Analysis of Apodized Fiber Bragg Grating and Comparision of Gaussian and Tanh in Optical Communication System

Shama Afreen[#1]
[#1] Assistant Professor ECE Department, VSGOI, Unnao

ABSTRACT

This paper presents the performance analysis of incorporating apodized Fiber Bragg Grating in optical communication system. The effected fiber bragg grating for Gaussian and Tanh with respect to their gain and noise have been implemented and investigated. The variable file of Apodized FBG performance is visualized, including utilization in the NRZ beat generator. The corresponding framework throughout the optical fiber mode channel is simulated using Optisystem version 12.0. Results show a fit correlation for the range Gain, Noise, Eye diagram and Q-Factor

Keywords: *Optical Communication, FBG, Optisystem 12.0, Q-factor, Apodized FBG.*

INTRODUCTION

Optical communication is a way of propogating the information from transmitter to receiver with the help of light source and optical fiber as a medium. There are three main elements of optical communication system, light source as a transmitter side (convert electrical mode signal information in the optical mode), transmission medium (optical fiber) and light detector at receiver side (convert optical signal to electrical signal). FBG is an important element in optical fiber communication working as dispersion compensator, gain flattener and filter so, as to improve higher compression ratio. Optisystem simulator is innovative, advanced, easy, powerful design tool to simulate, test and evaluate broad area of spectrum almost in any type of optical communication system for LAN (local area network) and MAN (metropolitan area network) and is used in Fiber Optics modeling for an optical communication system, incorporating a library of various optical components

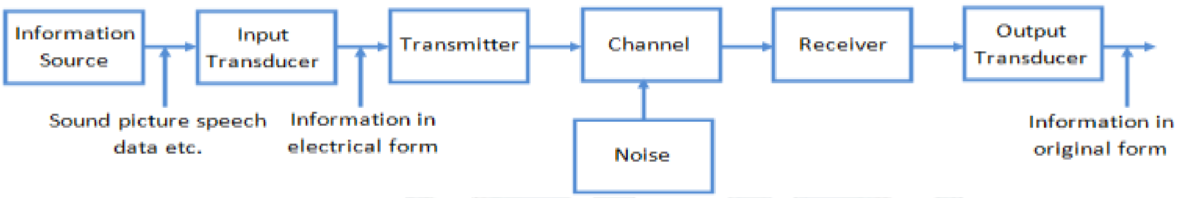


Figure 1: Block Diagram of Optical Communication System.

In the past decades our lives have totally changed with the utilization of the fiber optics based systems because of the salient properties of its immunity to various natural as well as manmade interferences, better tolerance to have environments thus brought-up novel system in the field of optical fiber communication. In the uses of fiber optic, the specific developments in the channel are contrasted without change in the electrical properties. One of advance novel technique is the apodization of optical fiber core which make its utility in enhance performance of optical fiber based communication system as well as various type of sensors. The execution of FBG based sensor in the current and old studies contain many missing to influence a grouping of set up apodization. This paper introduces wide investigation and utilizing in apodization profile such as, Gaussian and Tanh execution of FBG to build tried parameters to achieve enhance performance of various optical fiber systems showing better range, eye diagram etc.

MATERIAL AND METHODS

(i)Fiber Bragg Grating (FBG)

The concept of fiber bragg grating was first introduced in 1980 and has been used in several applications and widely researched. A fiber Bragg grating (FBG) is a type of distributed Bragg reflector constructed in a short segment of optical fiber that reflects particular wavelengths of light and transmitting all others. This is achieved by creating a periodic variation in the refractive index of the fiber core, which generates a wavelength-specific dielectric mirror.

A fiber Bragg grating can therefore be used as an inline optical filter to block certain wavelengths, or as a wavelength-specific reflector. FBG can also function as a simple and cost effective filter for selective wavelength which is essential for low cost and high efficient optical network. FBG has the quality of filtering and reflecting as well as highly efficient and low noises.

