

Performance Analysis of Free Space Optical communication In Presence of Atmospheric Turbulence

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Abstract: Free space optical (FSO) communication has emerged as a viable technology for broadband wireless applications which offers the potential of high bandwidth capacity over unlicensed optical wavelengths. The only essential requirement for an FSO system to work is that there is a free line of sight between the transmitter and receiver. A comparison of BER is also presented with the changing value of the channel turbulence with gamma-gamma channel model in free space optical communication system. Finally, outage analysis of log normal fading channel with fading is presented with changing value of variance. With the increase in channel variance outage probability also increases. From the results we can conclude that the outage probability of a channel is the function of channel variance in free space optical communication system.

Keywords: Free space optical communication (FSO), Nakagami-m channel model, bit error rate (BER), channel model, Atmospheric Turbulence.

I. INTRODUCTION

The main of the communication applications is the requirement of higher data rate and more reliable communication. We present the different factors that affect the performance of the communication channel in free space optical communication system. Different fading channel models are presented such as Rayleigh, Rice and Nakagami models. The performance controlling parameters are considered to be outage probability and bit error rate in free space optical communication system. BER and outage probability is studied with different level of channel turbulence in free space optical communication system. Outage probability is presented with log normal channel by varying the channel variance. We are using different channel models with different level of channel turbulence. The weak turbulence is modelled as log normal distribution channel. On the other hand, strong turbulence is modelled as gamma-gamma distribution channel. Simulation results are presented for fading channel for different level of channel turbulence. Bite error rate (BER) analysis is presented for fading channel and compared with the theoretical BER. Results also shows that as the signal to noise ratio increase BER goes on decreasing and try to approaches the ideal value. A comparison of BER is also presented with the changing value of the channel turbulence with gamma-gamma channel model in free space optical communication system.

II. FREE-SPACE OPTICAL COMMUNICATION (FSO)

Free Space Optics (FSO) refers to the transmission of modulated visible or infrared (IR) beams through the atmosphere to obtain broadband communications. FSO systems can function over distances of several kilometres. Communication is theoretically possible as long as the line of sight between the transmitter and the receiver is clear, and as long as the transmitted power is high enough to overcome atmospheric attenuation. FSO is proposed as a complementary technology to the RF technology. It offers an unregulated bandwidth in excess of terahertz technology (THz) and very high speeds, which makes this an extremely attractive means of meeting the ever-increasing demand for broadband traffic, mostly driven by the last-mile access network and high definition television (HDTV) broadcasting services. FSO systems based on the WDM technology can reach up to 1 Terabit/s capacity or even beyond. Further advantages include smaller and more compact transceivers, reduced installation and development costs and immunity to electromagnetic interference. Free-space optical communication (FSO) systems (in space and inside the atmosphere) have developed in response to a growing need for high-speed and tap-proof communication systems. Links involving satellites, deep-space probes, ground stations, unmanned aerial vehicles (UAVs), high altitude platforms (HAPs), aircraft, and other nomadic communication partners are of practical interest.

III. FADING

The mobile channel places fundamental limitations on the performance of wireless communication systems. The radio link between the transmitter and the receiver varies from simple line-of-sight to one that is severely obstructed by buildings, mountains, and hence suffers from severe multipath fading. Mobile channels are very different from stationary and predictable wired channels, because of their randomness. There are several factors which determine the behavior of such a channel. For example: terrain features between the transmitter and receiver, the speed of transmitter and receiver, weather conditions etc. Over the years several studies and measurements have been undertaken in different locations for such channels. Various models have been proposed for both indoor and outdoor environments. The instantaneous signal strength at a receiver can be predicted using the traditional large-scale and small-scale models, wherein the large-scale models predict the average received signal strength depending on the transmitter-receiver distance and the small scale channel models represent local variations about the average signal strengths. The lognormal model, in which the measured signal levels have a normal distribution about the mean received signal, are suitable for emulating the large scale fading effects for mobile channels models. The normal deviation about the mean captures the random shadowing effects that occur because of the variation in the clutter surrounding a moving vehicle, though the mean signal strength at the vehicular receiver remains the same.

