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# 10 Gbps Free Space Optics Link under the Impact of Atmospheric Turbulences

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***Abstract: With the advancement in communication technologies, need of high data rates have been evolved over the years. Our work is focused in designing such a system that can withstand effects of atmospheric turbulences. A single channel 10 Gbps Free Space Optics (FSO) systems is designed to transmit data under the impact of transmitting pointing errors over a distance of 3000 m. Minimum acceptable Bit Error Rate (BER) is obtained and successful transmission of data is replicated by Eye Diagrams.***
***Keywords: Free Space Optics (FSO), Bit Error Rate (BER)***

## I. INTRODUCTION

Communication has become an important part in our daily routine. Communication means exchanging or transferring information by speaking, writing from one place to another place using some medium. Different services are used to transmit information like voice, video, text, data etc. Now-a-days there is a huge demand of these services. Light technology has been used to achieve high data rates and for greater bandwidth [1, 2].

Free space optics is essential for worldwide broadband network. It is a growing technology to carry a large amount of information and have capacity to handle a high data rates. Free space optics is a line of sight technology which uses lasers (transmitter) and photo detectors (receiver) to provide full duplex transmission of data, voice and video in certain applications. FSO is a optical communication technology that uses light propagating in free space which transmit the data wirelessly for telecommunication or computer network [3-6].

The principle of FSO is similar to the optical fiber cable but the difference is that the optical beams are sent through free air instead of OFC cores that is glass fiber. In 1870, the Alexander Graham Bell demonstrated his first wireless telephone system named as “Photo Phone”. It was the world first wireless telephone system. It converts the sound wave to electrical telephone signals and transmitted voice signal over a distance by using sunlight as a carrier [7, 8]. In 1960, there is an invention of first working laser at Hughes Research Laboratories, Maliber, California.

There is a great advancement was observed and technology of FSO has changed [9]. In 1962, the researchers in the MIT Lincolns Laboratory using GaAs LED source to transmit television signals up to 48Km distance. In 1970s, Nippon Electric Company (NEC, Japan) made the first full duplex FSO link of 14 Km distance between Yokohama and Tamagawa using He-Ne laser of 0.6328 [10]. The first inter-satellite laser communication link was successfully demonstrated by European Space Agency (ESA) between two satellites SPOT-4 and ARTEMIS for optical data-relay services at 50 Mbps [11]. From 1990s to till date the research in this field has increased substantially.

FSO communication is subjected to atmospheric effects. FSO technology uses atmospheric channel as a propagating medium. There are various challenges in FSO like clouds, snow, fog, haze etc which cause attenuation in optical signal and limit the link distance [12].

During dense fog conditions there is a high attenuation which is more than 350db/km [13]. The impact of rain is not more like fog. There is a 2.5mm/hr attenuation loss at light rain and 25mm/hr attenuation loss at heavy rain [14]. The size of snow particles are between rain and fog particles. The attenuation due to snow is more than snow but less than fog. The attenuation is ranging between 30-350db/km [15].

## II. SYSTEM DESCRIPTION

The performance of proposed FSO link is evaluated under the impact of atmospheric turbulences in OptiSystem software. Figure 1 shows the schematic diagram of proposed system under the impact of atmospheric turbulences. The turbulences are considered as attenuation of 5dB/Km.