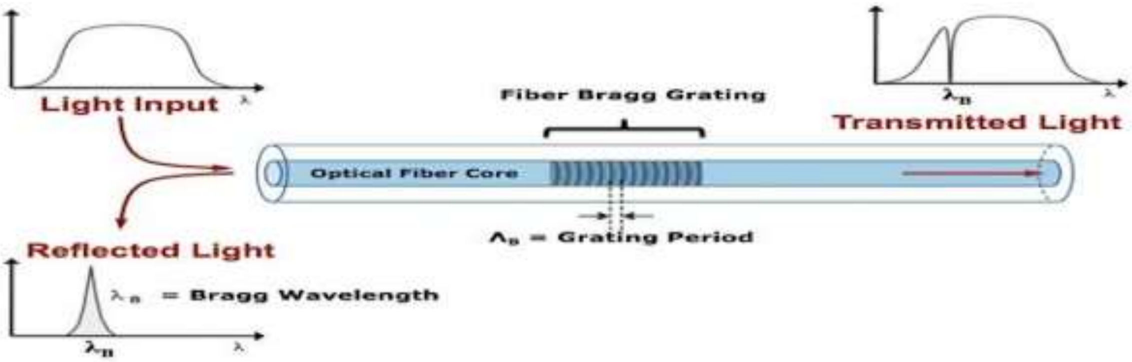
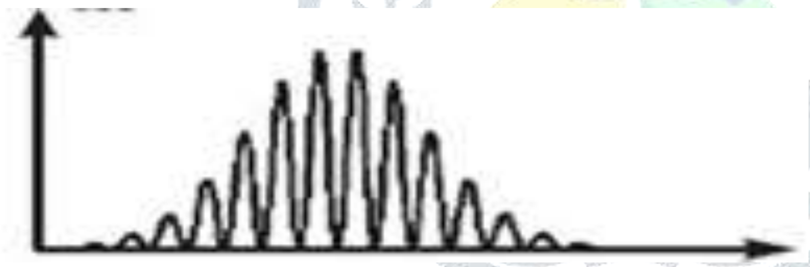


Figure 2: Fundamental of Bragg's light structure

(ii)FBG Apodization

The term apodization refer to the grading of the refractive index to approach zero at end of grading. It offer significant improvement in the side-lobe suppression while maintaining the reflectivity as well as bandwidth. Figure 3 explain the profile of apodization in FBG techniques.

(a)



(b)

Figure 3: The apodization profile Refractive index

Mathematically, the apodization profile could represented by the following formulas as Gaussian and Tangent change. The hyperbolic tangent and Gaussian model is formed as-

A. Hyperbolic Tangent:

$$f(z) = \tanh\left(\frac{S.Z}{L}\right).\tanh\left[S.\left[1-\frac{z}{L}\right]\right] + 1 - \tanh^2\left(\frac{S}{2}\right)$$

B. Gaussian:

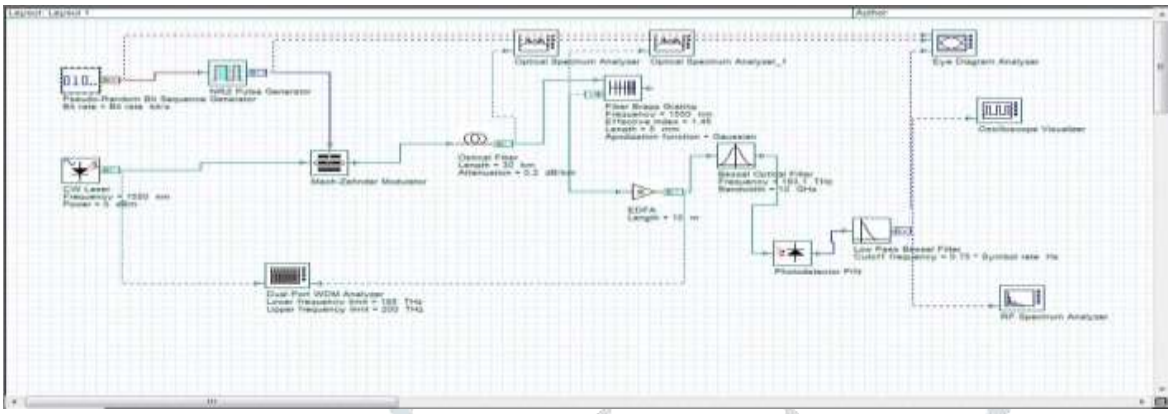
$$f(z) = \exp.\left\{(-4\log 2).\left(\frac{\left(\frac{z-L}{2}\right)}{S.L}\right)^2\right\}$$

