

Under Water Wireless Communication Using Ofdm-Idma Link

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Abstract

Cellular communication on land and underwater varies greatly because distinct water columns might occur within one body of water, such as an ocean. A transmitter-receiver pair built to function at deep sea level will not work in shallow coastal areas because the water column properties present in both the transmitter and the receiver are very different from one another. The difficulty of building the communication link is increased by the complicated nature of the water's surface. The most promising technique being used to create an UWC link right now is acoustics. But multipath phenomena, which introduces a significant delay spread, makes this technique ineffective. As a result, the performance of the system will be negatively impacted by Intersymbol Interference (ISI). The delay spread will be decreased by using the OFDM technology. A better method for decreasing errors burst of multi-access underwater applications is provided by OFDM combined with IDMA. This study presents an IDMA-OFDM Simulink model. On the BER graph, which showed a BER v/s SNR plot, its performance was evaluated.

Keywords : Interleaver Divison Multiple Access (IDMA) Orthogonal Frequency Multiplexing (OFDM).

I. INTRODUCTION

Our Earth differs from other planets due to the presence of massive water bodies. Oceans and deep seas have long fascinated humans with their mystery. Since the past ten years, there has been a lot of interest in underwater communication. It is essential for gathering scientific data, monitoring the environment, spotting disasters, navigating, and other military-based uses.

To construct a UWC link, there are three main ways of communicating available: RF waves, acoustic waves, and optical waves. The most promising options for UWC at present are acoustic signals. Due to issues with multiple paths transmission, the process of absorption scattering, water salinity, pH dispersion, physical blockage.

Establishing a UWC link is highly challenging. Since the narrow acoustic channel is such a

challenging media for data transmission, it has been difficult to create dependable

communications networks for such conditions. Digital data is encoded using OFDM on several carrier frequencies. Here, a bit stream is split up into a number of parallel, low-bit-rate streams, and individual bearer is then modulated using an appropriate modulation method at low data rates. By preventing signal overlap, inter carrier interference is decreased. In its transmitting and receiving sides, OFDM uses the IFFT and FFT respectively. OFDM is a good contender for UWC because of its exceptional capacity to withstand challenging channel conditions. Orthogonal Frequency Multiplexing (OFDM) is a technique used to transmit a bit stream by dividing into parallel bit stream each with low bit rate.

The signals in OFDM are less prone to the interference from reflection because of the low data rates. As a superior substitute for CDMA, IDMA is employed. IDMA does not use a user-specific spreading sequence, unlike CDMA. Instead, forward error correction completely utilises bandwidth growth. Iterative receiver selection is less complicated than Rake receiver thanks to IDMA's iterative chip-by-chip multiple users detection technique. These numerous benefits have caused a rise in the number of applications for it, including DAB, HDSL, VDSL, and many others.

In this paper, we propose a multi access communication network that combines OFDM with an IDMA overlay and offers immune performance in the presence of substantial time delay spread and other channel impairments caused by shallow water. A low complexity Random interleaver, Convolutional encoding, and Viterbi decoding are used in the proposed OFDM-IDMA method. A UWC Simulink model

was created using Matlab version R2018a. The system's BER vs. SNR performance was examined using the BER tool for various input values. Input consists of random integers selected from the workspace.

II. RELATED WORK

For saving of energy in terrestrial wireless sensor networks the channel coding methods are preferred wireless sensor networks the authors have determine the trade-off between transmission and consumption of energy. The work recognizes and chooses the suitable coding technique to be used in wireless sensor node, so that the network life period is maximized. In [8] the author has demonstrated for Additive White Gaussian Noise (AWGN) and Rayleigh fading channels in wireless sensor network the best coding rate choice a between wireless nodes. The detailed study in [9], investigates the ARQ method achieved when the code rate of the error-correcting coding technique is improved In underwater wireless acoustic networks, due to the nodes potential energy savings the optimization of channel coding strategies has also been investigated. have examined convolutional coding technique and Frequency Shift Keying modulation technique in underwater wireless communication. To improve Signal to noise ratio(SNR) and code rate the authors have enhanced the frame error rate processing frequency.