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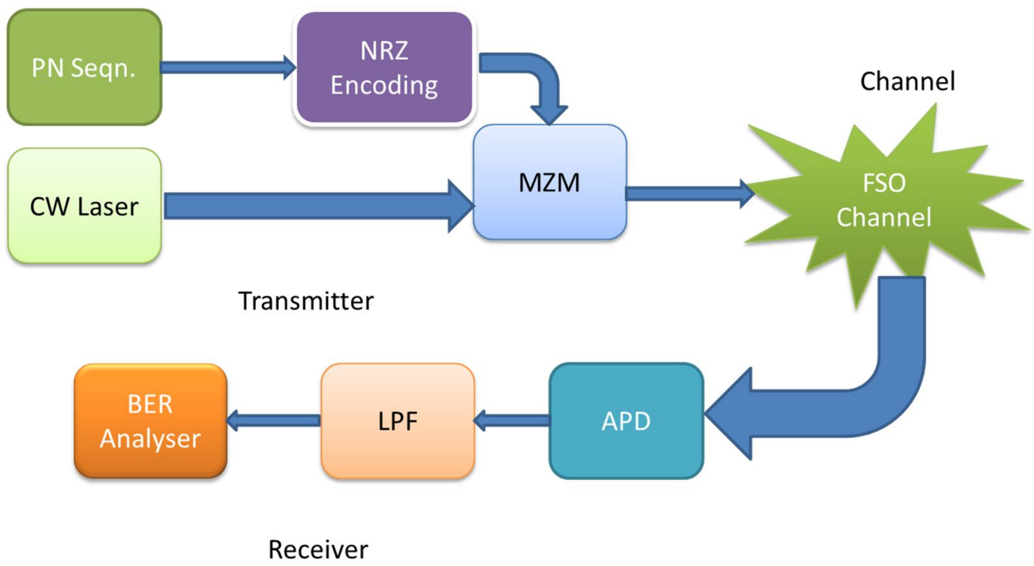



Fig. 1. Proposed FSO system under the impact of Turbulences

## III. RESULTS AND DISCUSSION

In this section, results obtained from the simulation of proposed single channel FSO system.. Figure 2 shows the measured minimum BER and max q factor for proposed system up to 18000 mtr while Figure 3 Shows the measured minimum BER and max q factor for proposed system upto 3000 mtr under the impact of attenuation of 5dB/Km.

