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Minimization of BER for Hydro Acoustic Communication using OFDM Deciphering

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Abstract— The hydro acoustic communication is used for military purpose for under water communication. The acoustic communication is only possible under water and its free from license unlike electromagnetic spectrum. Orthogonal Frequency Division multiplexing (OFDM) is utilized for purpose of security in wireless network due to highly difficult access of the wireless network by hackers or unwanted users at lesser bandwidth unlike spread spectrum technique. But most of the previous methods having more Bit Error Rate (BER) at higher baud rate. The spread spectrum technique requires much more bandwidth. Therefore for security purpose the OFDM has been chosen which is, band limited spread spectrum. The proposed Bit Error Rate Minimizing Orthogonal Frequency Division multiplexing (BERMOFDM) algorithm will lower the BER of the OFDM system at receiver end.

Keywords— Orthogonal Frequency Division Multiplexing (OFDM), Bit Error Rate (BER), Bit Error Rate Minimizing Orthogonal Frequency Division multiplexing (BERMOFDM), local area network (LAN), primary frequency detection (PFD), compute hopping order (CHO), remaining frequency identification (RFI).

INTRODUCTION

Underwater acoustic communication is a rapidly growing field of research and engineering. The wave propagation in an underwater sound channel mainly gets affected by channel variations, multipath propagation and Doppler shift which keep lot of hurdles for achieving high data rates and transmission robustness. In order to achieve high data rates it is natural to employ bandwidth efficient modulation. Orthogonal frequency-division multiplexing (OFDM) has recently emerged as a promising alternative to single-carrier systems for UWA communications because of its robustness to channels that exhibit long delay spreads and frequency selectivity. To support high spectral efficiencies over long intervals of time in a non-stationary environment such as the UWA channel, we consider communication systems employing adaptive modulation schemes. While adaptive signaling techniques have been extensively studied for radio channels, only preliminary results for UWA channels are reported in , where simulations and recorded data are used to demonstrate the effectiveness of the proposed adaptation metrics. The requirement of underwater wireless communications exists for applications like remotely controlled off-shore oil industry, monitoring pollution for environmental systems, receiving recorded scientific data from ocean-base stations at bottom, speech transmission among divers, and ocean floor mapping to recognize objects as well as discover new resources on ocean floor. Wireless communications under the water can be established by utilization of acoustic waves. Underwater communications, which once were exclusively military, are extending into commercial fields. The basic block diagram of OFDM system is shown below in fig.1.

Fig.1. Basic block diagram of OFDM system.

LITERATURE SURVEY

Orthogonal Frequency Division Multiplexing (OFDM) based on adaptive modulation prospects of design has been explored by authors for underwater acoustic (UWA) communications, and study by real-time at-sea experiments for its accomplishment [1]. Numerical and experimental results obtained from real-time at-sea experiments, respectively, show that the adaptive modulation scheme provides significant throughput improvements as compared to conventional, non-adaptive modulation at the same power and target BER.

Authors experimentally compared the performance of OSDM and orthogonal frequency-division multiplexing (OFDM) with respect to characteristic of communication, baud rate, length of frame and complexity in calculation. The OSDM achieves far better accomplishment of BER as compared to the other methods in both static channels and dynamic channels [2].

Authors defined and derived the channel sensitivity with respect to variations of time and the different BER performance effects as threshold target by numerical results. The accomplishment of RC-LDPC codes is good in SWA channels with wide range of rates [3].

To construct the codebook and quantize the CSI of receiver by the Lloyd algorithm implementation to achieve process of limited feedback. After selecting an first bit loading vector over the recent CSI, the index is broadcasted receiver by its the transmitter, then the bandwidth efficient bit loading algorithm is computed at transmitter to allocate the respective power and each subcarrier bits. Results revealed the proposed iterative loading algorithm is an effectively minimized the transmission power while maintain constraint conditions simultaneously [4].

METHODOLOGY

The proposed OFDM Detector algorithm will maximize the throughput of system for a objective average bit error rate (BER) for underwater acoustic communication. The block diagram of OFDM transmitter and receiver is shown below.

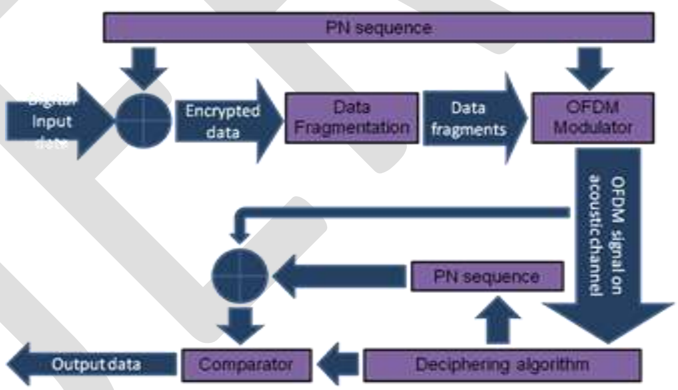

Fig. 2. BERMOFDM algorithm in hydro acoustic system.

