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Reduced BRE in OFDM System using ANN Technique for Optical Communication

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Abstract: In an optical communication channel, multiple signals are transmitted using the concept of orthogonal frequency division multiplexing (OFDM), which efficiently handles inter-symbol interference and efficiently utilises the frequency and available bandwidth. Because the transmitting antenna sends a signal through a noisy channel, the channel noise must be estimated. The channel estimation technique aids in analysing the effect of noise on transmitted data in a noisy channel. Orthogonal frequency division multiplexing (OFDM) is important in wireless communication because of its high transmission rate. In space-time shift keying (STSK), information is transmitted in both spatial and temporal dimensions, which can be used to strike the right balance between diversity and multiplexing gains. STBC is a strong technique used at the transmitter to achieve high data rates, increased capacity, and a low Bit Error Rate (BER). This study investigates compressed sensing (CS) to improve throughput and reduce bit-error performance by transmitting extra information bits in each subcarrier block, as well as to reduce the complexity of the equaliser. The space time block coding algorithm is combined with channel estimation via the ANN technique in this study. The results show that the proposed methodology outperforms the others in terms of BER.

Keyword :- OFDM, DSP, IFFT, MC, RF

I. Introduction

OFDM has sparked a lot of interest in optical fiber communications as an efficient multiplexing innovation that is immune to inter symbol interference (ISI) and inter carrier interference (ICI) caused by a scattering channel, and it could be a candidate for more elastic optical fiber networks [1-3]. The versatility and scalability of the OFDM system are due to its unique frame structure. To reduce ISI and ICI, a guard interval (GI) is introduced between neighboring OFDM symbols. Based on the guard interval design method, there are now three primary types of OFDM systems.

The first type is Cyclic Prefix OFDM (CPOFDM). CP is a partially identical copy of the OFDM symbol that lacks the symbol duration. ISI has no effect on the system due to its cyclic structure, and subcarrier orthogonality is guaranteed. When the length of the cyclic prefix exceeds the maximum transmission latency of the channel, all ISI can be eliminated and the subcarriers are kept orthogonal to each other [4-6]. The second type is Zero Padding OFDM (ZP-OFDM). To eliminate ICI, ZP is used as the guard interval instead of the traditional CP, and zero padding can save transmission power efficiently. Because it can use the extended cyclic channel matrix to effectively reduce complexity channel equalization, ZP-OFDM is more adaptable than CP-OFDM [7, 8].

The third type is Time Domain Synchronous OFDM (TDS-OFDM). In this type of OFDM, the guard interval is filled with pseudo noise (PN) sequences. Because it is recognized at the receiver end, the PN sequence can be used for system synchronization and channel estimation. TDS-OFDM is also known as PN Padding OFDM (PN-OFDM). TDS-OFDM is used in the multi-carrier portion of the Chinese Digital Terrestrial/Television Multimedia Broadcasting (DTMB) network standard, which describes physical layer transmission protocols like frame structure, channel coding, and modulation schemes [9, 10].

Optical CP-OFDM has recently piqued the optical communications society's interest, and it has undoubtedly demonstrated its capabilities in a wide range of applications across all levels of optical networking, from long haul to metro, access, and network services [9-10]. However, because the useless fraction of data symbols is also included in the transmission process, using CP results in data rate loss (bandwidth). CP also reduces power when compared to the empty guard interval. Power loss is valued in proportion to the CP to OFDM symbol timeframe ratio [2-6]. Using the improved algorithms, we thoroughly examine the TDS-OFDM principle and revise an appropriate TDS-OFDM frame structure. Based on the simulation results, we can conclude that the proposed TDS-OFDM scheme achieves stable overall performance of synchronous accuracy and carrier frequency offset (CFO) prediction in a coherent optical communication system.

II. LITRATURE REVIEW

W. Zhang, C. Jing, X. Tang, X. Zhang, L. Xi, and C. Jing [1], In optical fiber communication, this study combines the features of QPSK OFDM and 16QAM OFDM systems. The proposed methodology has been shown to have a high level of CFO evaluation and sequential accuracy.

