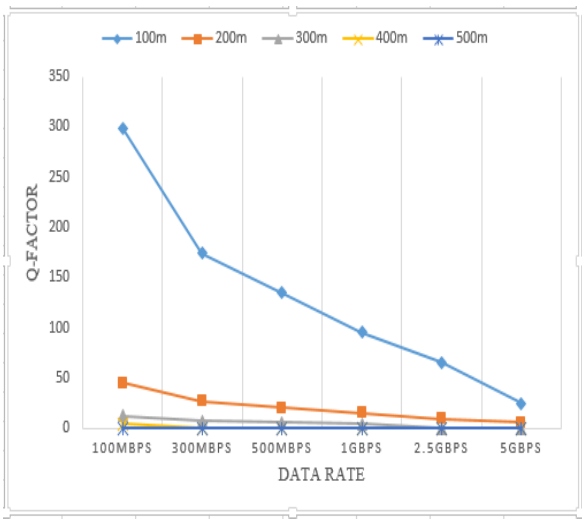
For Analyzing the results the graph is plotted between data rate vs q-factor at different distance.



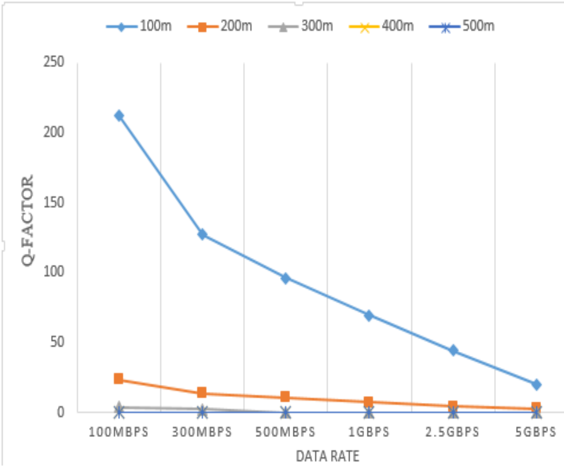
(f) 0.2 dB/km



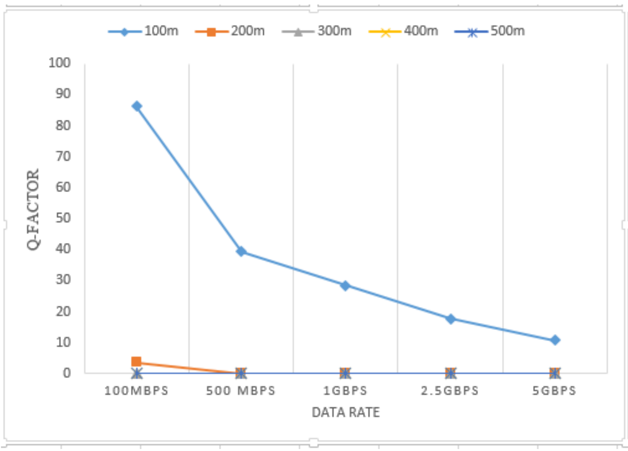
(g) 8 dB/km



(h) 25 dB/km



(i) 40 dB/km



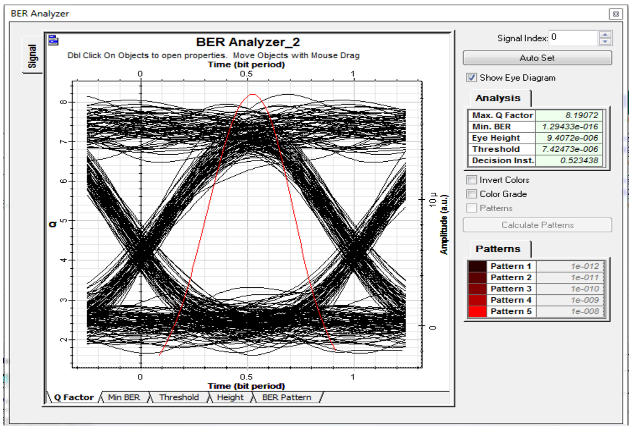
(j) 80 dB/km

Fig 3: Red wavelength at different data rate and different distance in different atmospheric (a) 0.2 dB/km, (b) 8 dB/km, (c) 25 dB/km, (d) 40 dB/km (e) 80 dB/km