Where

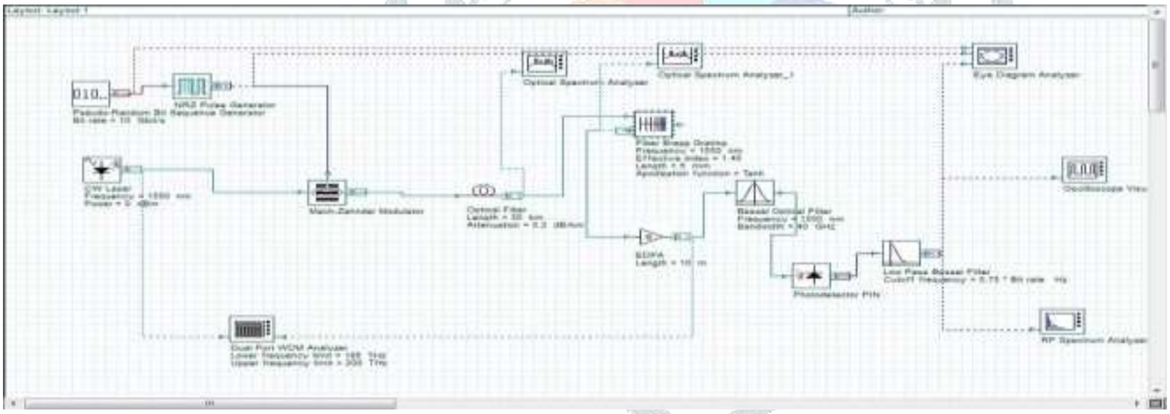
L: Length of the grating.
Z: direction of the light generation over the length for Fiber Bragg Grating.
S: called decrease measurable factor utilized in the exact setting of reflection range

EXPERIMENTAL OBSERVATION

The transmitter, channel and receiver of optical frame work has been designed and simulated using Optisystem 12.0. The length of 30km SMF has been utilized in Transmitter channel and photodetector in receiver path. The constant wave laser is the transmitter and the Mach-Zehnder modulator is used to modulate constant wave laser signal as data transmission signals. The wavelength of 1550nm is used as a laser constant signal with 0dBm power balanced at 10 Gbps in the proposed Mach-Zehnder modulation technique. There refractive index is 1.45, OFC length 30 km and FBG length variation from 1mm to 5mm is used in , Gaussian and Tanh profiles .Additionally ,EDFA is utilized with variable flag enhancement values. The EDFA utilization in the in the PIN photograph locator is spread throughout it. Through Bessel optical channel, the enhanced sign is gone due to several specifications in data transfer of 40GHz with a bearer wavelength of1550nm in the suggested model as illustrated in Figure 4.The investigation outcome of the suggested techniques are shown in Table1, Table 2, Table 3 and Table 4. The apodization capacities in FBG optical fiber group framework using Optisystem 12.0 shows correlation in examining parameters.



(a) Simulation setup for Gaussian function



(b) Simulation setup for Tanh function

Figure 4: Proposed transceiver model

RESULTS AND DISCUSSION

During this work, examining the parametric usage and correlation of the distinctive apodization capacities of the FBG group in single mode optical fiber transmission framework is accomplished by optisystem-12.0.The outcome of the investigation, reproduction of the various attenuation and FBG length list utilizing different FBG apodization capacities for a solitary transmission divert so as to clarify from Table1, Table 2, Table 3 and Table 4.

Table 1:Gaussian format of FBG with different Attenuation.

Attenuation (db/km)	Gain(dB)	Noise Figure(dB)	Q-Factor
0.2	15.405	18.884	21.99
0.25	14.835	20.587	20.88
0.3	14.193	22.226	21.52
0.35	13.433	23.933	20.34
0.4	12.699	25.416	20.28

Table 2:Tanh format of FBG with different Attenuation.