A QPSK OFDM system has a BER less than 3.8e-3 at a 13-dB optical signal-to-noise ratio (OSNR), while a 16-QAM OFDM system has a BER less than 3.8e-3 at a 20-dB OSNR.

Members HaoWu, YuanLiu, and KaiWang [2], On a massive-MIMO system, the effect of an extended Kalman filter transmission estimation method was demonstrated. When the SNR is low, it has been discovered that not allocating sub carriers to Zero padding yields better results. To torque for short complexity, the methodology employs the high speed Fourier transform/inverse high speed Fourier transform. In addition, a DFT-based modulation scheme for transceiver massive MIMO systems is investigated in this paper. The simulation results demonstrate the limitations of the proposed method in low SNR AWGN channels.The best results are obtained by combining an improved Kalman filter with an FFT system, which also greatly reduces computational complexities.

Channel state information (CSI) evaluation for sensing of input signal data was created by Aqiel Almamori and Seshadri Mohan [3], using the Kalman Filter and basic channel or established pilot bits.

The OFDM-based QPSK modulation technique was used in the tests. On the received data, a re-configured Kalman filter is used to provide channel state information (CSI) and estimate channel noise. The enhanced Kalman filter's result analysis is less dependent on channel statistics and yields the lowest MSE.

D.I.Kim, J.W.Choi, B.Shim, Y.Ding, B.Rao, and J.W.Choi [4], A high-level overview of CS advanced technologies such as basic configuration, the piecemeal recovery process, and performance assurance was presented. As a result, we describe three distinct CS sub-problems in various wireless communication systems: vulnerability estimation, medium identification, and vulnerability detection. We also discuss some of the most important factors to consider when developing CS-based wireless communications systems. This includes the potential and constraints of CS strategies, beneficial recommendations to remember, minor details to remember, and several preliminary knowledge for performance improvement.

Z.Gao, L.Dai, C.Qi, C.Yuen, and Z.Wang [5] To significantly improve detection accuracy, a low complexity signal technique based on structured compression sensors (SCS) was recommended. To build the required constructed economy, we first propose an integrated reporting categorised at the transmitter level in which discrete SM signals are classified in distinct constant frequency ranges to carry the symbol of the prevalent space cluster.

As a result, the receiver is advised to use a constructed subspace tracking technique (SSP algorithm) to cohesively gather many SM signals using systematic scarcity.

III. METHODOLOGY

A low complexity signal method based on established compression sensors (SCS) was recommended to significantly improve detection accuracy. To build the necessary constructed economy, we first propose a comprehensive reporting category at the transmitter level in which discrete SM signals are classified in distinct continuous frequencies ranging to carry the symbol of the prevalent space cluster.

As a result, the receiver is advised to employ a constructed subspace tracking methodology (SSP algorithm) to collect many SM signals in a cohesive manner using systematic scarcity.

The O-OFDM principle is the same as the OFDM principle. The only difference is that the signal is converted from an energy domain wireless signal to an opportunistic domain signal. Figure 1 depicts the O-OFDM system's architecture block diagram. The transmitter includes OFDM baseband transmission, RF up-conversion, and optical modulation. The receivers include optical detection, RF down-conversion, and OFDM baseband reception. At the transmitter, the binary serial digital signal is S/ transformed into N-channel parallel data. The M-ary SK or AM technique is used to modulate each piece of data. The signal is mapped to the appropriate complex domain using a constellation diagram. The N parallel carriers are then converted to serial ones using IFFT, and an OFDM symbol is placed before each symbol.

The cyclic prefix (C) is added, and the signal is converted to an OFDM baseband analogue signal using digital-to-analog conversion. Before being delivered into single mode fibre, the baseband signal is modulated to RF carrier frequency and then to opportunistic carrier frequency (SMF). The DS of the receiver is essentially the inverse of the DS of the transmitter. The optical signal is converted into electrical domain by a detector (D), and then into digital domain by an analogue to digital converter (ADC) (ADC). Following that, C is removed and a /S conversion is performed. The signal is then translated to the frequency domain using FFT. Finally, the signal is damped and converted to serial data. The five functional blocks of conventional OFDM systems are as follows:

- Baseband OFDM transmitter
- Electrical-to-optical (E/O) up-converter
- Optical fiber link
- Optical-to-electrical (O/E) down-converter
- Baseband OFDM receiver

Each OFDM signal frame consists of a frame header (FH) and a frame body (FB) (FB). A signal frame is an OFDM symbol. The baseband symbol rate is the same for FH and FB. The implanted guard interval (FH) is used to keep the subcarriers orthogonally aligned.

