A SURVEY: PERFORMANCE ANALYSIS OF FREE- SPACE OPTICAL COMMUNICATIONS OVER NOMA BASED-GAMMA FADING CHANNELS

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Abstract- *Free space optical communication (FSO) plays a pivotal role in optical communication technology. Free space optical links can be resolved using infrared laser light and LIFI technologies. This paper initially presents free space optical (FSO) systems by channel modeling under different turbulence conditions. The transmitting channel is typically modeled by a Gamma-Gamma distribution. The downlink channel is jointly affected by the turbulence-induced fading in two opposite passes as well as the NOMA, and its normalized channel fading can be described as the product of two correlated gamma-gamma random variables (RVs). The channel model of the downlink is proximated by a single _μ distribution via moment matching method.Thus we propose an effective signal modulation and detection to achieve the NOMA communication. The bit error rates (BERs) of the NOMA based FSO systems are calculated by analytical formulas. . The effect of system configurations and propagation conditions on the system performance is reviewed, and the optimal designs to make a trade-off between the uplink and downlink performance aredeliberated.*

Keywords— *Free space optical communication (FSO), NOMA, Bit Error Rate (BER),OOK modulation.*

1.INTRODUCTION

Free space optical communication (FSO) is hinge on that propagate through light which wirelessly transmit data for telecommunications or computer networking. Free space optical system consists of two identical transceivers as the link terminals offer high data rate and highly secured wireless data transmissions. For the conventional FSO communication, the system performance will decrease when the turbulence strength becomes larger. The MRR FSO system including the double-pass propagation undergoes more turbulence-induced fading leading to more performance im-pairment compared to the conventional FSO system with the same link distance. [1],[6]. This approach mainly concentrated on the study of FSO under weather environment for an outdoor system, especially dealing with the effect of atmosphere and total attenuation [2]. There is an increasing demand for high bandwidth in communication networks is relentless. The tracking down for a range of applications, including metro network extension, cellular backhaul, enterprise connectivity etc. has created adiscrepancy.

The solution to this discrepancy termed as "last mile bottleneck" was possible with FSO systems which facilitated solutions like bandwidth scalability, cost-effectiveness, and portability. A parallel transmission in frequency domain was established by OFDM. The cyclic prefix code of the CO-OFDM system makes the system more resistant to inter-symbol interference (ISI) and intercarrier interference (ICI) [4].In our proposed concept we analyze the performance of free space optical system also known as wireless optical communication over NOMA based OOK modulation technique which increase the signal security and outage probability and also reduce the power consumption for transmitting the signal or message.

2.RELATED WORK

Guowei Yang examined the effect of fading correlation, turbulence strength and aperture size on the downlink performance, and compare the bit error rate (BER) performance of the downlink with the asynchronous and synchronous transmission modes. Furthermore, the optimal designs for the full duplex (FDX) transmission are investigated in order to balance the uplink and downlink performance. [1]. Jain's paper mainly deals on finding the best suitable optical band for channel allocation in WDM networks under adverse weather conditions in FSO link. The comparison of optical bands is made on the basis of various simulation parameters like Q factor, minimum BER, eye diagram and received signal power. FSO system consists of a transmitter, propagation channel and a receiver. The optical transmitter consists of a message signal generated through a bit 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 a CW laser source is modulated using a Mach Zender Modulator (MZM). The output of the system is also compared on the basis of NRZ and RZ modulation formats [3]. In his paper, three optical bands: S-band, C-band and L- band are compared for the allocation of channels in CWDM and hybrid WDM networks... The link performance can be enhanced by using the Erbium Doped Fiber Amplifier (EDFA). The combination of S, C and L bands can also be preferred among other bands because they lie in an area of low absorption[7].

The paper by Srikanth describes that to analyze how far we can effectively transmit an RF signal using FSO link. This paper address the performance of RF signal over optical FSO links for different distances using Orthogonal Frequency Division Multiplexing (OFDM) Technique. The System is designed by using a commercial free space optical system simulating tool, OptiSystem10.In this we can create environment, according to the normal outside conditions which are affecting the signal. So simulation concept are show off the most important aspect here. It takes parameters like distance between transmitter and receiver and weather conditions, attenuation etc[4]. His paper explains that for high transmission rate and low-cost optical components by using different types of M-array modulation, such as Quadrature Amplitude Modulation (QAM) or Mach -Zehnder Modulation (MZM) [8]. Gauravsoni's paper presents the proposed FSO link with link range of 500 meters and a wavelength of 1550 nm is simulated under weak turbulence conditions and the link performance is evaluated at different data rates. The selection of wavelengths, divergence angle, receiver area, transmitter area and a distance between transmitter and receiver can be adjusted to minimize the attenuation effect on FSO. This is to ensure FSO will operate with sufficient transmission power and minimal losses, even during bad weather conditions[2].