Attenuation (db/km)	Gain (dB)	Noise Figure (dB)	Q-Factor
0.2	16.049	14.736	26.94
0.25	16.392	16.459	25.77
0.3	15.683	17.925	25.70
0.35	15.240	19.410	25.80
0.4	14.582	21.259	25.05

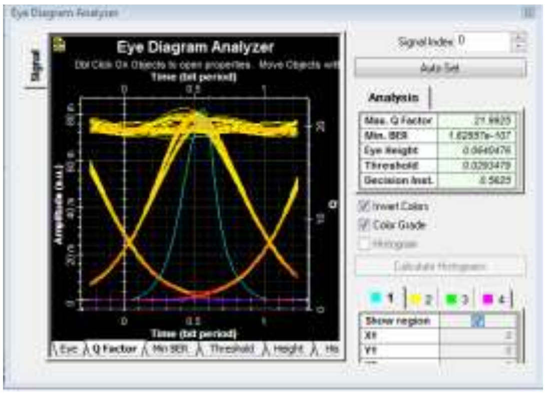
Table 3: Gaussian format of FBG with different FBG lengths.

FBG Length (mm)	Gain (dB)	Noise Figure (dB)	Q-Factor
1	7.801	33.130	11.97
2	11.931	26.840	15.07
3	13.705	23.347	17.18
4	14.817	20.637	18.98
5	15.405	18.886	22.36

Table 4: Tanh format of FBG with different FBG lengths.

FBG Length (mm)	Gain (dB)	Noise Figure (dB)	Q-Factor
1	11.600	27.421	14.10
2	14.585	21.254	16.86
3	15.707	17.839	19.02
4	16.178	15.861	22.58
5	16.404	14.668	25.78

The eye diagram of optical channel with 30 km length, 1.45 refractive index and 5 mm FBG , optical channel with 1.45 refractive index, 30 km length and 0.2 db/km attenuation is illustrated in Figure 5 , Figure 6 which represent the Gaussian and Tanh technique respectively.



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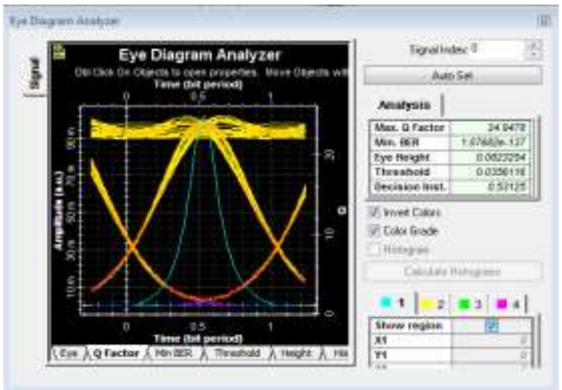

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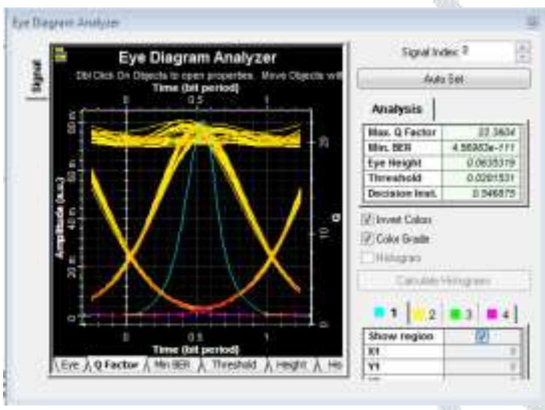
Figure 5: Gaussian and Tanh eye diagram



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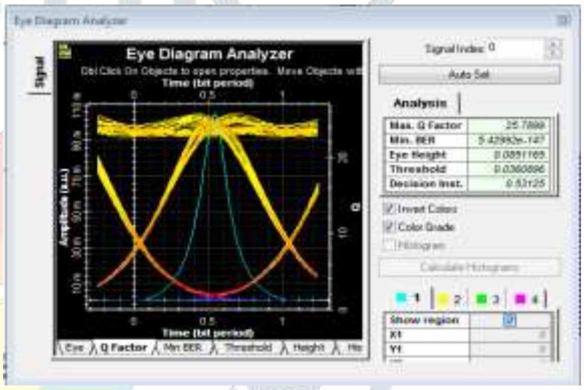

