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Light Polarized Coherent OFDM Free Space Optical System

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Abstract

This work is focused to carry out the investigation of Coherent detected OFDM-FSO system using a simulated test-bed employing Light Polarization under clear weather conditions. The data rate transmission is achieved to 1 Tbps range by using coherent detection scheme over a FSO link as compared to direct detection based OFDM-FSO system Here, the simulated work is demonstrated for light Polarization CO-OFDM-FSO systems to achieve acceptable BER at 10 dB improved SNR value having data rate (up to 1Tbps) compared to CO-OFDM FSO System at same range and data rate.

Keywords-Orthogonal Frequency Division Multiplexing, Free Space Optics (FSO), Light Polarization, Coherent Detection.

Introduction

FSO is one of the brightest Technologies for broad-band communications, offering high transmission rates difficultly possible by RF technology. FSO has the features both of wireless and fiber optics. High bandwidth, license free spectrum, easily installation, has made them a good candidate for high data rate transmissions. FSO has less or almost negligible interception because of using point to point laser signals that provides security to transmission [1]. FSO has fulfilling many broad band networks requirement because of its advantages but some restrictions it has that limit the performance. So, it is important to take care about several internal or external system parameters into notice such as rain, dust, snow, fog, or smog that degrade the transmission path that shut down the network that's are external parameters. The internal parameters include transmission bandwidth, optical power linewidth, optical loss on transmitter side, BER, lens diameter [2].

In FSO links, multipath fading is one of the ascendant factors that impoverish the functioning of such systems. A considerable effort needs to be done to attenuate the multipath fading by introducing subcarrier modulation, OFDM Modulation. The

OFDM technique disperse the data over a large number of carriers that are spaced apart at specific frequencies with overlapping bands. The FFT used for modulation provides orthogonality to the subcarriers, which prevents the demodulators from seeing frequencies other than their own [3]. Optical communication, optical OFDM (OOFDM) system can construct high-speed, large-capacity and low-cost optical transmission network through OFDM technology [4]. OFDM has two detection methods that are direct detection and Coherent Detection. Coherent Optical OFDM have provided high data rate and high capacity in the optical communications and motivated researchers, which got special attention due to its tolerance to Chromatic Dispersion (CD) and Polarization Mode Dispersion (PMD) [5].

In this paper, The technology has been applied to atmospheric laser communications, and acquired some research results. There are two types of FSO-OFDM model [6], namely, the direct up, direct down-conversion model and the intermediate frequency (IF) model. The method, which can achieve direct up/down-conversion model by employing the light polarization, is proposed in this paper. As the horizontal polarized light and vertical polarized light pass through the same optical path, the atmospheric attenuation will be counteracted by each other in the solution of optical polarization angle when using light polarization modulation, and, hence the FSO-OFDM polarization modulation can reduce or even eliminate the effect of atmospheric channel (weather effect and turbulence), and improve the system reliability and system confidentiality.

In previous research work, used CO-OFDM with WDM to reach a data rate of 400 Gbits/s over 1000 Km through single mode fiber (SMF). The 400 Gbits/s signal is generated through eight multiplexed OFDM with 50 Gbits/s for each OFDM. Data rate is further increased to Tbits/s by using 20 channels Wavelength Division Multiplexing (WDM) Coherent Optical Orthogonal Frequency Division Multiplexing (CO-OFDM) with 4-QAM for long haul transmissions of 1800 Km SM [7]. A design of fading resistant FSO direct detection system using a simulated test-bed employing OFDM scheme is reported to calculate the FSO range with acceptable SNR and BER with the highest data rate of 5 Gbps under the impact of different weather like hazing, fog and clear weather conditions is reported [8]. In [9] designed CO-OFDM-FSO to achieve Tbps data transmission in prolonged FSO link with acceptable BER under clear weather conditions. Further, the work is also demonstrated the role of ODSB- and OSSB-schemes to report the best scheme to be used in CO-OFDM-FSO systems. In this paper, the work is further extended to realize Light Polarized CO-OFDM FSO System with improved SNR and Q-Factor under clear weather condition at the Data rate of 1Tbps.