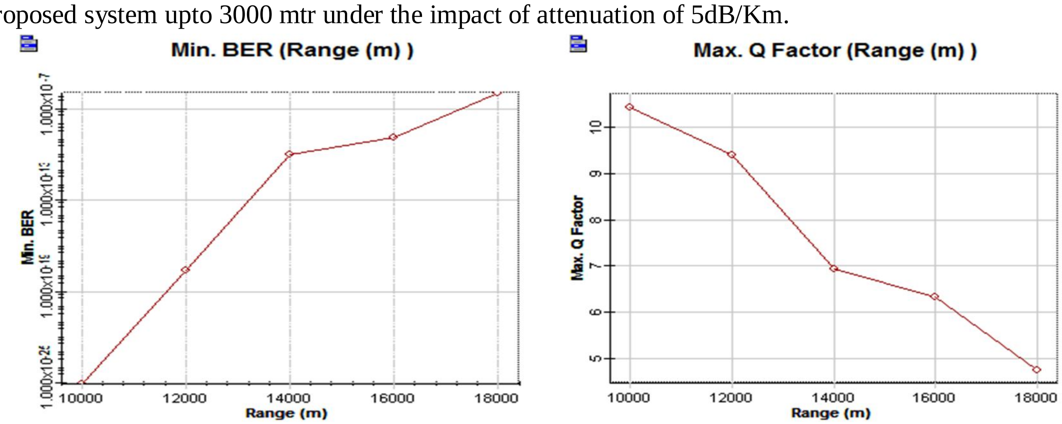



Fig 2. Minimum BER and Max Q Factor vs Range

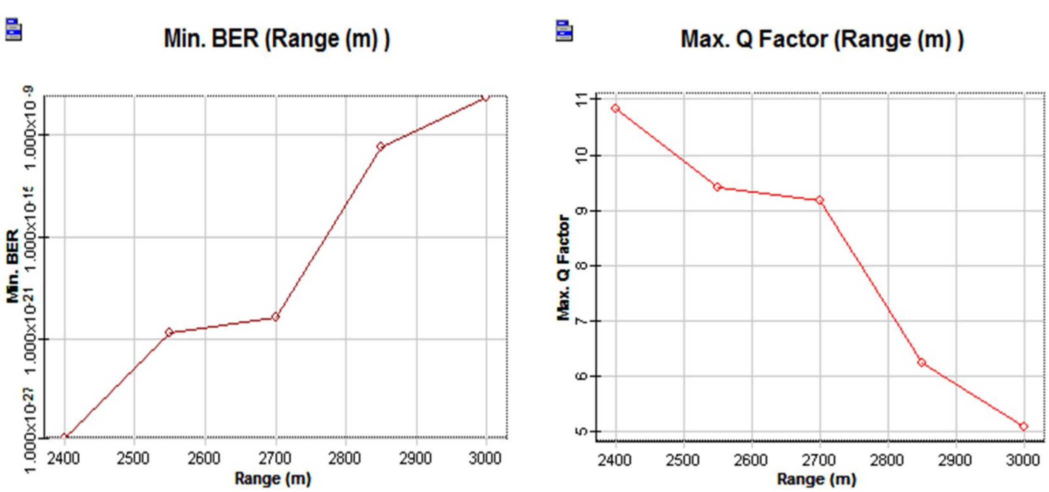



Fig. 3 Minimum BER and Max Q factor Vs Transmitting Pointing errors

The value of BER for system with is noted as $7.94 \times 10^{-26}$, $1.06 \times 10^{-10}$ and $1.15 \times 10^{-6}$ at a distance of 10000, 14000 and 18000 mtr respectively without any turbulence whereas Max Q factor of 10.43, 6.92 and 4.73 at a distance of 10000, 14000 and 18000 mtr respectively was measured. The system is further subjected to turbulences that is attenuation of 5dB/Km. The value of BER for system with is noted as $1.22 \times 10^{-27}$, $1.95 \times 10^{-20}$ and $1.66 \times 10^{-7}$ whereas Max Q factor of 10.81, 9.17 and 5.09 at Free Space transmitting 2400, 2700 and 3000 mtr respectively was measured.

Figure 4 and 5 shows the eye diagrams for both the cases with turbulence and without turbulence. As it is clear from the eye opening that data has been successfully received.

