A Survey Paper on Space Time Block Code OFDM System for Optical Communication

[1]Mukesh Kumar Gupta, Research scholar , Department of ECE VIT , RKDF University Bhopal (MP) , India
[2] Abhinav Shukla, Asst. Prof. Department of ECE VIT , RKDF University Bhopal (MP) , India
[1]mukeshguptadyp@gmail.com, [2] abhinav.shukla@hotmail.com

* Corresponding Author: Mukesh Kumar Gupta

Abstract: *Because of the benefits of optical fibre, data transfer speeds and propagation distances can be increased. OFDM is utilized in hybrid optical-wi-fi gadget designs as a multicarrier technique (MC) as it has the best spectrum performance to radio frequency (RF) interruption and decrease multipath distortion. OFDM (orthogonal frequency department multiplexing) is a sort of multi-provider transmission era that employs orthogonal frequency division multiplexing (OFDM). It makes use of digital sign processing (DSP) to carry out an inverse Fast Fourier transform (IFFT) and assemble a sequence of orthogonal sub-carriers for information transmissions of lowrate virtual signals, permitting the switch of high-speed information bits. Its brilliant spectrum performance and anti-dispersion abilties make it perfect for a huge variety of high-potential and long-distance optical fibre verbal exchange utility structures and optical get right of entry to networks.*

Keywords: ***OFDM, DSP, IFFT, MC, RF.***

I. Introduction

OFDM, or orthogonal frequency division multiplexing, is a multicarrier virtual modulation method that developed along DSP technology. OFDM alerts have stepped forward spectral performance and anti-multipath interference fulfilment than different multi-carrier multiplexing structures considering they're orthogonal in each the time and frequency domains. With each the assist of DSP processors, OFDM signals may be without difficulty created and demodulated. Equalization of the channels and different operations also are pretty straightforward. As a result, OFDM is broadly utilized in wireless, wireline, and broadcast communications.

Because OFDM is a multi-carrier transmission system, it can be classified as either modulation or multiplexing technology. OFDM is based on the same principle as frequency division multiplexing (FDM). It uses digital signal processing to create a succession of orthogonal sub-carriers enabling simultaneous transmission of low-rate digital signals, allowing high-speed digital communications to be transmitted.

The effects of chromatic dispersion and polarisation mode dispersion (PMD) of optical fibre links on communications networks is governed not only by the function of the optical transmitter and receiver, but also by the influence of chromatic dispersion and polarisation mode dispersion (PMD). With the evolution of communication technology and the ongoing improvement of communication requirements, the data rate of single channel transmission in optical communication has increased substantially, reaching 100 Gb/s. When the data rate exceeds 100 Gb/s, however, standard optical fibre modification becomes prohibitively expensive and time-consuming, and effective dispersion compensation becomes impossible.

Because of OFDM's improved computational properties, complex frequency-domain operations can be performed. OFDM technology, particularly optical OFDM, is thought to be used in optical communication since the dispersion of optical fibres can be effectively regulated (O-OFDM). This approach can improve resistance to optical fibre chromatic dispersion and PMD. This paper introduces the fundamental principle of O-OFDM. The application of OFDM in optical communication networks is addressed in the second section. Finally, the problems with O-OFDM, as well as potential solutions, are discussed. remedies.

II. The Principle of O-OFDM

The O-OFDM principle is the same as the OFDM principle. The signal is converted from an electrical domain wireless signal to an optical domain optical signal as the only difference. Figure 1 depicts the O-OFDM system's architecture block arrangement. The transmitter includes OFDM baseband transmission, RF up-conversion, and optical modulation. The receiver includes optical detection, RF down-conversion, and OFDM baseband reception. At the transmitter, the S/P transformation converts the binary serial digital signal into N-channel parallel data. Each piece of data is modulated using M-ary PSK or QAM.