System design

The Light Polarized CO-OFDM system is simulated and studied using an OptiSystem V. 12 simulation tool. The design consists of three main parts:CO-OFDM Tx (Transmitter), optical FSO link and CO-OFDM Rx (Receiver)

Light Polarized CO-OFDM Transmitter Design

In our proposed Light Polarized CO-OFDM-FSO transmission system as shown in Fig. 1, QAM data signals at 1Tbps are generated using 4QAM sequence generator having 2 bit per symbol. This QAM data signals are then OFDM modulated by means of OFDM modulator using 512 sub-carriers and FFT size of 1024 to generate high speed OFDM analog data signals. These OFDM analog signals at this data rate are modulated with light carrier generated by a CW laser having wavelength of 1550 nm and power of 10 dBm. CW Laser light is spitted by Polarization Splitter and used to module two groups of OFDM analog signals by means of two DMZM modulators (for 1 group). This QAM-OFDM treated analog data signals are directly transmitted over an optical span At the receiver base station, the signal is retrieved successfully using four PIN photo-detectors which are derived by local oscillator having same wavelength as that of transmitter to realize coherent detection

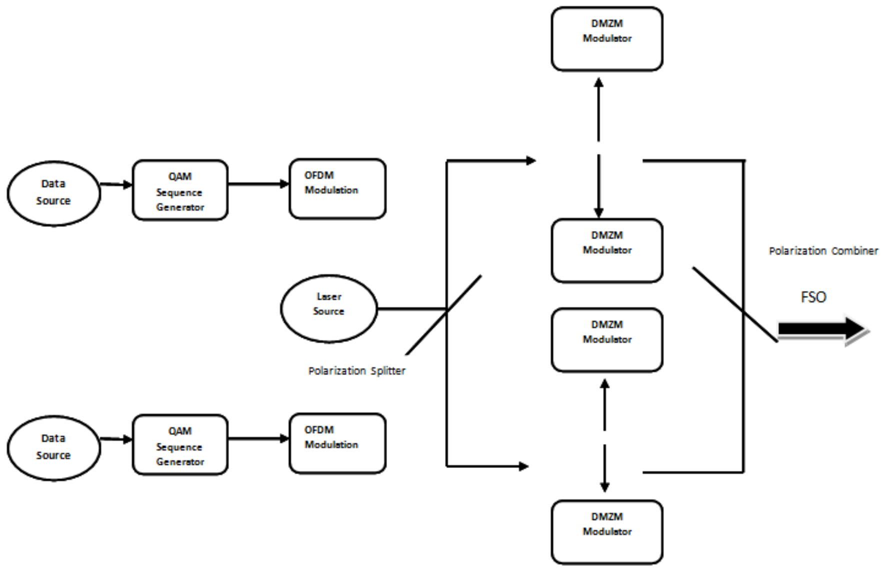


Fig 1 Light Polarized FSO OFDM Transmitter

Optical FSO Link

The FSO link contains different parameters like range, aperture diameter, path loss, delays etc we can set it according to computing requirement. Here we are considering the clear weather condition so we take the attenuation value 0. 155 dB/km, Transmitter and Receiver aperture diameters are 15 cm

Light Polarized CO-OFDM Rx Design

CO-OFDM receiver design; to recover the I/Q component of the OFDM signal, two pairs of balanced PIN photo detectors and LO (Local Oscillator) lasers are used. The balanced detectors perform the I/Q optical to electrical detection and help perform the noise cancellation. At Receiver the Polarization Splitter is used to split the light and then light is coherently detected. The Polarization Splitter is also used with Local Oscillator. Amplifiers are used to adjust the signal intensity. After the balanced detectors the resulting signal is demodulated using the OFDM de modulator with similar parameters as the OFDM modulator in transmitter. After that the signal is fed into a 4-QAM decoder, and the BER and SNR is calculated.