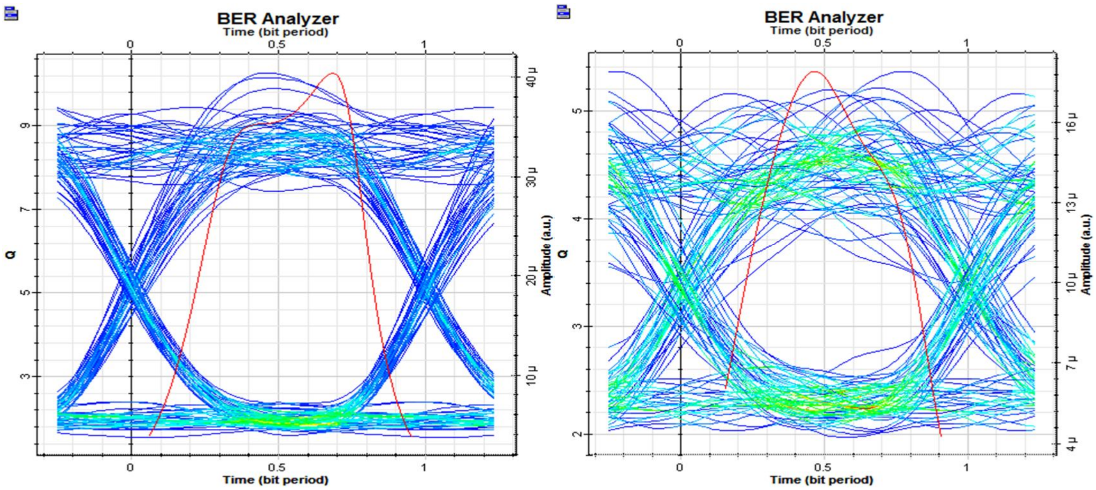



Fig. 4 Eye diagram at 10000 mtr and 18000 mtr without Turbulences

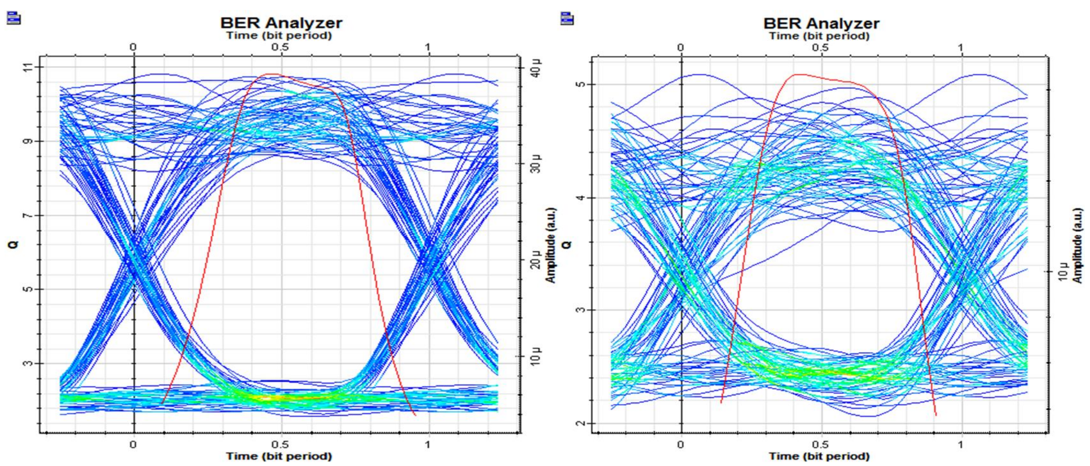



Fig. 5 Eye diagram at 2400 mtr and 3000 mtr and attenuation of 5 dB/Km

## IV. CONCLUSION

In this work, we have successfully transmitted 10 Gbps of data over a distance of 18000 mtr without any turbulences and upto 3000 mtr with attenuation of 5dB/Km. The reported result shows the successful transmission of 10 Gbps data Is-OWC link with acceptable BER and Q factor and eye pattern under the impact of transmitting pointing errors.

## REFERENCES

[1] Bowman, M., Debray, S. K., and Peterson, L. L. 1993. Reasoning about naming systems.
[2] Ding ,W. and Marchionini, G. 1997, “A Study on Video Browsing Strategies” ,Technical Report. University of Maryland at college Park.
[3] Arun K. Majumdar and Jennifer C. Ricklin, Free Space Laser Communications: Principles and Advances, (Springer, New York 2008).
[4] Arun K. Majumdar, Advanced Free Space Optics (FSO): A Systems Approach, (Springer, New York2015).
[5] Scott Bloom, Eric Korevaar, John Schuster and Heinz Willebrand, “ understanding the performance of free space optics” , Journal of Optical Networking, Vol. 2, No. 6, pp. 178-200, June 2003.
[6] F. E. Goodwin, “A review of operational laser communication systems” , Proceedings of IEEE, Vol. 58 , pp.1746-1752, October 1970..
[7] D. Hochfelder, “Alexander Graham bell,” Encylopedia Britannica, 2015.

[8] D. L. Hutt, K. J. Snell, and P. A. Belanger, "Alexander graham bell's photophone," Tech. Report: Optic & Photonics News, 1993. [4] J. Hecht, "Beam: The race to make the laser," Tech. Report: Optics & Photonics News, 2005.

[9] J. Hecht, "Beam: The race to make the laser," Tech. Report: Optics & Photonics News, 2005.

[10] Hennes Henniger and OtakarWilfert, "An introduction to free space optical communication" , Journal of Radio Engineering, Vol. 19, No. 2, pp. 203-212, 2010.

[11] Nielsen and G. Oppenhauser, "In-orbit test result of an operational optical intersatellite link between ARTEMIS and SPOT4, SILEX," Proc. SPIE, Free Space Laser Comm. Tech. XIV, vol. 4635, 2002.

[12] Hemani Kaushal and Georges Kaddoum, " Optical Communication In Free Space: Challenges and Mitigation Techniques" , DOI 10.1109/COMST.2016.2603518.

[13] I. I. Kim and M. Achour, "Free-space links address the last-mile problem," vol. 37, 2001.

[14] A. Z. Suriza, I. M. Rafiqul, A. K. Wajdi, and A. W. Naji, "Proposed parameters of specific rain attenuation prediction for free-space optics link operating in tropical region," J. of Atmosp. and Solar-Terres. Phys., vol. 94, pp. 93–99, 2013.

[15] A. Vavoulas, H. G. Sandalidis, and D. Varoutas, "Weather effects on FSO network connectivity," J. Opt. Comm. and Net. vol. 4, No.10, pp. 734–740, 2012.