The signal is translated to the relevant complex domain using a constellation diagram. The N parallel carriers are then converted to serial ones using IFFT, and an OFDM symbol is added in front of each sign. After inserting the cyclic prefix (CP), the signal is converted to an OFDM baseband analogue signal via digital-to-analog conversion. Before being sent by single mode fibre, the baseband signal is transformed to the RF carrier frequency and subsequently to the optical carrier frequency (SMF). The DSP in the receiver is essentially the inverse of that in the transmitter. The optical signal is converted to electrical domain by a detector (PD), which is then converted to digital domain by an analog-to-digital converter (ADC).

III. APPLICATION OF OFDM IN OPTICAL COMMUNICATION

For all paragraphs, indentation is essential. All paragraphs must be justified on both the left and right sides, which means they must be justified on both sides.

Direct detection O-OFDM(DDO-OFDM) System

The topology of a DDO-OFDM system is shown in Figure 1. Based on the approaches utilised to generate O-OFDM signals, DDO-OFDM systems are divided into two classes.: linear

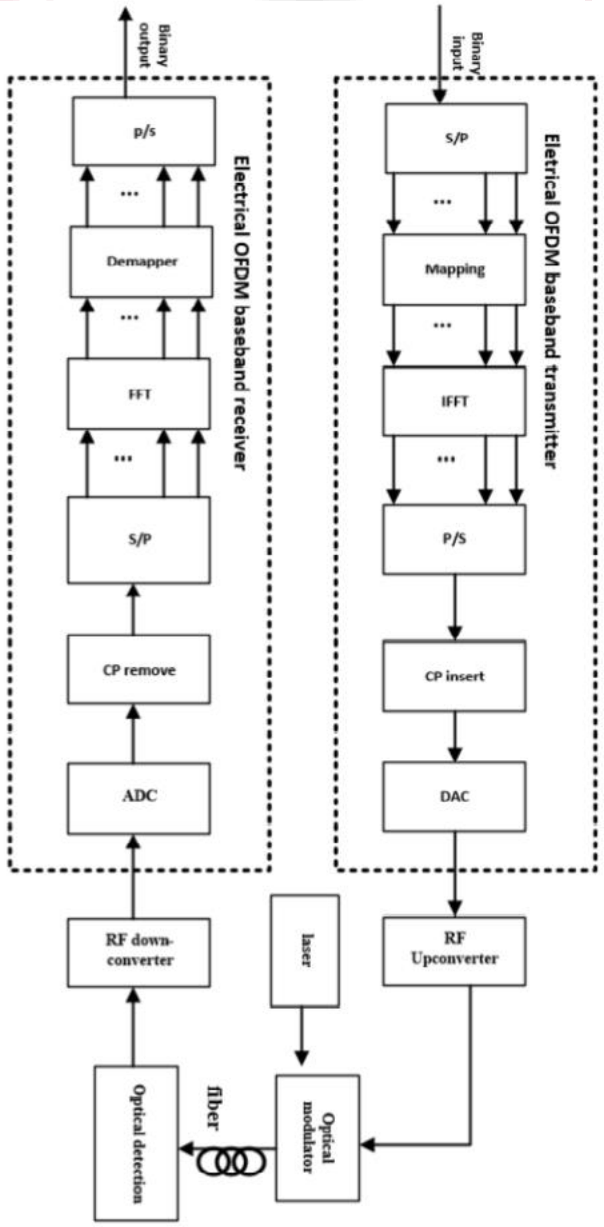

FIG 1:-Structure diagram of O-OFDM system

Figure 1 depicts the structure of a DDO-OFDM system. DDO-OFDM systems are classified into two groups based on the methods used to create O-OFDM signals. direct access to the OFDM optical spectrum In a linear mapping DDO-OFDM system, the frequency of optical OFDM is the linear transfer of baseband OFDM spectrum, meaning that duplication is direct.

The dispersion coefficient affects the transmission distance in this system, hence it's crucial to account for it in the electrical or optical domains. Furthermore, because the number of subcarriers affects the DDO-OFDM system, the number of subcarriers must be carefully chosen based on spectrum usage and bit error rate requirements.