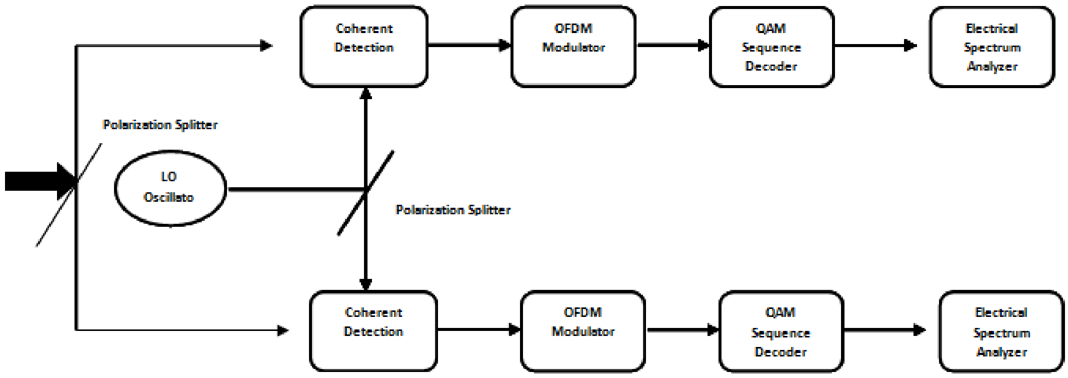
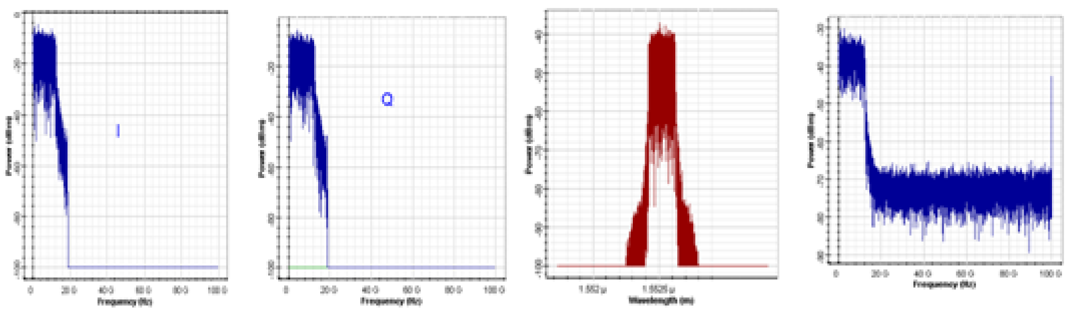


Fig. 1 Light Polarized FSO OFDM Receiver

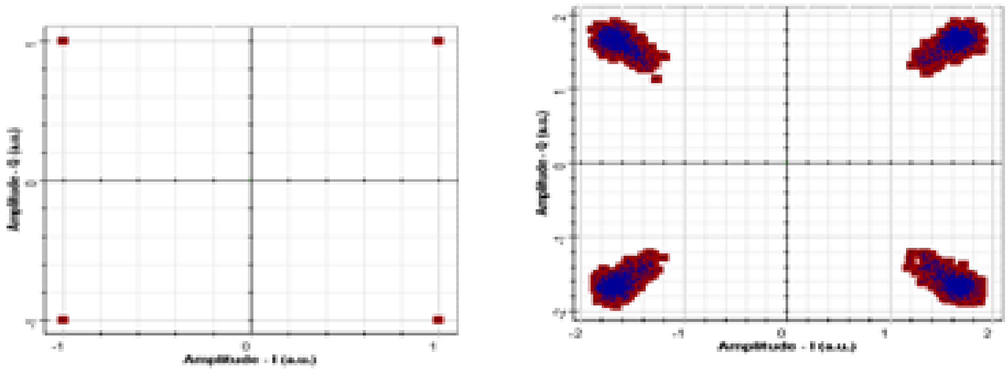
Results and discussions



(a) (b) (c) (d)

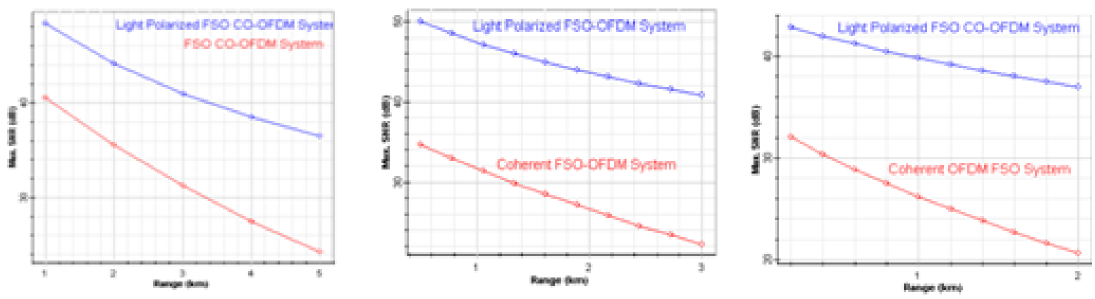
Fig. 3 (a) OFDM I Spectrum (b) OFDM Q Spectrum (c) OFDM Signal after the two DMZMs (d) RF spectrum of the signal at the receiver side