IV. SIMULATED RESULTS

The analysis of free space optical communication system in the presence of atmospheric turbulence is presented with the channel modeling is selected to be of nakagami fading channel. We are considering basically to parameters to analysis the performance of nakagami fading channel are bit error rate and outage probability. The outage probability, P_{out} , is defined as the probability that the received SNR per symbol falls below a given threshold- Y_{th} . If the SNR of the received signal fall be the given threshold than outage is occur at the receiver. This is one of the important parameter that is used for the analysis the performance of fading channel. Here, we are using Nakagami fading channel with log normal distribution and gamma-gamma distribution. Simulation is performed in the presence of atmospheric turbulence. This experiment is performed in different level of channel turbulence. The performance of the system is affect more due to the presence of more atmospheric turbulence in the channel. Outage probability of the fading channel is the function of channel variance. As the channel variance changes outage probability also changes. With the increase in the SNR of system outage probability of the system also goes on increasing behavior. The Simulation has been done in MATLAB. Simulation results of lognormal distributed and gamma-gamma distributed fading channel is presented with changing level of turbulence. If the level of turbulence is small system behave in a better manner. As the level of turbulence increase the performance of the system degraded.

6.2 Example 1: Bit Error Rate Performance of Log normal distribution in free space optical communication system In this experiment, bit error rate parameter is considered for the performance analysis of the Log normal distribution channel. Here, we are considering the channel to be free of all kinds of noises. Fig. 6.1 shows the simulated Bit error rate analysis of Log normal distribution in free space optical communication system. Fig. 1 demonstrates the ideal Bit error rate analysis of Log normal distribution channel in free space optical communication system. Fig. 2 shows the Comparison of ideal and simulated Bit error rate analysis of Log normal distribution channel in free space optical communication system.

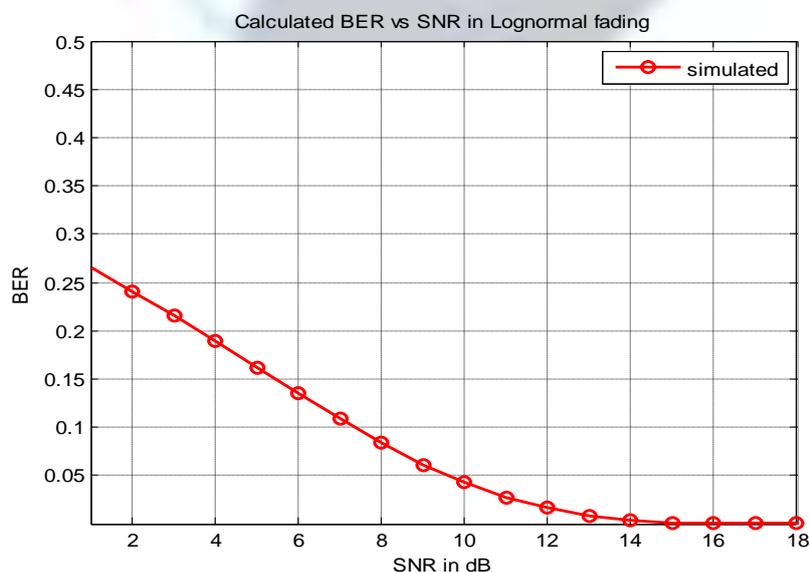


Fig.1 Simulated Bit error rate analysis of Log normal distribution in free space optical communication system