OFDM Demodulator to Improve BERMOFDM algorithm for Hydro Acoustic Communications :

- Stage 1Primary Frequency Detection (PFD), locates the first frequency in the network.
- Stage 2 Remaining Frequencies Identification (RFI), detects the remaining frequencies.
- Stage 3 Compute Hopping Order (CHO), calculates the entire hopping pattern.
- Stage 4 Demodulate the OFDM signal.
- Stage 5 Retrieve the PN sequence.
- Stage 6 Decode data using retrieved PN sequence.

The Primary frequency detection stage (PFD) is used to identify the first frequency denoted as f_o. This method is used to scan through all the frequencies, and if no frequency is found scan all the frequencies again. When f_o is found then it is passed to the second stage. When the PFD is complete & passes f_o to the Remaining Frequencies Identification (RFI). The RFI records when frequencies stops transmission with respect to the end of the f_o signal. After RFI the output is fed to CHO. The CHO sort the input array t_x, calculates the dwell time for f_o. Calculate the rest of the dwell times. Then the output of the previous stage is fed to the demodulator and then retrieved the PN sequence and data.

The proposed algorithm retrieves the data by EXORING the retrieved PN sequence to the rest of the sequence. After EXORING the PN sequence the 8-bit string of 0 or 1 is generated. The numerical representation for the decoding data is shown in Fig. 3.

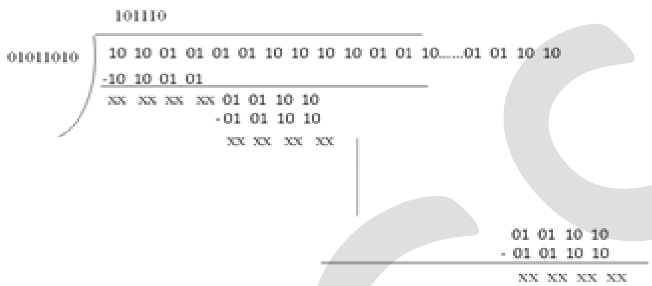

Fig. 3. The numerical representation for the decoding data.

The proposed algorithm will provide more security to the hydro acoustic communication. This algorithm significantly decreases the BER and increases the throughput of the system.

ANALYSIS

The BER is directly proportional to the baud rate and inversely proportional to bit duration. For the analysis of the BER of proposed BERMOFDM system with respect to conventional OFDM method is constant and does not increases. The mathematical analysis is shown below:

$$E = (nB)/T \tag{1}$$

Here, n is coefficient of proportionality, B baud rate, Time period of each bit and E bit error rate. For the proposed protocol n will always be 1. Therefore the BER will be constant.

SIMULATION RESULTS

The Simulation result of the PN sequence, i/p data, encrypted data, OFDM o/p, frequency count, retrieved encrypted data and retrieved PN sequence & receiver o/p (6-bit) is shown below in fig. 4.

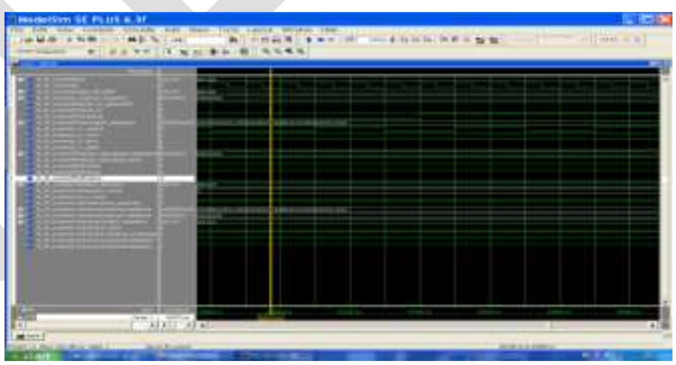

Fig. 4. Simulation results of the proposed BER minimizing OFDM algorithm.

The simulation results above shows that the 6 but input data is encrypted with 8 bit PN sequence. This Encrypted data string is therefore 48 bit long. This 48 bit long encrypted sequence is then fragmented in two bit symbol then modulated signal is available at s_tx_output. Then the deciphered output is available at the output_decoded.

The ModelSim ISE 6.3f package is utilized for the design and simulation of the proposed BERMOFDM algorithm for hydro acoustic system. This tool ModelSim ISE 6.3f from the Altera is very simple and versatile tool for development in VHDL.

CONCLUSION

The simulation results show that the proposed system will efficiently control the BER. Therefore the proposed system is more efficient as compared to the existing OFDM system in hydro acoustic communication.

Due to three times data encryption at transmitter the communication is highly secure for under water communication. With the more data encryption and lower BER the proposed algorithm has higher throughput. This algorithm has one drawback that first LSB of the input sequence must be 0 for its operation.

This system can also be utilized for various purposes like military industrial and commercial communication to users in future. The optimum development of this proposed algorithm in hydro acoustic system can support the intercontinental communication to users at free.

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