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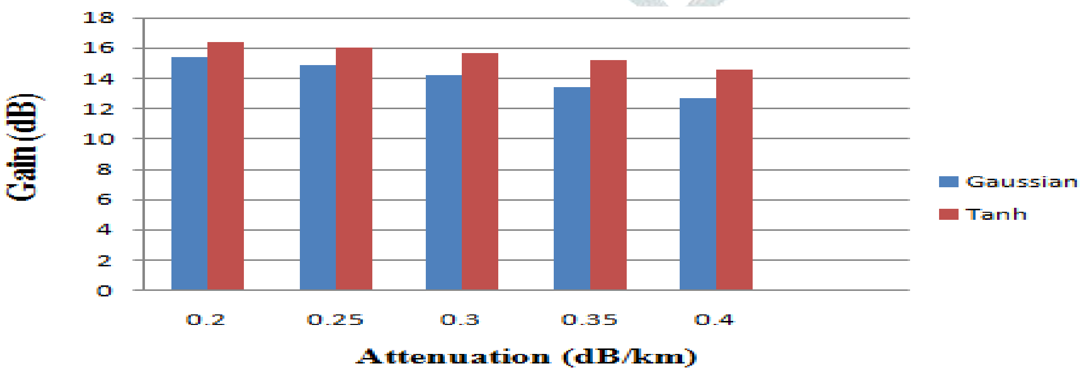
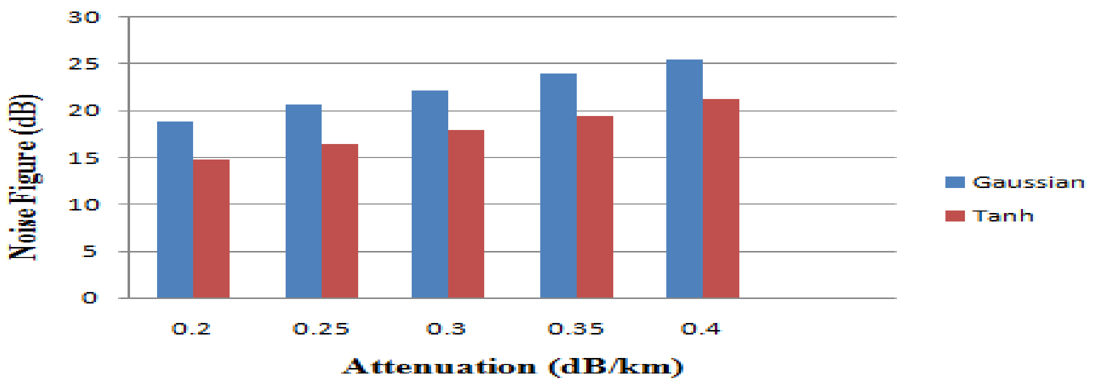
Figure 6:Gaussian and Tanh eye diagram.

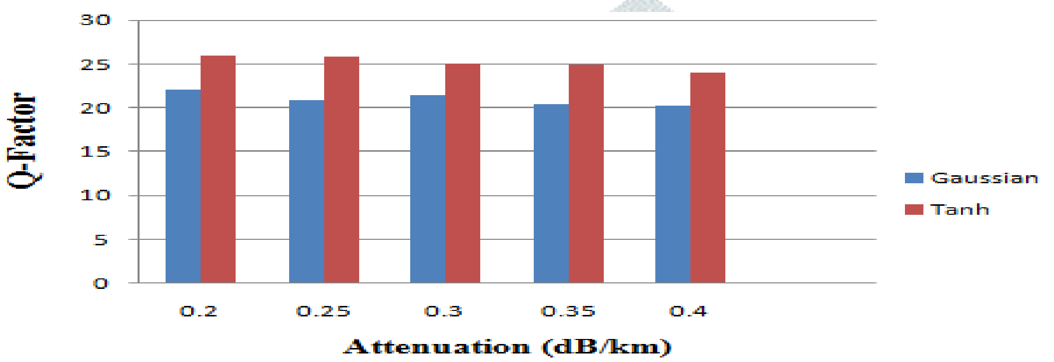
The relationship among attenuation list and FBG Length list with specified parameter for various Apodizattion FBG profile of Gaussian and Tanh is llustrated in Figure 7, Figure 8.