The other simulated parameters are listed in It is observed that the SNR is calculated as[40. 56 dB, 35. 564 dB, 31. 233 dB, 27. 48 dB and 24. 234 dB] at optical range of [1 km, 2 km, 3 km, 4 km, 5 km] for CO-OFDM –FSO for 0. 1 Tbps. In case of Light Polarized CO-OFDM-FSO transmission system, the SNR is reported as [48. 39dB, 44. 14 dB, 40. 94, 38. 47dB and 36. 47dB] at optical span of [1 km, 2 km, 3 km, 4 km, and 5 km]. For 0. 5 Tbps SNR values are [34. 63 dB, 28. 46 dB, 22. 21 dB] at range of [0. 5 km, 1. 6 km, 3. 0 km] for CO-OFDM-FSO transmission system and for Light Polarized CO-OFDM-FSO System SNR’s are [49. 99 dB, 44. 90 dB, 40. 81 dB] at same range. At 1 Tbps SNR values are [32. 02dB, 26. 19 dB, 20. 62 dB] at range [0. 2 km, 1. 0 km, 2. 0 km] for CO-OFDM –FSO System and [42. 86 dB, 39. 81 dB, 36. 98 dB] at same range for our system.



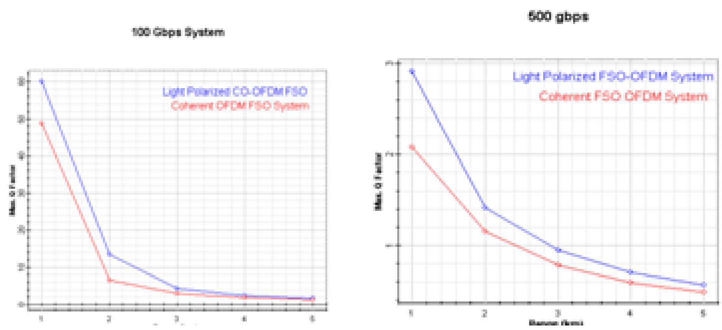
(a) (b)

Fig. 5 (a) 4-QAM constellation diagram at the transmitter side (b) Constellation diagram after Optical Span



(a) (b) (c)

Fig. 6 SNR vs FSO range of Light Polarized FSO CO-OFDM-FSO system at (a) 0. 1 Tbps (b) 0. 5 Tbps (c) 1 Tbps



(a) (b) (c)

Fig. 7 Q-Factor vs FSO range of Light Polarized FSO CO-OFDM-FSO system at (a) 0. 1 Tbps (b) 0. 5 Tbps (c) 1 Tbps

Conclusion

From our results, it is concluded that the proposed Light Polarized CO-OFDM-FSO system performs better than hybrid CO-OFDM OFDM-FSO system with acceptable BER over FSO link of attenuation 0. 155 dB. The Comparison at 0. 1 Tbps shows, for our system there are 8 dB SNR improvement at lower range and 12 dB at higher range. At 0. 5 Tbps SNR of 15 dB is improved at lower range and 18 dB at higher range. For 1 Tbps, improved SNR is 10 dB and 16 dB at lower and higher range respectively at acceptable BER.

References

[1] Sharma V, Kaur G. *Degradation measures in free space optical communication (fso) and it's mitigation techniques-a review.* International Journal of Computer Applications 2012; 55 (1):23-27.

[2] Bloom S, Korevaar E, Schuster J, Willebrand H. *Understanding the performance of free-space optics.* Journal of optical networking 2003; 2 (6):178-200.

[3] Raeshidy H, Komaki S. *Radio over fiber technologies for mobile communications networks.* Artech House 2002.

[4] Mitchell J. *Performance of ofdm at 5. 8 ghz using radio over fiber link.* Electron Lett 2002 40 (21).

[5] Fontaine N, Scott R and Yoo S. *Tb/s coherent optical ofdm systems enabled by optical frequency combs.* Journal of Lightwave Technology 2010:28 (14):2054-2061.

[6] Roy Y, Joseph K. *Upper-bounding the capacity of optical im/dd channels with multiple-subcarrier modulation and fixed bias using trigonometric moment space method.* IEEE Transactions on Information Theory; 48:514-523.

[7] Alatawi K, Almasoudi F, Matin M. *Performance study of 1 tbits/s wdm coherent optical ofdm system.* Optics and Photonics Journal 2013:330-333.

[8] Sharma V and Sushank. *High speed co-ofdm-fso transmission system.* Optik 2014:1761-1763.

[9] Sharma V and Kaur G. *High speed, long reach ofdm-fso transmission link incorporating ossb and otsb scheme.* Optik 2013:6111-6114.