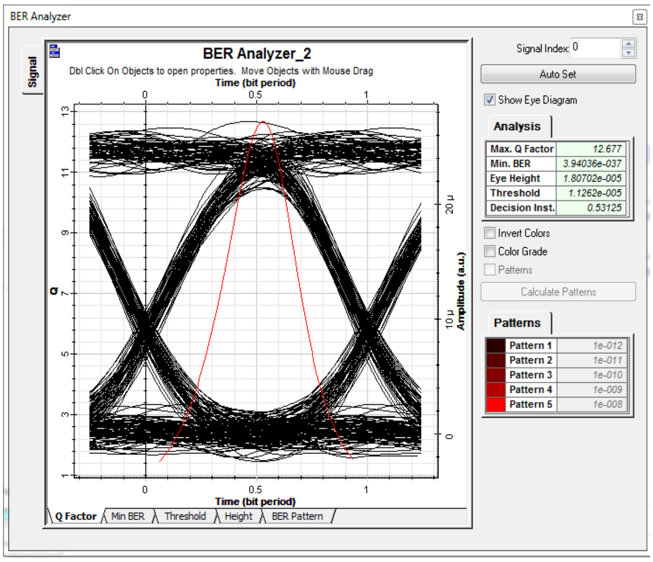
From the above graphs (f), (g), (h), (i), (j), it is clear that the red wavelength laser can transmit audio signal to larger distance at different operating conditions.

3.3: BER Analyzer for Red Wavelength laser at different operating conditions:

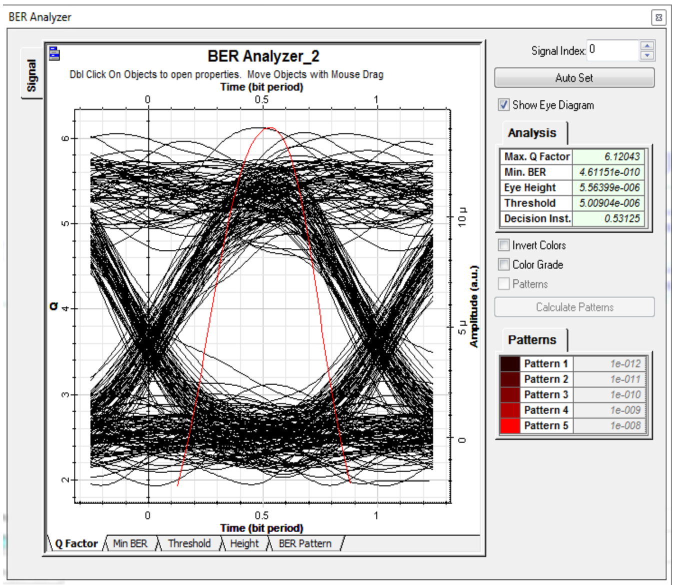
Here BER Analyzer is used for analyzing the red wavelength laser (680 nm) at different operating conditions. Operating conditions in the range of 300m at 0.2 dB/km, 200m at 8 dB/km, 200m at 25 dB/km,100m at 40 dB/km, 100m at 80 dB/km is taken into account. The results of the BER analyzer are discussed below.