(a) Attenuation with Gain relationship



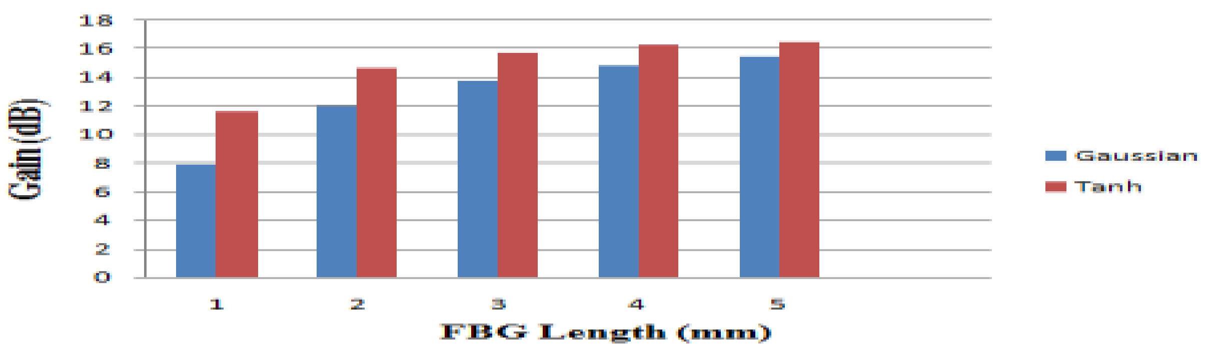
(b) Attenuation with Noise Figure relationship



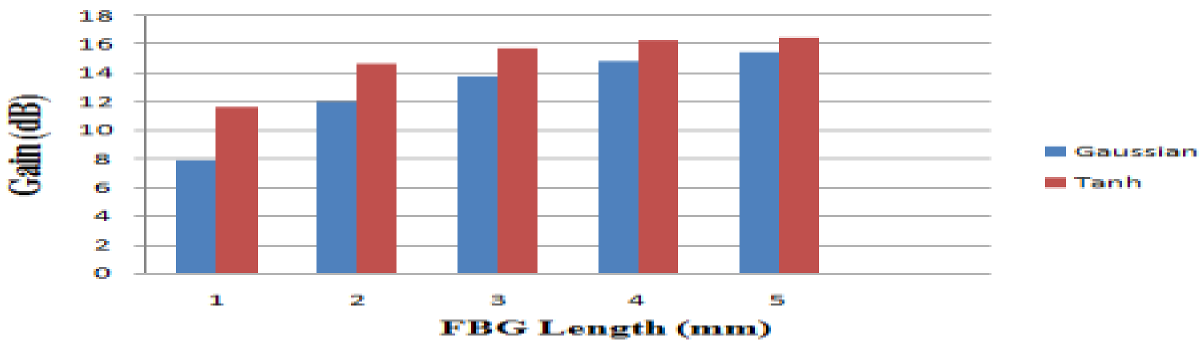
(c) Attenuation with Q-Factor relationship

Figure: 7

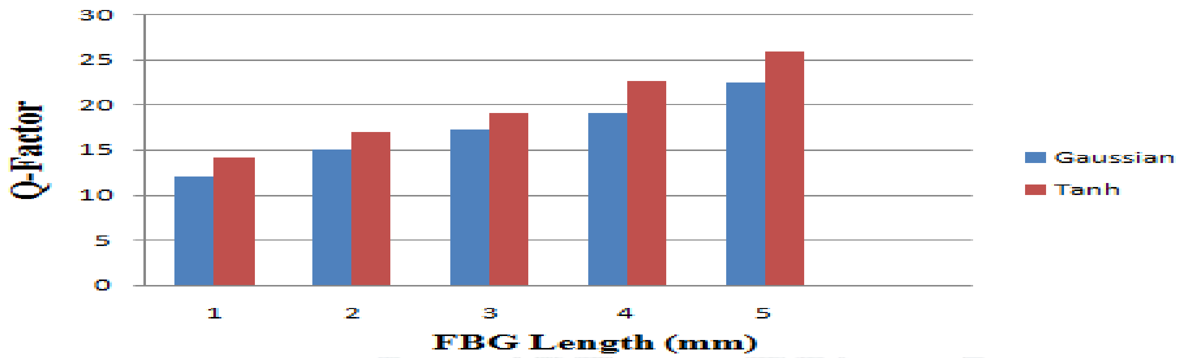
Figure 7 shows the variation of Attenuation with Gan, Noise Figure and Q-Factor. On varying the Attenuation from 0.2 dB to 0.4 dB, the parameters calculated for an Gaussian apodization Gain=15.405, Noise Figure=18.884dB, Q-Factor=21.99 and Tanh apodization Gain=16.392dB, Noise Figure=14.736dB, Q-Factor=26.94.