III. PROPOSED METHOD

An UWC link essentially consists of an input signal that is first encoded using an appropriate encoder, which could be seen from the block diagram. We utilised a convolutional encoder in this case. A discrete linear invariant to time system is referred as a convolutional encoder. Every encoder output can be characterised by a unique transfer function that is connected mathematically to the generator function. Buffering is helpful to prevent losing data when it is arriving quicker than it will be processed. Upon the completion of this interleaver operation is done which is the Random Interleaver uses a random permutation to reorder the

components of its input vector.

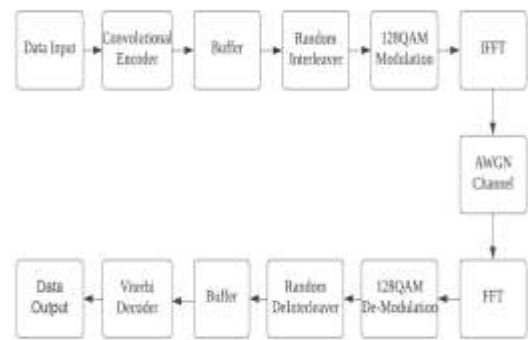


Fig. Block Diagram of Proposed Method

Convolutional encoder:

A discontinuous linear time-invariant system is referred as a convolutional encoder. Every encoder output can be characterised by a unique transfer function that is connected mathematically to the generator polynomial. Through Z-transform, an impulse response and transfer function are coupled. The technique to handle faults created by the original stream during the stage it is transmitted in data communication is to use error-correcting codes. It is regarded as an error identification and correction technique in which redundant bits are used to encrypt the information signal.

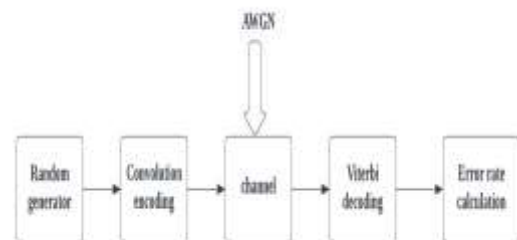


Fig. Convolutional Encoder

Buffer:

When transmitting data from one device to another, a buffer process or medium of storage used in telecommunications makes up for a discrepancy in the rate at which data flows or the timing of events.

The buffer is a portion of the main memory that is utilised for storing or hold the data. In other terms, a buffer holds data sent from one device briefly.

Radom interleaver:

The Random Interleaver uses a random permutation to reorder the components of its input vector. With the aid of several produced permuter indices, the information that arrives is reorganised.

A device that produces pseudorandom permutations of given memory locations is known as a permuter. The order of the data is determined by the pseudo-randomness of the memory locations. A communication channel with memory can be turned into one without memory using the interleaving technique. By putting the encoded signal through a combining process, Forward Correction of Errors (FEC) systems that operate in presence of burst faults perform better.

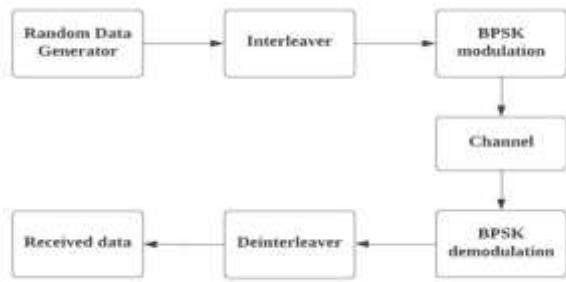


Fig. Random Interleaver

Random Deinterleaver:

The permuter-indices for the de-interleaver must be precisely in the identical order as those for the interleaver. Using the permuter-indices, the de-interleaver puts the overlapped data back in its original order. IFFT:

Consequently, the IFFT block offers a straightforward method for modulating information into N orthogonal subcarriers. A single OFDM symbol is made up of a sequence of N outputs bits from the IFFT. The time domain signal generated by the IFFT is delivered via the radio channel after some extra processing.