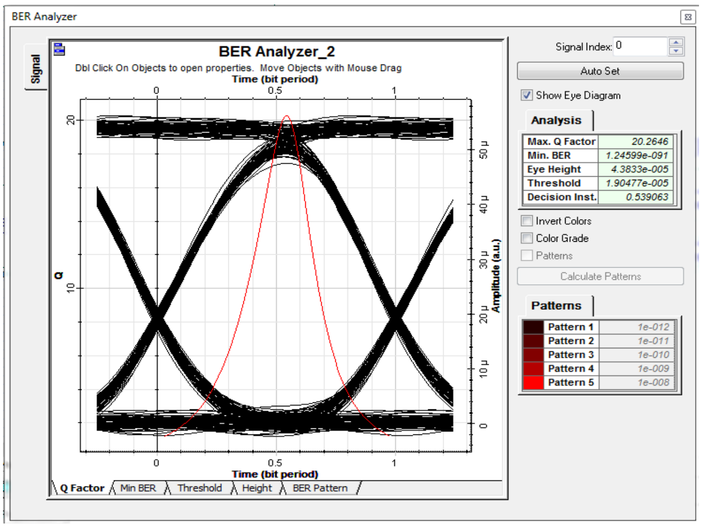
(k) 300m at 0.2 dB/km



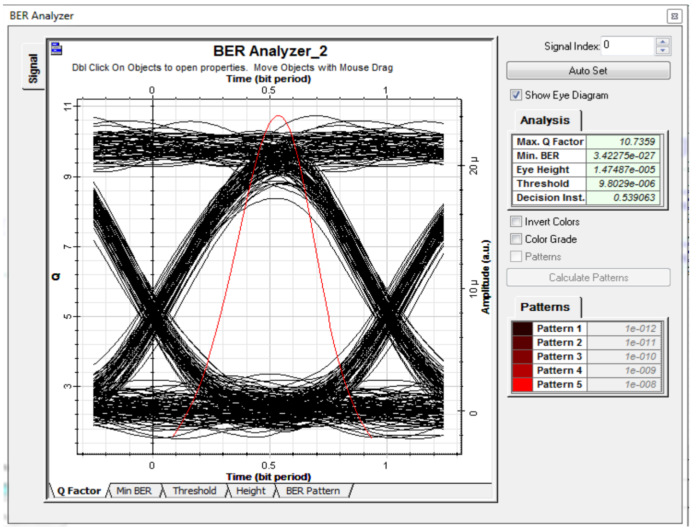
(l) 200m at 8 db/km



(m) 200m at 25 dB/km



(n) 100m at 40 dB/km



(o) 100m at 80 dB/km

Fig 4: BER Analyzer for (k) 300m at 0.2 dB/km, (l) 200m at 8 dB/km, (m) 200m at 25 dB/km (n) 100m at 40 dB/km, (o) 100m at 80 dB/km

IV. CONCLUSION

We have proposed a study of Visible Light Communication for red laser and practically measured channel characteristics using numerical tool. The FSO link is used for transmitting 5Gbps data rate at different distance under different weather condition by using Red (680nm) laser. The 5Gbps data rate are transmitter at 300m in 0.2 dB/km the q-factor is 8.19, 200m in 8 dB/km the q-factor is 12.6, 200m in 25 dB/km the q-factor is 6.1, 100m in 40 dB/km the q-factor is 20.2646and 100m in 80 dB/km the q-factor is 10.7.

REFERENCES

[1] Dilukshan karunatilaka, Fahaf Zafar, Vineetha Kalavally, R. Parthiban "LED Based Indoor Visible Light Communication" in Communication Magazine, IEEE, March 26, 2016.

[2] Shuvo Raj Paul, Md.Hanif Ali Sohag "A Practical Approach For Transferring File Within Computer Networks Using Visible Light Communication" in International Conference on Informatics, Electronics and Vision (ICIEV), Khulna University of Engineering and Technology, Bangladesh, 2016, pp. 268-271.

[3] Pornchanok Namonta, Panarat Cherntanomwong " The Improvement of Repeater System for Visible Light Communication".

[4] Yingjie He, Liwei Ding, Yuxian Gong, Yongjin Wang "Real-time Audio and Video Transmission System Based on Visible Light Communicatiob" in Optics and Photonics Journal, 2013, pp. 153-157.

[5] Do Ky Son, EunByeol Cho, Inkyu Moon, Zabih Ghassemlooy, Soeun Kim, Chung Ghiu Lee "Simultaneous transmission of audio and video signals using visible light communications" in EURASIP Journal on wireless communication and networking, 2013.

[6] J. Rufo, J. Rabadan, F. Delgado, C. Quintana, R. Perez-Jimenez "Experimental Evaluation if Video Transmission Through LED Illumination Devices" in IEEE Transaction on consumer Electronics, Vol. 56, No.3, pp.1411-1416.

[7] Grantham Pang, Ka-Lim Ho, Thomas Kwan, Edward Yang "Visible Light Communication for Audio Systems" in IEEE Transaction and Consumer Electronics , Vol. 45, No. 4, pp. 1112- 1118.

[8] P. A. Haigh, T. T. Son, E. Bentley, Z. Ghassemlooy, H. Le Minh, L. Chao "Development of a visible light communication system for optical wireless local area networks".

[9] Jelena Grubor, Sebastian Randel, Klaus-Dieter Langer, Joachim W. Walewski "Broadband Information Broadcasting Using LED-Based Interior Lighting" in Journal of Lightwave Technology, Vol. 26, No. 24, pp. 3883-3892.

[10] Z. Ghassemlooy, B. Wilson "optical PWM data link for high quality video and audio signals" in IEEE Transaction and Consumer Electronics , Vol. 40, No. 1, pp. 55-63.

[11] Poonam Singal, Saloni Rai, Rahul Punia, Dhrove Kashyap "Comparison of Different Transmitter Using 1550nm and 1000nm in FSO Communication Systems" in the International Journal of Computer Science and Information Technology , Vol. 7, No.3, pp. 107-113.

[12] Deeksha Jain, dr. Rekha Mehra, "performsnce Analysis of Free Space Optical Communication System For S, C, and L band" in the International Conference on Computer, Communication and Electronics.