TDS-OFDM is a technological breakthrough in optical communication in a variety of ways. To begin, TDSOFDM employs N as the guard interval in order to provide significantly faster synchronization than C-OFDM. Second, N specifies the unique signal frame address within each sub-frame. Third, by using the well-known N sequence as FH to minimize ISI, TDS-OFDM provides the advantage of quick network acquisition because it can be done entirely in time domain.

In this study, optical communication is used rather than wireless communication, with OFDM integration. As shown in Fig. 3, the proposed scheme is divided into N parallel groups, with b number of data bits processed in each group. For each group of b bits, b1 bits are mapped to the IM selector, which chooses K active indices from Na available indices. The remaining b2 bits are used to generate K STTC code-words, which are then resynchronized to provide more diversity gain for improved BER and MSE performance.

Using the IM selector, the activated indices are then mapped to the K coordinate interleaved code-words, while the inactive indices are set to zero. The block creator then collects all code-words from all G groups in parallel to form a frame, which is then mapped to space-time trellis code-words, modulated with DWT-OFDM, and finally transmitted. In the system shown in Fig. 3, we investigate OFDM modulation with Nc subcarriers that are equally divided into N subcarrier groups, each group containing Mg = Nc/N subcarriers in the frequency domain. In each subcarrier group, K indices are active out of the Na possible subcarrier indices in the virtual domain.

If the index selector is applied directly to Nc in OFDM, there could be an enormous number of alternative active indices combinations, making active indices selection nearly impossible. As a result, the subcarriers are divided into N smaller groups in order to perform index selection. As shown in Fig. 3, the data packets are separated into G groups at the transmitter's input.