Linear mapping DDO-OFDM is formally expressed as,

$$s(t)=e^{j2\pi f_0}+\alpha e^{j2\pi(f_0+\triangle f)r}\cdot s_B(t) \qquad (1)$$

In formula (1), f_0 is the optical carrier frequency; Δf is the protection bandwidth here between optical primary carrier as well as the OFDM band; s(t) is an optical OFDM signal; and α is a proportional coefficient describing the relationship between both the energy of the OFDM band and the primary carrier. S_B (t) is a given baseband OFDM signal, which can be expressed as:

$$s_B(t)=\sum_{k=-\frac{1}{2}N+1}^{\frac{1}{2}N} C_K e^{j2\pi f_k r} \qquad (2)$$

The k-th subcarrier's information symbols and frequencies are denoted by ck and fk, respectively.

The directly modulated waveform in the non-linear mapping DDO-OFDM system is as follows

$$E(t)=e^{j2\pi f_0 r}A(t)^{1+jc} \qquad (3)$$

$$A(t)=\sqrt{p(t)}=A_0\sqrt{1+\alpha\mathrm{Re}(e^{j(2\pi f_{IF}t)}\cdot s_B(t))} \qquad (4)$$

$$m=\alpha\sqrt{\sum_{K=-\frac{1}{2}N+1}^{\frac{1}{2}N}|c_k|^2} \qquad (5)$$

E(t) is the optical OFDM signal; A(t) and P(t) are the instantaneous amplitude and power of the optical OFDM signal, including both. C is the chirp constant of the direct modulated DFB laser; f_{IF} is the pulse width intermediary frequency of the electrical OFDM signal; m is the optical modulation index; and is the constant of proportionality used to choose the appropriate modulation index m to minimise the limiting vibration.

Because the channel model of DDO-OFDM is no longer normal under the interaction of factors forms of optical dispersion, it is only suitable for short-range applications such as multimode fibre (MMF) local area network (LAN) or short-range SMF transmission.

A. Coherent detection OFDM (CO-OFDM) system

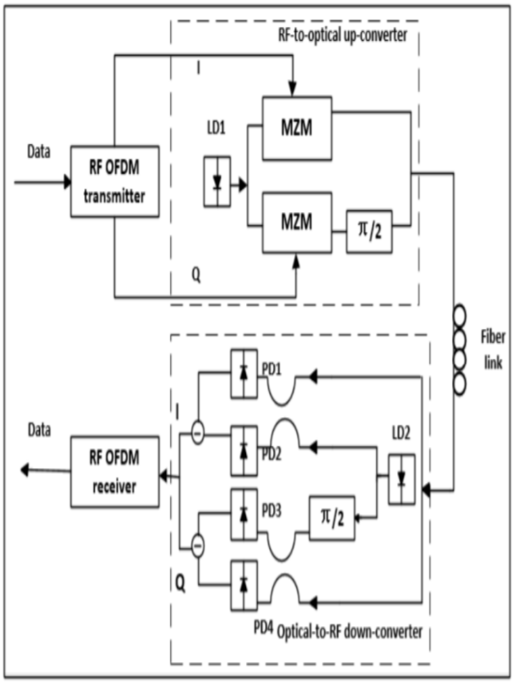

FIG 2:- coherent optical OFDM system

In a DDO-OFDM system, only the maximum insertion of light can be detected, not the sequence information. CO-OFDM, on the other hand, has a very high receiver sensitivity and can reimburse for the disadvantages of DDO-OFDM, allowing for long-distance transmission. Figure 2 depicts a schematic representation of the CO-OFDM system. Correspondingly, the number of subcarriers has a direct effect on the quality of the CO-OFDM system. Channel interference will o ccur if the number is too large.

If the number is too small, the use of spectrum will be reduced. As a result, it is critical to keep track of the number of subcarriers. Furthermore, different modulation configurations in a COOFDM system would affect the optical signal-to-noise ratio (OSNR), nonlinear influence, and optical fibre dispersion tolerance, necessitating the involvement of qualified technical personnel. Choose a fair debugging mode after trying to balance communication range, transmission capacity, and debugging time. Bit error rate and spectrum utilisation It is important to note that the difference in differential group delay is significant. (DGD) has the potential to negatively impact system performance. As DGD increases, system performance improves; however, as DGD exceeds a certain threshold, system performance declines because the main factor that affects system performance becomes PMD(DGD), which can also be increased.

