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OFDM Deciphering to Minimize BER for Hydro Acoustic Communication

Umesh Ramphal Mandal
Dept. of Electronics Engineering
GHRCE, Nagpur
umeshmandal4177@gmail.com

Trushna Deotale
Dept. of Electronics Engineering
GHRCE, Nagpur
trushna.deotale@raisoni.net

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 used for security purpose in wireless network because it becomes difficult to access the wireless network by 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), initial frequency detection (IFD), remaining frequency detection (RFD), compute hopping pattern (CHP).*

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 need for underwater wireless communications exists in applications such as remote control in off-shore oil industry, pollution monitoring in environmental systems, collection of scientific data recorded at ocean-bottom stations, speech transmission between divers, and mapping of the ocean floor for detection of objects, as well as for the discovery of new resources. Wireless underwater communications can be established by transmission 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.

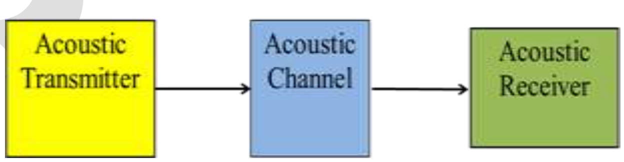

Fig.1. Basic block diagram of OFDM system.

LITERATURE SURVEY

Authors explored design aspects of adaptive modulation based on orthogonal frequency division multiplexing (OFDM) for underwater acoustic (UWA) communications, and study its performance using real-time at-sea experiments [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 communication quality, data rate, frame length, and calculation complexity. The OSDM achieves far better BER performance compared to the other schemes in both static and dynamic channels [2].

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

The Lloyd algorithm is employed to quantize the CSI at the receiver and construct the codebook, which is adopted to achieve the limited feedback process. After selecting an initial bit loading vector upon the current CSI, the receiver will broadcast its index to the transmitter, then the transmitter will compute the bandwidth efficient bit loading algorithm and allocate the corresponding power and bits to each subcarrier. 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 system throughput under a target average bit error rate (BER) for underwater acoustic communication. The block diagram of OFDM transmitter and receiver is shown below.

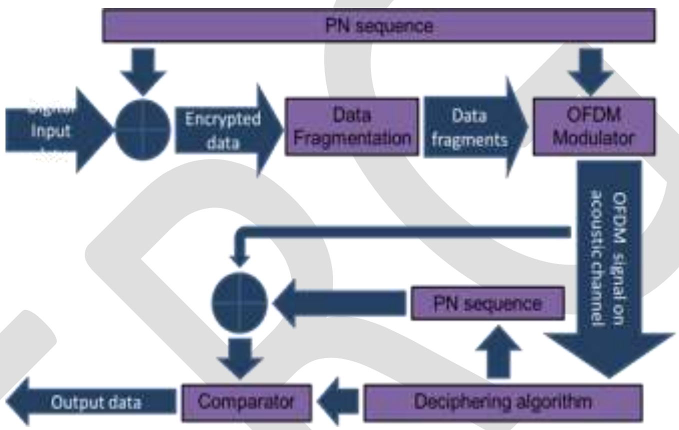

Fig. 2. BERMOFDM algorithm in hydro acoustic system.

OFDM Demodulator to Improve BERMOFDM algorithm for Hydro Acoustic Communications :

- Stage 1Initial Frequency Detection (IFD), locates the first frequency in the network.
- Stage 2 Remaining Frequencies Detection (RFD), detects the remaining frequencies.
- Stage 3 Compute Hopping Pattern (CHP), 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 initial frequency detection stage (IFD) 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 IFD is complete & passes f_o to the Remaining Frequencies Detection (RFD). The RFD records when frequencies stops transmission with respect to the end of the f_o signal. After RFD the output is fed to CHP. The CHP 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.

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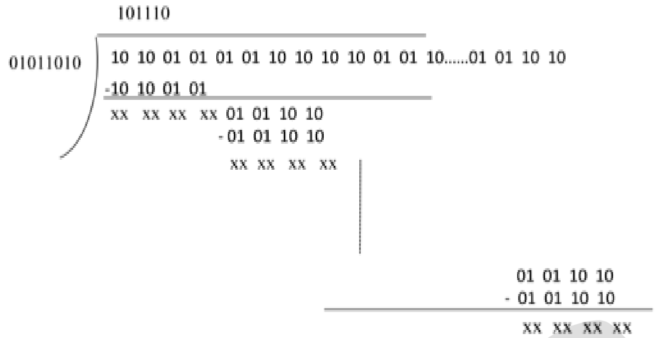

Fig. 3. The numerical representation for the decoding data.

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.

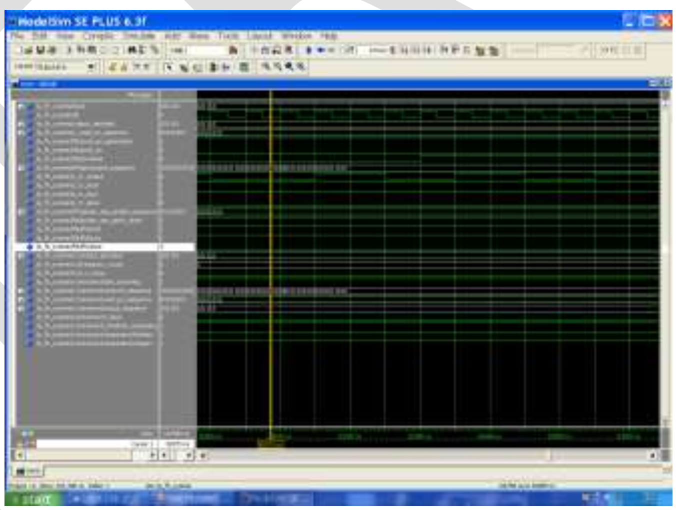

Fig. 4. Simulation results of the proposed BER minimizing OFDM algorithm.

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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