(a) FBG length with Gain relationship



(b) FBG length with Noise Figure relationship



(c)FBG length with Q-Factor relationship

Figure: 8

Figure 8 shows the FBG length with Gain, Noise Factor and Q-Factor. On varying FBG length from 1 to 5mm. The parameters calculated for Gaussian apodization Gain=15.405dB Noise Figure=18.886dB Q-Factor=22.36 and Tanh apodization Gain=16.404dB Noise Figure=14.668dB Q-Factor=25.78.

CONCLUSION

Based on the research and investigation of Gaussian and Tanh apodization profiles n communicaton systems. The result obtained, while comparing and analyzing apodization profiles, that the apodized FBG technique provide enhanced system performance incorporating an attenuation and apodized FBG length considering the parameters like Gain, Nose Figure and Q-Factor where attenuation coefficient is inversely proportional to the Q-Factor and FBG the length is directly proportional to Q-Factor. With the variation in attenuation and apodized FBG length, a comparison was made among Gaussian and Tanh apodization with respect to Q-Factor, Gain and Noise Figure. It was found that with the corresponding Graph that the Gaussian profile gives better result among two profile with low Noise Figure, high Gain and high Q-Factor.

The suggested model and technique promising to support the current and future generation communication system and gave enough research chance to develop their ideas, which enhance to introduce new developed model.

REFERENCES

[1] Pulkit Berwal, "Development in the Field of Optical Fiber Communication Systems", International Journal of Engineering, Management, Humanities and Social Sciences Paradigms, pp. 1-5, Vol. 02, No. 01, 2013.

[2] Mr. Tushar Kant Panda, Ananta Narayana Sahu et al., "Performance Analysis of 50km Long using Fiber Bragg Grating for dispersion compensation", International Research Journal of Engineering and Technology, pp.95-98, Vol. 03, No. 03, 2016.

[3] Nazmi A. Mohammad et.al., "Design and performance evaluation of a dispersion compensation unit using several chirping functions in a tanh apodization FBG and comparison with dispersion compensation fiber", Appilied Optics ,pp.H239-H247, Vol.53, no. 29, 2014.

[4] M.Ferchichi, M. Najar, and H.Rezig, "Design of temperature-strain tunable UDWDM, DWDM, WDM FBG filter for Passive Optical Network Access", ICTON, Marrakech, pp. 1-5, 2008.

[5] Kaushal Kumar, A.K.Jaiswal et.al., "Performance Analysis of Dispersion Compensation using Fiber Bragg Grating (FBG) in Optical Communication," International Journal of Current Engineering and Technology, pp. 1527-1531, Vol. 04, No. 03, 2014.

[6]Kapil Kashyap1, Dr. Hardeep Singh et.al., "Compensation of Dispersion in Optical Fiber Using Fiber Bragg Grating (FBG)", International Journal of Advance Research in Science and Engineering, pp. 124-132, Vol. 02, No. 04, 2013.

[7] Anurag Kuma, A.K Jaiswal, and Neelesh Agarwal, "Anaysis of a Special Period Sample Bragg Grating (SPBG) Structure Combined with the large Chrip parameter", International Journal of Computer Applications ,pp. 5-9, Vol. 128, No. 18, 2015.

[8] Qiying Chen and Ping Lu, "Fiber Bragg Gratings and their Applications as Temperature and Humidity Sensors", In; Atomic, Molecular and Optical Physics (Book Chapter) , pp. 235-260, 2008.