Nistazakis describe his work is a study of how the performance metrics are affected by the atmospheric conditions and other parameters such as the length of the link and the receiver's aperture diameter. In his work, he explains the performance of FSO channels by investigating the outage probability and the average capacity respectively and also the dependence of the reliability and the performance of the system as a function of the main parameters of such a link, being the length of the link, the aperture diameter of the receiver and the atmospheric turbulence conditions between the transmitter and the receiver. Furthermore, he analyse their particular influence on a typical FSO system and proposed ways to increase the practical link efficiency. Thus, he derives closed-form expressions for the outage probability and the average capacity of optical links over atmospheric turbulence- induced fading channels modeled by log-normal and gamma- gamma distribution with respect to the turbulence strength, as well as the other important system parameters such as optical link length and the receiver's aperture diameter[5].

3.SYSTEM MODEL

The schematic of a typical FDX FSO system that consists of the transmitter and receiver section is shown in figure 1and 2. In this concept the prototype consists of transmitter and receiver which is made of LIFI module and also having APR voice module for giving input signal.

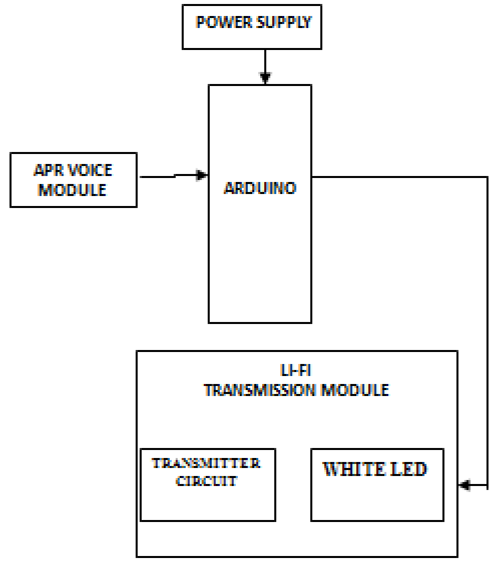

Fig.1Transmitte
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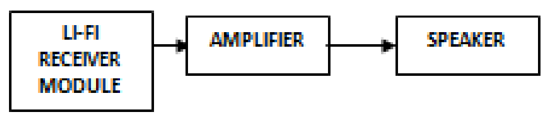

Fig.2

Receiver PROTOTYPE

3.1.ARDUINO UNO

Arduino/Genuino Uno is a microcontroller board based on the ATmega328P and which consists of 14 digital I/O pins (of which 6 can be used as PWM outputs), 6 analog inputs,and also having a 16 MHz quartz crystal, a USB connection, a power jack, an ICSP header and a reset buttonThe Uno board is primitive in a series of USB Arduino boards, and the prototype model for the Arduino platform; for an extensive list of current, past or outdated boards see the Arduino index ofboards.

Technical specification:

Microcontroller	ATmega328P
Operating Voltage	5V
Input Voltage (recommended)	7-12V
Input Voltage (limit)	6-20V
Digital I/O Pins	14 (of which 6

	provide PWM output)
PWM Digital I/O Pins	6
Analog Input Pins	6
DC Current per I/O Pin	20 mA
DC Current for 3.3V Pin	50 mA
Flash Memory	32 KB (ATmega328P) of which 0.5 KB used by bootloader
SRAM	2 KB (ATmega328P)
EEPROM	1 KB (ATmega328P)
Clock Speed	16 MHz
LED_BUILTIN	13
Length	68.6 mm
Width	53.4 mm
Weight	25 g

3.2.LIFI module

LIFI is a module to transmit data through illumination by taking the fiber out of fiber optics by sending data through a LED light bulb that varies in intensity faster than the human eye can follow. Li-Fi is the term some have used to identify the fast and cheap wireless-communication system, that is the optical version of Wi-Fi.It is possible to encode data in the light by changing the rate at which the flicker of LED on and off to give different strings of 1s and 0s.The LED intensity is modulated so rapidly that human eye cannot notice, so the output appears constant. More sophisticated techniques could dramatically increase VLC datarate.

3.3. APR9600 multi-section sound recorder/replay IC and experimental board

APR9600 is a sound record/replay IC which haslow-cost high performance incorporating flash analogue storage technique. Recorded sound is detained even after power supply is removed from the module. The replayed sound illustrates high quality with a low noise level. The 60 second recording period sampling rate is 4.2 kHz that gives a sound record/replay bandwidth of 20Hz to 2.1 kHz. However,by varying an oscillation resistor, a sampling rate as high as 8.0 kHz can be attained. This reduces the total length of sound recording to 32 seconds. Total sound recording time may be varied from 32 seconds to 60 seconds by altering the value of a single resistor.