C. Application of OFDM in access network

In access networks, multiple services must be assigned to multiple customers at a time. Present EPON and GPON systems require complex task scheduling and framing approach will enable multiple services. The performance of these TDM-PONs is influenced by packet forwarding delays and other data traffic passing through that kind of link. Moreover, because every service can use a different wavelength, WDM-PON can allocate a variety of services impartially. Signals are affected by polarization-dependent loss (PDL), PMD, and chromatic aberration.

Multiple transmitters and arrayed waveguide gratings (AWG) or optical filters may be required to dissipate the wavelength to the relevant receivers, mandating the use of multiple transmitters and arrayed waveguides gratings (AWG) or optical filters. Expenses and system costs are on the rise. Moreover, WDM-PON is incapable of rapidly allocating resources across multiple services. The use of OFDM advanced technologies in PON has the potential to significantly reduce the expense of WDM PON.

Inputs are affected by isotropic lost opportunity (PDL), PMD, and chromatic aberration.

In OFDM-PON, OFDMA, as a multi-access advanced technologies, can constantly disburse distinct subcarriers to multiple users in OFDM-PON, enabling for allocation of resources in both the time domain and frequency domain. It can transparently support a range of services and dynamically allocate bandwidth to all these applications. OFDM-PON can be combined with TDM-PON can provide additional resource management systems.

IV.LETRETURE REVIEW

The CO-OFDM system can effectively adjust and approximate PMD in optical fibres. To boost system capacity, polarisation division multiplexing (PDM) innovation must be presented into the CO-OFDM system, which not only meets the system's necessary requirements for each component but also improves transmission rate. As a result, the PDM CO-OFDM system has recognized as a crucial component of future ultra-high capacity, ultra-high speed, and ultra-long distance transmission networks. The effects of polarization-dependent loss (PDL), PMD, and chromatic dispersion influence optical signal transmission in SMFs, which typically have two polarisation modes.

Title	**Author Name**	**Year of Publication**	**Work Done**
Time domain synchronous OFDM system foroptical fiber communications	C. Jing, X. Tang, X. Zhang, L. Xi and W. Zhang	2019	This research combines the features of QPSK OFDM and 16QAM OFDM systems in optical fiber communication. The proposed methodology has been demonstrated to have high CFO evaluation and sequential accuracy. A QPSK OFDM system has a BER of the less than 3.8e-3 at a 13-dB electro - optic signal-to-noise ratio (OSNR), while the 16-QAM OFDM system has a BER of less than 3.8e-3 at a 20-dB OSNR.
Analysis of DFT-Based Channel Estimation for Uplink Massive MIMO Systems	HaoWu, Member, YuanLiu, and KaiWang	2018	The impact of an extended Kalman filter transmission estimation method on a massive-MIMO system was illustrated. Whenever the SNR is low, this one has been revealed that non-allocating sub carriers to Zero padding lead to

