Improving Performance of MIMO System using OSTBC

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Abstract— *Optimization of Channel estimation is the main challenging tasks in Multi Input Multi Output (MIMO) wireless communication systems. In this work, a Multi-Channel Optimization Algorithm approach is used for the channel estimation of antenna in a transmission area. The main advantage of this method is, that it reduces the loss of bandwidth during data transmission effectively. Here, we considered various channel estimation techniques and then optimization for improving the transmission speed and reducing the unused bandwidth. Initially, the message is given to the input of the communication system and then, the symbol mapping process is performed for converting the messages into signals. It will be encoded based on the space–time encoding technique.*

Keywords— MIMO, BFO, OSTBC, BER

I. INTRODUCTION

Wireless communications has seen a grand development over the last thirty years. There are a large number of various application, which inducing more and more complicated technical challenges. Some of these challenges include higher data rates, ubiquity of wireless devices, trend towards faster, smaller and cheaper hardware and frequency congestion. The wireless radio channel is a shared, naturally limited resource which has a characteristic that varies with time, frequency and space. Radio waves are affected by various phenomena which can cause errors and affect the quality of communications. In this thesis we have conducted measurements and use different physical and statistical models to characterize the wireless channels encountered in harsh communication environment.

There are many important requirements that need to be satisfied for a successful deployment of wireless sensor networks in process automation and discrete manufacturing. Some typical examples of process automation industries include mining, oil and gas, steel, pulp and paper, etc. Their main common characteristic is that the products are produced in a continuous manner, i.e. the oil is produced in a continuous flow. In discrete manufacturing, the products are produced in discrete steps, i.e. the products are assembled together using sub-assemblies or single components. Typical examples of discrete manufacturing industries are the automotive, medical, and the food industries. Discrete manufacturing heavily relies on robotics and the conveyors belts, hence, they have stricter requirements with respect to latency and real-time requirements compared to process automation. The different types of applications can be sensitive to different characteristics, like data consistency, jitter, retransmission or delays.

In order to guarantee a certain quality of service, not only high bit rates are required, but also a good error performance. However, the disruptive characteristics of wireless channels, mainly caused by multipath signal propagation (due to reflections and diffraction) and fading effects, make it challenging to accomplish both of these goals at the same time. In particular, given a fixed bandwidth, there is always a fundamental tradeoff between bandwidth efficiency (high bit rates) and power efficiency (small error rates).

The organization of present paper is as follow. Section II presents the literature survey which highlights the facts of various researchers. Section III describes the methodology used for proposed work as in this paper OSTBC is used. Result analysis is presented in section IV following the concluding remarks in section V.

II. LITERATURE REVIEW

This section will provide the brief description and highlights the contribution, remarks and factors of the work done by the researchers. Many attempts have been made in the past to achieve the minimum bit error rate while the transfer of optimum amount of energy from source to destination.

Wang, Wen-Qin et al. (2015) [1] In this paper, multiple-input multiple-output (MIMO) radar waveform diversity design has received much attention, but most of the existing waveforms lack a large time-bandwidth product and are difficult to be implemented by real-life hardwares.

Zhang, Yan-Yu, et al. (2015) [2] In this paper, we consider a multiple-input-multiple-output optical wireless communication (MIMO-OWC) system suffering from log-normal fading

Jamali, Mohammad Vahid, et al. (2016) [3] In this paper, results show that spatial diversity can considerably improve the system performance, especially for channels with higher turbulence, e.g., a 3×1 multiple-input single-output transmission in a 25 m coastal water link with a log-amplitude variance of 0.16 can introduce 8 dB performance improvement at the BER of 10^{-9}.

He, Chen, et al. (2016) [4] In this paper, Motivated by this, orthogonal space-time block code (OSTBC), which is very successful in mobile communications for its low complexity and high performance, has already been investigated for MIMO backscatter RFID. The proposed BUTQ-mOSTBC can resolve the linear decoding problem, keep the simplicity and high performance properties of the classical OSTBC, and achieve the query diversity for the MIMO backscatter RFID.