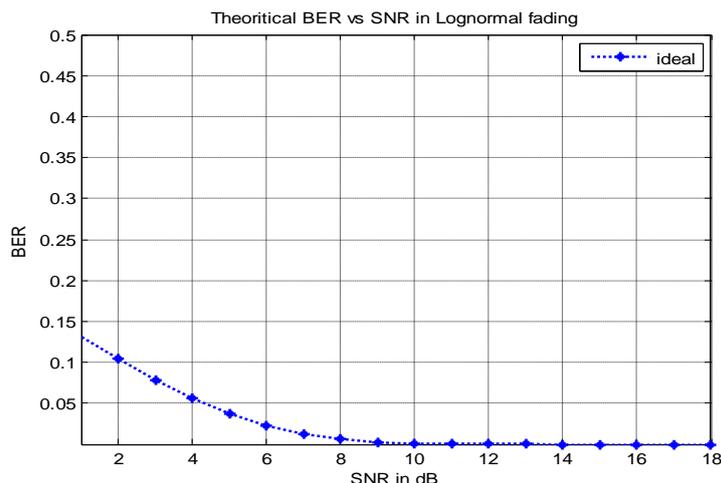


Fig. 2 Ideal Bit error rate analysis of Log normal distribution channel in free space optical communication system

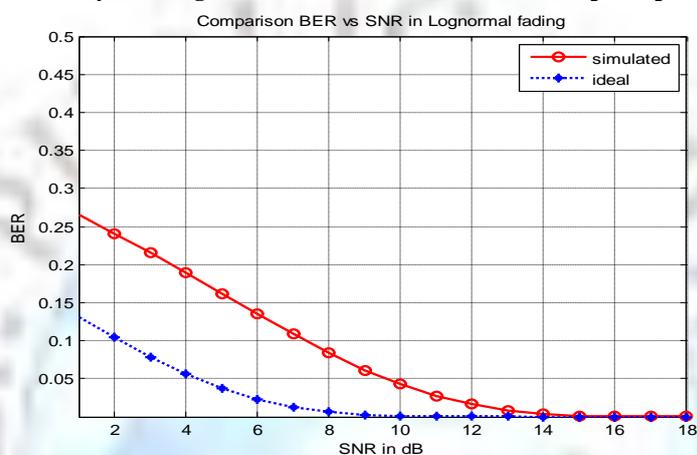


Fig. 3 Comparison of ideal and simulated Bit error rate analysis of Log normal distribution channel in free space optical communication system

Bit Error Rate Performance of gamma-gamma distribution of fading channel in free space optical communication system In this experiment, bit error rate parameter is considered for the performance analysis of the gamma-gamma distribution channel in free space optical communication system. Fig. 6.4 shows the Bit error rate analysis of gamma-gamma distribution channel with strong level turbulence in free space optical communication system. Fig. 6.5 demonstrates the Bit error rate analysis of gamma-gamma distribution channel with moderate level turbulence in free space optical communication system. Fig. 6.6 shows the Bit error rate analysis of gammagamma distribution channel with Weak level turbulence in free space optical communication system. Fig. 6.7 reveals the Comparison of Bit error rate analysis of gamma-gamma distribution channel with different level of turbulence in free space optical communication system.

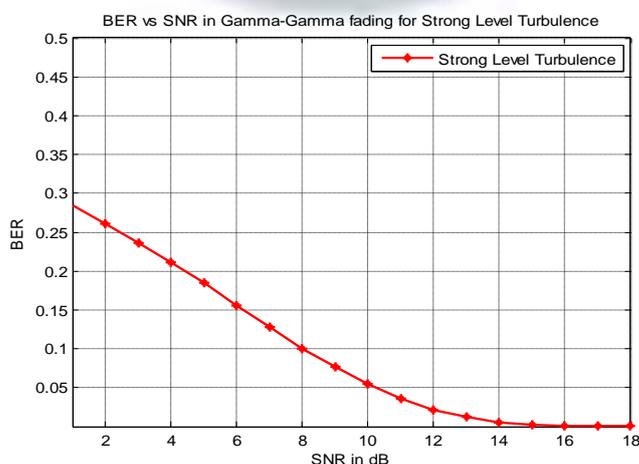


Fig. 4 Bit error rate analysis of gamma-gamma distribution channel with strong level turbulence in free space optical communication system