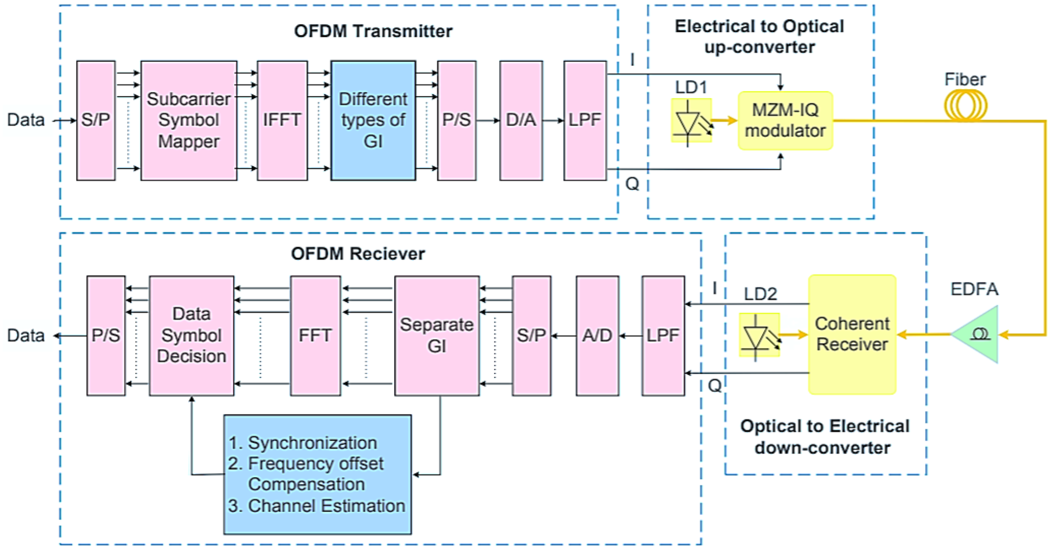

Figure 1: Optical OFDM

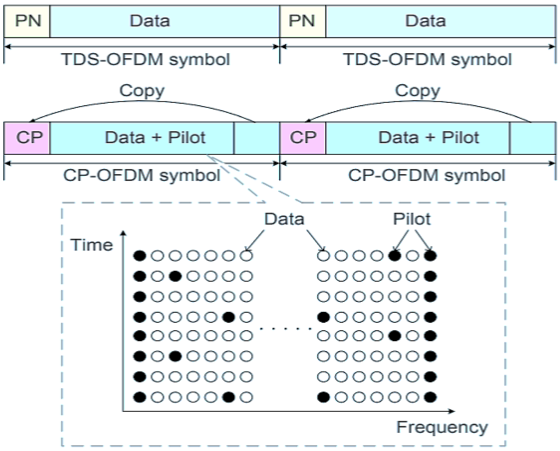

Figure 2: OFDM Symbols

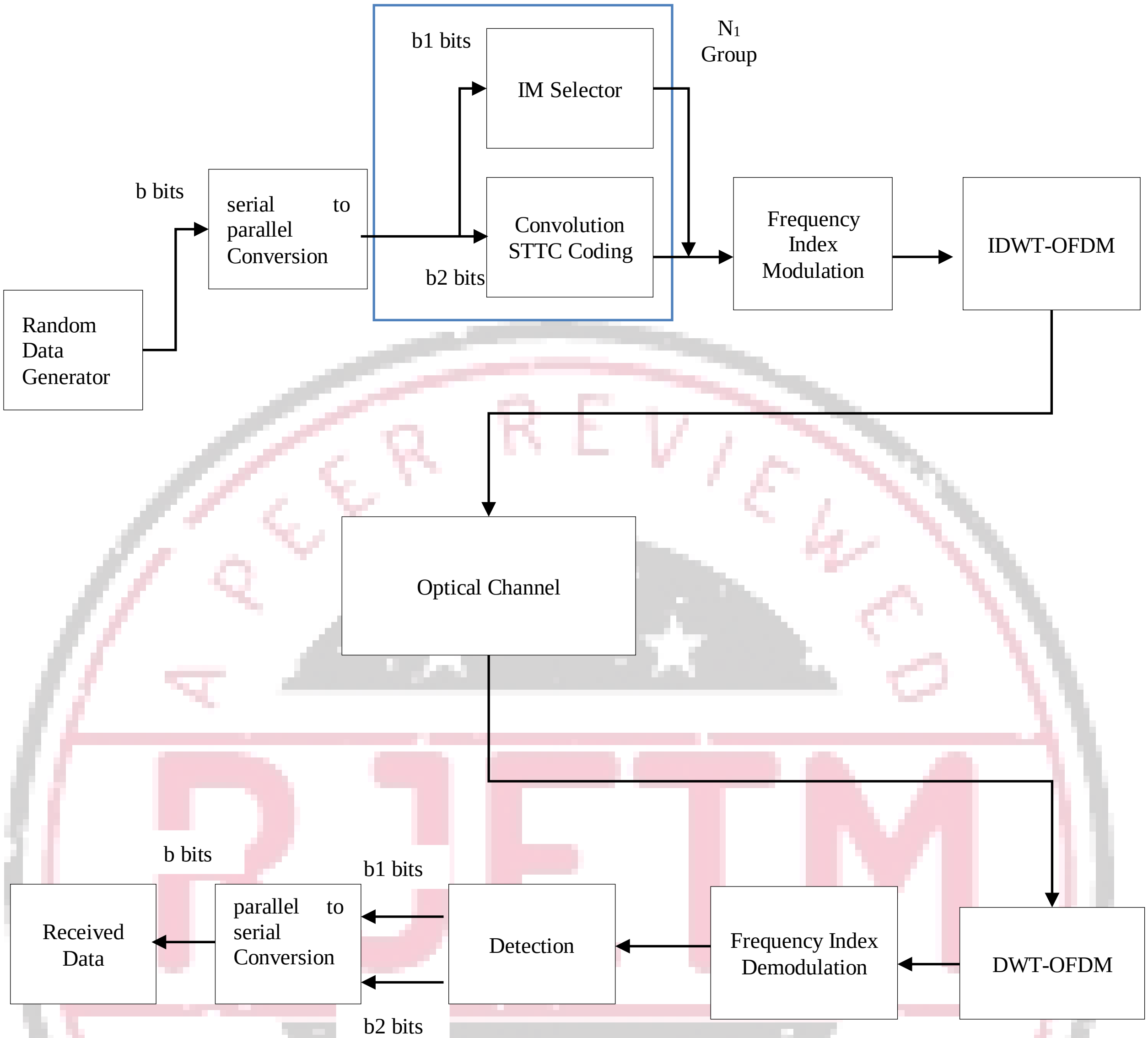

Figure 3: The Proposed Transceiver Architecture

IV. RESULT ANALYSIS

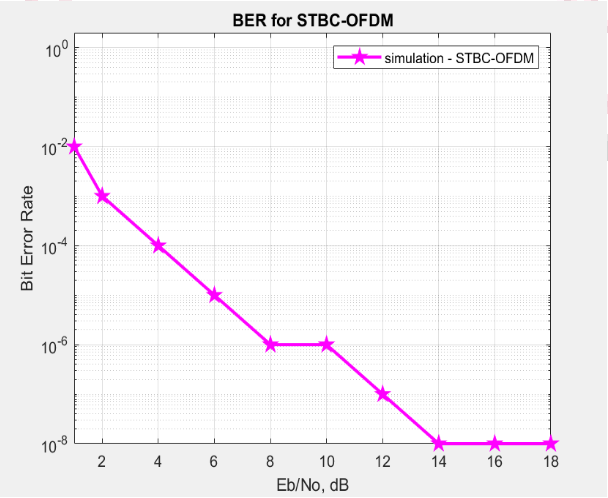

Figure 4: BER Performance of CS-STBC Vs SNR

Mean Square Error performance is analysed in simulation of proposed approach using Matlab software with frequency index modulation. As shown below, the research framework is simulated and compared to each other using a variety of signal to noise ratios (Eb/No). At the same transmission data rates, the optical-OFDM and the CS-aided STBC optical-OFDM are compared. The BER performance of these methods is evaluated using Monte Carlo simulations.

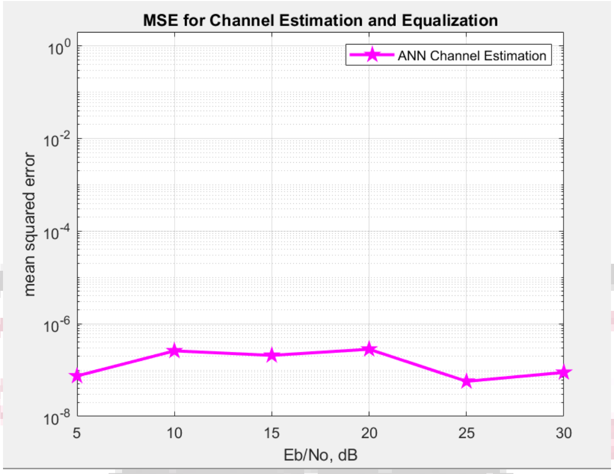

Figure 5: MSE Performance of ANN Equalizer with CS-STBC Vs SNR

The suggested technique has a performance range of 0-18 dB, as shown in Fig. 4. When compared to the existing system, the proposed algorithm has a 10-7 BER. Despite having a lower decoding complexity, the proposed methodology has been found to be adequate for achieving a better performance. To further reduce complexity, NN channel estimation and equalization are performed, and it is demonstrated that NN have less MSE than traditional channels estimation techniques. Figure 5 depicts the performance of the MSE.

V. CONCLUSION

This study investigates a space time block code bandwidth index modulation scheme based on CS-aided low complexity detections for transmission over single frequency channels. Information bits are transmitted using the space, time, and frequency dimensions to improve spectral efficiency and BER performance. The proposed methodology used space time block coding in the simulation, which has better BER performance than the traditional OFDM-STSK system. In terms of MSE performance, NN channel-estimation outperforms traditional MMSE channel estimation techniques.

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