Cheng, Shengjuan et al. (2016) [5]In this paper, multiple-input multiple-output radar waveform diversity design has received much attention, but many of existing waveforms are lack of a large time-bandwidth product. This paper proposes an orthogonal frequency division multiplexing (OFDM) chirp waveform diversity design scheme to generate four waveforms with good correlation properties, ambiguity performance and Doppler tolerance. The method jointly utilizes classic chirp waveform and OFDM to conduct multi-carrier modulation. This scheme enables us to exploit full bandwidth for each waveform and thus has an high frequency utilization efficiency. The modulation and demodulation of the four OFDM chirp waveforms are presented. The performance of the designed waveforms is analyzed by the correlation and ambiguity functions. Simulation results validate that our proposal can generate more orthogonal waveforms without significant performance degradation.

Su, Xin, et al. (2016) [6] In this paper, massive multiple input, multiple output (M-MIMO) technologies have been proposed to scale up data rates reaching gigabits per second in the forthcoming 5G mobile communications systems.

Nam, Junyoung, et al. (2017) [7] In this paper, correlation across transmit antennas in multiple-input multiple-output (MIMO) systems has been studied in various scenarios and has been shown to be detrimental or provide benefits depending on the particular system and underlying assumptions

Cheng, Shengjuan et al. (2017) [8]In this paper, in multiple-input multiple-output radar systems, the employed waveforms should have a large time-bandwidth product, good correlation property and satisfactory ambiguity function performance.

Devi, Bhusa, et al. (2017) [9] In this paper, Multiple-Input-Multiple-Output (MIMO) systems, which use multiple antennas at the transmitter and receiver ends of a wireless communication system. MIMO systems are increasingly being adopted in communication systems for the potential gains in capacity they realize when using multiple antennas. Multiple antennas use the spatial dimension in addition to the time and frequency ones, without changing the bandwidth requirements of the system.

Ahmad, Ishtiaq et al. (2017) [10]In this paper, we investigate the performance of the SANET with the spatial transmit diversity techniques are employed. Based on the analysis of the packet error rate and throughput, we select the efficient multiple antenna schemes for SANET to improve the link reliability.

This section has provided the brief review of the work done in past. It also highlighted the factors, contribution and remarks on the achievement.

III. FRAME WORK FOR IMPLEMENTATION

The main objectives of research work are to Study and analyze various MIMO Diversity Techniques and to combine a new Optimization based method for improving Diversity in MIMO OFDM. To implement and evaluate the proposed scheme using various metrics such as BER, MSE etc.

The OSTBC may be suitable only when the channel characteristic does not change within symbol period. However, the channel for the terminal that move fast vary within a symbol period which is longer symbol period has a more severe effect on the channel estimation performance. At the receiver, the orthogonally among the subcarriers resulting in ICI maybe destroyed by the time varying channel. This channel estimation deals with the effect of the ICI in time varying channels. A transmitted signal using OSTBC can be written in the time domain

$$X[n] = \sum_{k=0}^{N-1} X[k]e^{j2\pi kn/N} \text{ , N = 0,1……… , N-1}$$

The corresponding signal received though a wireless channel with L path in OSTBC can be expressed as:

$$Y[n] = = \sum_{i=0}^{L-1} h_i[n]\, x[n-ti] + w[n]$$

Where $h_i[n]$ and t_i denote the impulse response and delay time for the i^{th} path of the time varying channel.