4. PROPOSED METHODOLOGY

Free space optical (FSO) communication system has studied to provide high-speed connectivity that is applicable for the various wireless access network, ground to satellite and satellite to satellite links. In this proposed system, we focus on the performance analysis and optimization of the NOMA based FSO system employing OOK modulation over the atmospheric channel. We establish a NOMA scheme which concludes the optimal decoding order as a function of the channel state information at the quality of service requirements of the BSs, such that the outage probabilities of both BSs are jointly underrated.

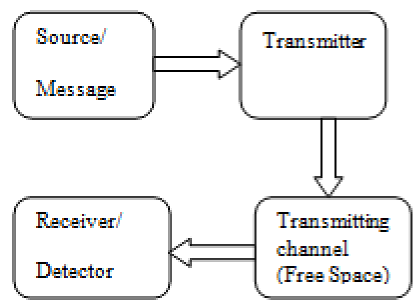

Fig.3 Basic Representation of FSO Communication

Moreover, we analyze the performance of the suggested NOMA scheme in terms of the probability outage over Gamma-Gamma FSO turbulence channels. We further procure the closed-form expressions for the outage probability for the high signal-to-noise ratio regime. This concept becomes less power consumptive and cost-effective. We use NOMA employing OOK modulation for signal security and reduce the bit error rate for effective and efficient transmission of message or signal from transmitting section to receiving unit through free space communication. In this concept we made a prototype based on lifi module and the input can be given either as a signal message or recorded voice message using APR voice module andarduino.

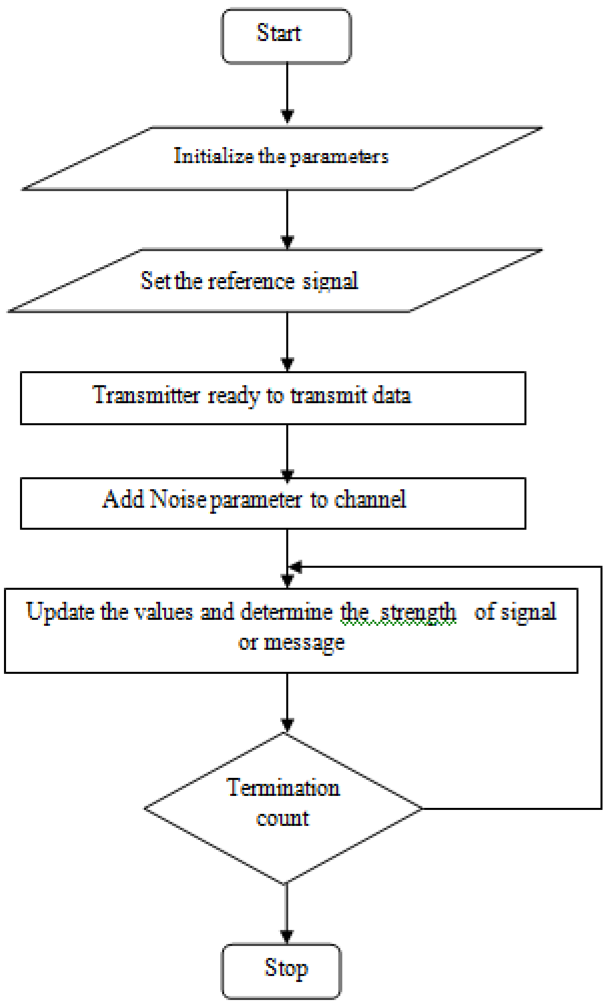

Fig.4 Flowchart for finding the BER of proposed system.

5. CONCLUSION

After briefly reviewing NOMA FSO technologies, we presented the channel modeling for the uplink and downlink of the NOMA FSO system in weak-to-strong turbulence regime. The single- pass channel in the uplink was consistently modeled by the distribution. The fading in the double-pass downlink channel was elucidated by the product of two correlated RVs and its PDF was related by a α-μ distribution with the aid of the moment matching method. From the above survey, we discussed the Monte Carlo simulations provides a complete and easy way to calculatethe system performance such as BER and bandwidth based on this model of signal response To achieve the FDX FSO communication, we preceded the OOK modulation with different modulation indices in the uplink and downlink.. The effect of the fading correlation, turbulence strength, aperture size and transmission mode on the system performance was extensively scrutinized. Finally, we presented the trade-off between the uplink and downlink performance .The proposed system is that experimentation of NOMA based FSO employing OOK modulation technique for improving the signal security and reduce the bit errorrate.

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