[16] Sharma, A., Chaudhary, S., Thakur, D., Dhasratan, Vigneswaran "A Cost-Effective High-Speed Radio over Fibre System for Millimeter Wave Applications", Journal of Optical Communications, Published Online: 2017-12-15 | DOI: https://doi.org/10.1515/joc-2017-0166

[17] Sushank Chaudhary, Priyanka Chauhan, Abhishek Sharma, "High Speed 4× 2.5 Gbps-5 GHz AMI-WDM-RoF Transmission System for WLANs", Journal of Optical Communications, Published Online: 2017-07-18 | DOI: https://doi.org/10.1515/joc-2017-0082

[18] Sushank Chaudhary, Deepika Thakur, Abhishek Sharma, "10 Gbps-60 GHz RoF Transmission System for 5 G Applications", Journal of Optical Communications, Published Online: 2017-07-22 | DOI: https://doi.org/10.1515/joc-2017-0079

[19] Rudrakshi Kapoor, Abhishek Sharma, Sushank Chaudhary, "Empirical Evaluation of 4 QAM and 4 PSK in OFDM-based Inter-Satellite Communication System", Journal of Optical Communications, Published Online: 2017-06-29 | DOI: https://doi.org/10.1515/joc-2017-0059

[20] Abhishek Sharma, Neha Chaudhary, Sushank Chaudhary, "6 × 20 Gbps Hybrid WDM–PI Inter-satellite System under the Influence of Transmitting Pointing Errors", Journal of Optical Communications, Published Online: 2016-05-27 | DOI: https://doi.org/10.1515/joc-2015-0099

[21] Abhishek Sharma, Neetu, "ANALYSIS AND MITIGATION OF RECEIVER POINTING ERROR ANGLE ON INTER-SATELLITE COMMUNICATION" International Journal of Innovative Technology and Research, Volume 3, Issue 6, Pages 2540-2544, Nov 2015

[22] Sushank Chaudhary, Abhishek Sharma, Neetu, "6 x 20Gbps Long Reach WDM-PI based High Altitude Platform Inter-Satellite Communication System" International Journal of Computer Applications, Volume 122, Issue 22, Pages 41-45, July 2015

[23] Savita Rana Abhishek Sharma, "Comprehensive study of Radio over Fiber with different Modulation Techniques – A Review", International Journal of Computer Applications, Volume 170, Issue 4, Pages 22-25, Aug 2017 DOI: 10.5120/ijca2017914829

[24] Abhishek Sharma, Deepika Thakur, "A Review on WLANs with Radio-Over-Fiber Technology", International Journal of Electronics and Communication Engineering (IJECE), Volume 6, Issue 5, Pages 1-6, Aug 2017.

[25] Kanika Thakur Abhishek Sharma, "Comparison of MDRZ, CSRZ and DRZ schemes using different Communiation Channels", International Journal of Computer Applications, Aug 2017 DOI: 10.5120/ijca2017915106

[26] Kanika Thakur Abhishek Sharma, "Study of Radio over Fiber with Different coding Channel – A Review", International Journal of Computer Applications, Aug 2017, DOI: 10.5120/ijca2017915033