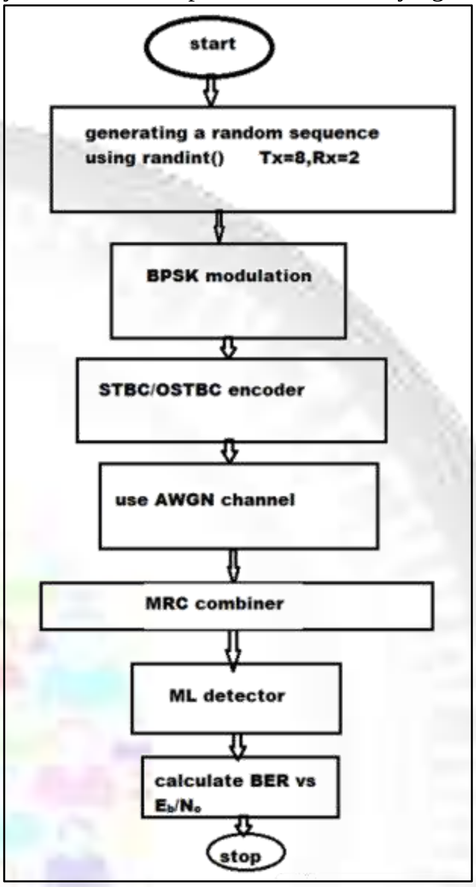

Fig. 1: Flow Chart of the Process

Assuming that the pilot sequence is known at the receiver and that channel parameters remain constant over two adjacent subcarriers and over n_t MIMO OSTBC symbols, channel estimation is performed at the pilot subcarriers and used to decode adjacent data subcarriers as described in previous section. In this Section, the channel estimation strategy of OSTBC is described for subcarriers located in the lower side of the pilot subcarrier of each group but proposed equations are also simultaneously used for the upper side. Received pilot and data subcarriers signal after FFT can be expressed as:

$$\overline{R_{p_j}} = \sum_{j=1}^{N_r} \overline{P}\overline{H}_{p_j} + \overline{N}_{p_j}$$
$$\overline{R}_j = \sum_{j=1}^{N_r} \overline{S}\overline{H}_j + \overline{N}_j$$

Where and represent the received pilot and data signal at the j^{th} antenna respectively and are the pilot and data signals respectively represent the channel parameters and the white Gaussian noise between the two transmit antennas and the N_r receive antennas for pilot and data signals respectively. The pilot elements of OSTBC can be expressed as:

$$\bar{R}_{p_j} = \left[R_{p_{j,k_p}}(n) R_{p_{j,k_p}}(n+1)\right]^T$$
$$\bar{H}_{p_j} = \begin{bmatrix} H_{p_{j,k_p}}(n) \\ H_{p_{j,k_p}}(n+1) \end{bmatrix} \quad (1)$$

$$\bar{P} = \begin{bmatrix} P_{1,k_p}(n) & P_{2,k_p}(n) \\ -P^*_{2,k_p}(n) & P^*_{1,k_p}(n) \end{bmatrix} \bar{N}_{p_j} = \begin{bmatrix} N_{p_{j,k_p}}(n) \\ N_{p_{j,k_p}}(n+1) \end{bmatrix} \quad (2)$$

Where k_p=0,1,…, Np-1.While the data elements are given as:

$$\bar{R}_j = [R_{j,k}(n) R_{j,k}(n+1)]^T$$

$$\bar{H}_j = \begin{bmatrix} H_{1,j,k}(n) \\ H_{2,j,k}(n+1) \end{bmatrix}$$

$$\bar{S} = \begin{bmatrix} S_{1,k}(n) & S_{2,k}(n) \\ -S^*_{2,k}(n) & S^*_{1,k}(n) \end{bmatrix} \bar{N}_{p_j} = \begin{bmatrix} N_{1,j,k}(n) \\ N_{2,j,k}(n+1) \end{bmatrix}$$

Where k=0,1,…, Ns-1.

Transmitted pilot and data signals are encoded in space, time and frequency as described in Fig 4.3. Therefore, P1(n) and P2(n) transmitted in MIMO OSTBC symbol n and P1(n+1) and P2(n+1) transmitted during the second MIMO OSTBC symbol n+1.

IV. Result Analysis

In this, main focus is on the bit error rate of different modulation technique. A comparison is done between multichannel bacteria forging optimization algorithm and orthogonal space time block codes.