			better results. The methodology utilizes the high speed Fourier transform/inverse high speed Fourier transform to torque for short complexity. This paper also investigates DFT-based modulation scheme for transceiver massive MIMO systems. The simulation results show the constraints of the proposed technique in low SNR AWGN channels. The best results are displayed using an improved Kalman filter with FFT system, that also immensely reduces computational complexities.
Of Channel State Information for Massive MIMO Basedon Received Data Using Kalman Filter	Aqiel Almamori, Seshadri Mohan	2018	Channel state information (CSI) evaluation for sensing of input signal data was created using the Kalman Filter and basic experience of the channel or established pilot bits. The examinations conducted the OFDM-based QPSK modulation technique. A reconfigured Kalman filter is applied to the received data that can provide channel state information (CSI) and estimate channel noise. The result analysis of the enhanced Kalman filter is less dependent on the channel statistics and yields the minimum MSE.
Compressed sensing for wireless communications: useful tips and tricks	J.W.Choi, B.Shim, Y.Ding, B.Rao, and D.I.Kim	2017	Presented an overview of CS advanced technologies at a high level, such as basic configuration, the piecemeal recovery process, and performance assurance As a consequence, in various wireless communication systems, we describe three distinct CS sub-problems: vulnerability estimation, medium identification, and vulnerability detection. We also go over some of the most significant factors when building CS-based wireless communications systems. Which include the potential and constraints of CS strategies, beneficial recommendations to keep in mind, slight points to keep in mind, and several preliminary knowledge for performance improvement.
Near-optimal signal detector based on structuredcompressive sensing for massive SMMIMO	Z.Gao, L.Dai, C.Qi, C.Yuen, and Z.Wang	2017	A low complexity signal technique based on structured compression sensors (SCS) was recommended to significantly enhance detection accuracy. To create the necessary constructed economy, we first propose an integrated reporting categorised at the transmitter level in which discrete SM signals are categorised in distinctive constant frequency ranges to carry the symbol of the prevalent space cluster. As a consequence, a constructed subspace tracking technique (SSP algorithm) is recommended to the receiver in order to cohesively gather many SM signals using systematic scarcity.

V. CONCLUSION

We present a space time block code bandwidth index modulation scheme for transmitting over frequency selective routes that is based on CS-assisted low complexity detector in this paper. The information bits are transmitted using space, time, and bandwidth dimensions to enhance bandwidth efficiency and BER performance. The proposed methodology was using space space - time block coding in the simulated universe, which outperformed the conventional OFDM-STSK system in terms of BER. In terms of MSE efficiency, ANN channel estimation outperforms classic MMSE channel estimating techniques.

REFERENCES

[1] C. Jing, X. Tang, X. Zhang, L. Xi and W. Zhang, "Time domain synchronous OFDM system for optical fiber communications," in China Communications, vol. 16,no. 9, pp.155-164, Sept. 2019.

[2] HaoWu, Member, YuanLiu, and KaiWang, "Analysis of DFT Based Channel Estimation for Uplink Massive MIMO Systems",IEEE Communications Letters, Vol. 22, no.2,2018, pp. 328-331.

[3] Aqiel Almamori ,Seshadri Mohan, "Estimation of Channel State Information for Massive MIMO Basedon Received Data Using Kalman Filter" IEEE Computing and Communication Workshop and Conference(CCWC), 2018,pp. 665-669.

[4] J.W.Choi, B.Shim, Y.Ding, B.Rao, and D.I.Kim, "Compressed sensing forwireless communications: useful tips and tricks, "IEEE Communications Surveys Tutorials, vol. PP, no.99, pp. 1–1,February,2017.

[5] Z.Gao, L.Dai, C.Qi, C.Yuen, and Z.Wang, "Near-optimal signal detector based on structured compressive sensing for massive SMMIMO, "IEEE Transactions on Vehicular Technology, vol.66, no.2, pp.1860–1865, Feb2017.

[6] Pham Hong Lien, Nguyen Due Quang and Luu ThanhTra, "Extended Kalman Filter for Channe land Carrier Frequency Offset Estimation" ,International Conference on System Science and Engineering, 2017, pp.61-65.

[7] Ibrahim A.Hemadeh, Mohammed El-Hajjar, Seung HwanWon, LajosHanzo, "Multiusers teered multi sets pace-time shift keying for millimeter wave communications," IEEE Transactionson Vehicular Technology, vol.66, no.6,pp.5491–5495,June2017.

[8] Kalpesh Hiray, K. VinothBabu, "A NeuralNetwork Based ChannelEstimation Scheme for OFDMSystem" ,International Conference on Communication and Signal Processing, 2016, pp.438-441.

[9] H.Zhang,L.L.Yang,andL.Hanzo,"Compressed sensing gimproves the performance of subcarrier index-modulation-assisted OFDM," IEEEAccess, vol.4, pp. 7859–7873, October 2016.

[10] I.A.Hemadeh, M.El-Hajjar, S.Won, and L.Hanzo, " Layered multigroupsteered space-time shift-keying for millimeter-wave communications," IEEEAccess, vol.4, pp. 3708–3718, April 2016