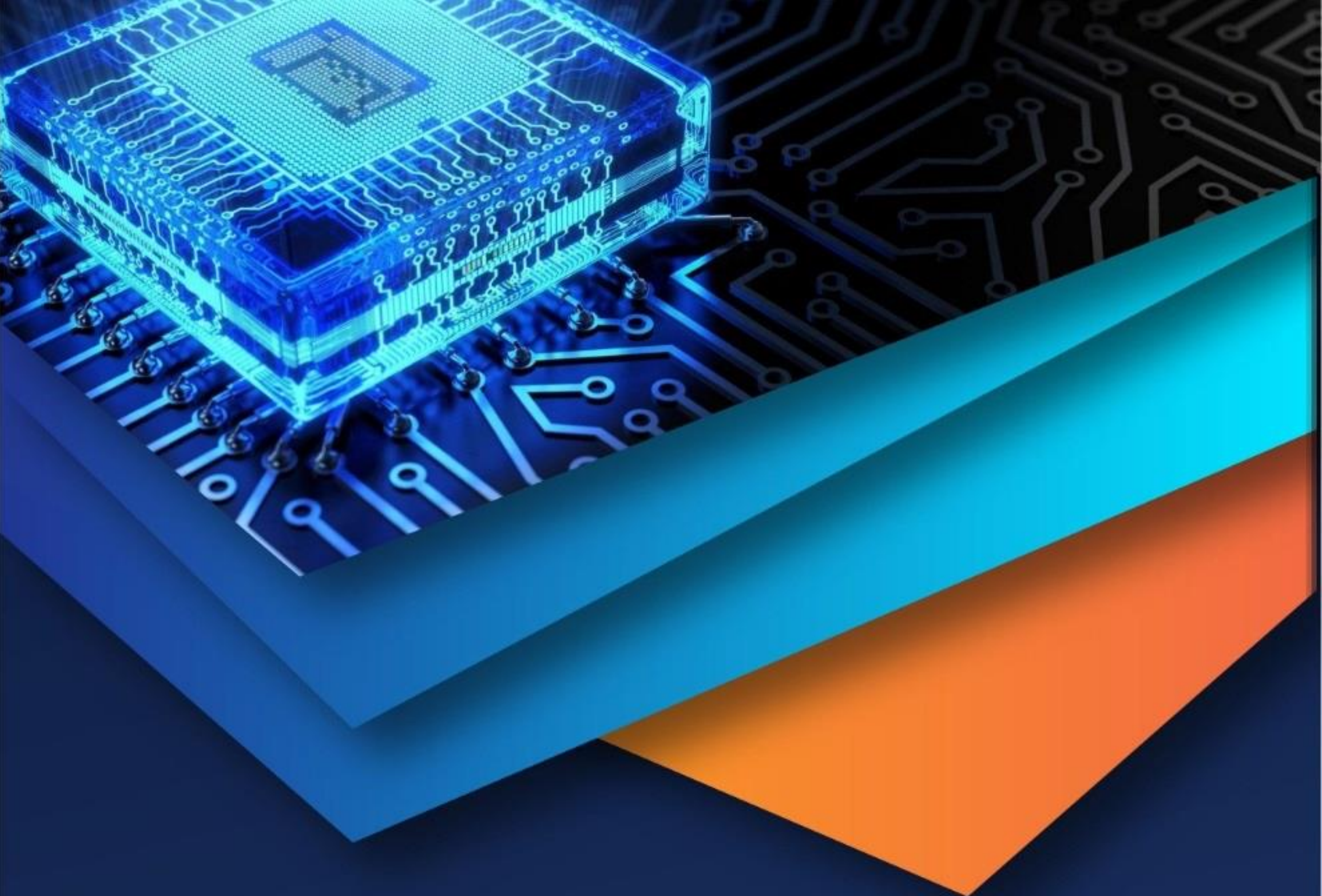
[27] Abhishek Sharma, Priyanka Chauhan, "A Study of Radio over Fiber Technology in WLAN Applications" International Journal for Research in Applied Science & Engineering Technology (IJRASET) Volume 5 Issue VIII, Page 416-420, August 201

[28] Abhishek Sharma, Rudrakshi Kapoor, "STUDY OF VARIOUS CHALLENGES IN Is OWC: A Review", International Journal for Research in Applied Science & Engineering Technology (IJRASET) Volume 5 Issue VIII, Page 802-807, August 201

[29] Abhishek Sharma, Savita Rana, "Implementation of Radio over Fiber Technology with different filtration techniques" International Journal for Research in Applied Science & Engineering Technology (IJRASET) Volume 5 Issue VIII, Page 783-789, August 2017.

[30] Priya Sood, Abhishek Sharma and Chandni. Analysis of FSO System and its Challenges - A Review. International Journal of Computer Applications 179(52):42-45, June 2018. DoI: 10.5120/ijca2018917353

[31] Sharma, Abhishek, and Priyanka Chauhan. "High Speed Radio over Fiber System for Wireless Local Area Networks by Incorporating Alternate Mark Inversion Scheme." Journal of Optical Communications. Published Online: 2018-08-08 | DOI: https://doi.org/10.1515/joc-2018-0084

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