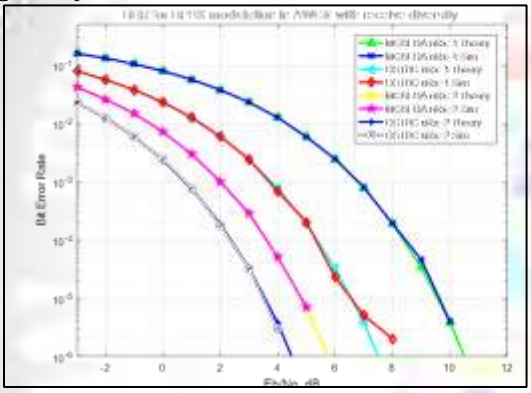

Fig. 2: BER for BPSK Modulation using AWGN Channel with Receiver Diversity ranging from 1-5 Receivers using MCBFOA and OSTBC

Fig 2 shows that bit error rate decrease with increase in signal to noise ratio. Bit error rate calculated for simulated & theoretical manner separately. Minimum bit error rate is 10^{-6} for 4.4 signal to noise ratio for OSTBC technique having 2 receiver.

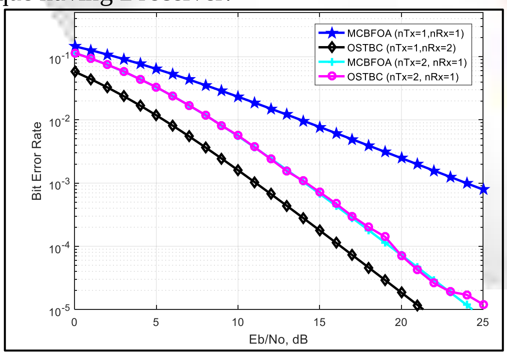

Fig. 3: BER performance of MCBFOA over Rayleigh channel with MRC and Receiver Diversity

Fig 3 gives the performance analysis of Raleigh channel in MCBFO & OSTBC technique for MIMO System. The graph shows that minimum bit error rate is comes from single transmitter & dual receiver for OSTBC technique. Signal to noise ratio is 21 db then bit error rate is 10^{-5}. There is comparison between 1×1, 1×2 and 2×1 MIMO system.

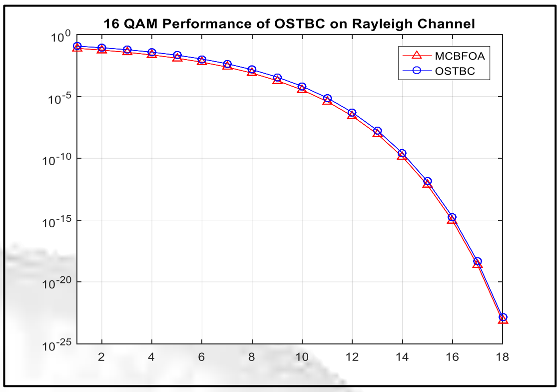

Fig. 4: 16 QAM Modulation Performance of OSTBC and MCBFOA at Rayleigh

Fig 4 shows the 16 QAM modulation performance for Rayleigh channel. OSTBC technique gives the better performance as compare MCBFO. Bit error rate decrease with increase in signal to noise ratio. For 18 db signal to noise ratio, mean square error comes up to 10^{-22}

V. Conclusion

In this work, the Rayleigh channel is selected based on the bandwidth range. After that, the channel is optimized by applying the optimization algorithm. Hence, the received signal is obtained by splitting the combined signal from a medium by de multiplexing the signals. In this analysis, the technique is mainly used to schedule the time for channels. In experiments, the performance of the MIMO optimization system is evaluated and analyzed in terms of average throughput, MSE, BER and outage capacity. Furthermore, the algorithm based upon OSTBC is compared with some of the existing MCBFOA optimization algorithms in order to prove the performance. When compared to MCBFOA, the OSTBC provides the best result.

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