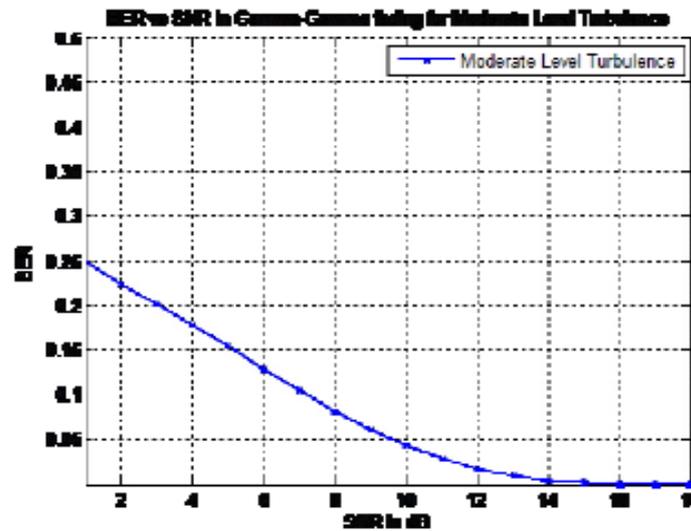


Fig. 5 Bit error rate analysis of gamma-gamma distribution channel with moderate level turbulence in free space optical communication system.

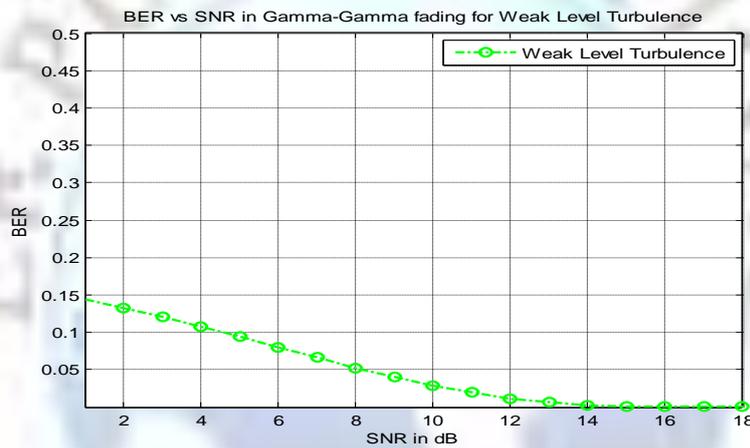


Fig. 6.6 Bit error rate analysis of gamma-gamma distribution channel with Weak level turbulence in free space optical communication system.

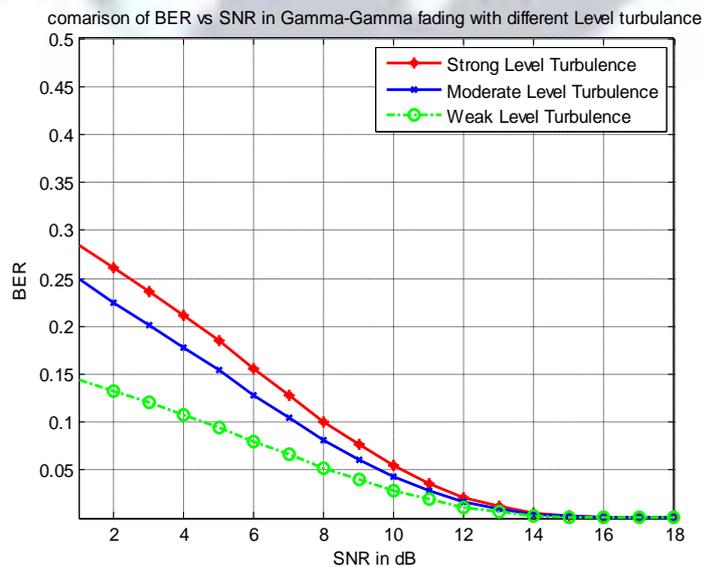


Fig. 6.7 Comparison of Bit error rate analysis of gammagamma distribution channel with different level of turbulence in free space optical communication system

V. CONCLUSION

Following point conclude as, we use the fading channel for performance analysis of the system model in free space optical communication system. Bit error rate analysis is performed with both the lognormal and gamma-gamma distributed fading channel whereas outage probability analysis is done with gamma-gamma distributed channel in free space optical communication system. Here, the performance is analysis with different level of turbulences in free space optical communication system. Results shows that the performance is better with small value of the turbulence in the fading channel in free space optical communication system.

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