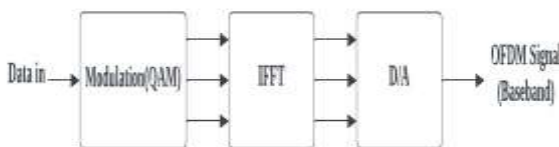


Fig. IFFT

AWGN channel:

The modulated data is given a white Gaussian noise boost by the AWGN Channel block. The AWGN channel model is frequently employed in situations where the main obstruction to communication is the addition of broadband or white noise with a uniform spectral density (measured in watt per Hz of frequency) and a Gaussian amplitude distribution. The model does not take into consideration

nonlinearity, interference, frequency selectivity, or fading.

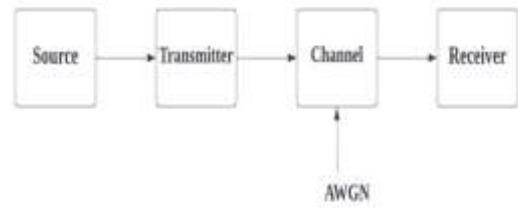


Fig. AWGN Channel FFT:

An algorithm known as a fast Fourier transformation (FFT) computes a sequence's discrete Fourier transformed (DFT) or its inverse (IDFT). A signal is represented in its frequency domain using Fourier analysis by translating it from its native domain, which is frequently time or space, and vice versa.

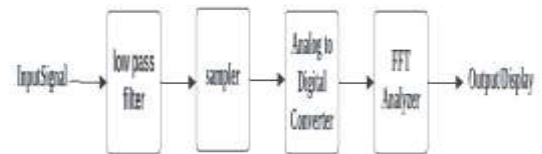


Fig.FFT

128QAM Modulation:

This indicates that the shortest Euclidian distance among the points of the constellation is raised by 2 compared to PM-16QAM while 128-SP-QAM carries seven bits per signal as opposed with the eight bits per symbol of PM-16QAM.

128QAM De Modulation:

The action of removing the original data, or SIGNAL, through the modulated carrier. When it comes to AMPLITUDE MODULATION or FREQUENCY MODULATION, a device known as the demodulator or detector is used. This device generates a signal that corresponds to the momentary modifications to amplitude and frequency, respectively.

Viterbi Decoder:

A convolution code or trellis code-encoded bitstream is decoded by a Viterbi decoder using the Viterbi algorithm. A Viterbi decoder can be implemented in software or hardware (in modems). Although values in the range of k=15 are used in practise, it is usually employed over decoding convolutional code with constraint lengths of k3.

The iterative the Viterbi decoding algorithm employs

3.1 SIMULINK MODEL

Regarding the above block diagram. A graphical tool called Simulink from Matlab is used to model

multi-disciplinary communication networks with a collection of programmable communication block libraries. It includes data flow analysis and simulation results in real time. The following describes the IDMAOFDM Simulink model:

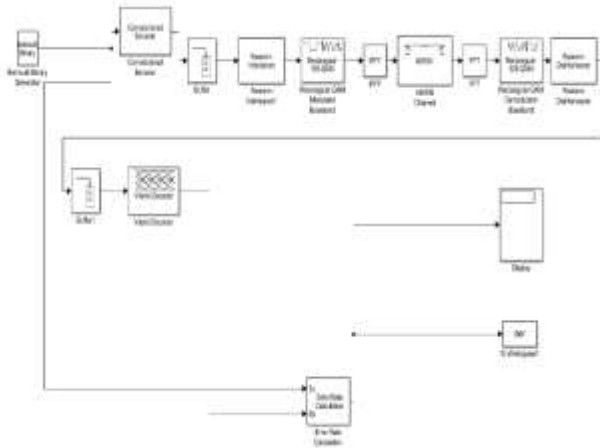


Fig. Simulink Model

The Simulink model operates as follows:

The Simulink Model receives the signal via input from the Matlab workspace. It is compressed using a convolutional encoder, which may compress many symbols simultaneously. Data stream is converted into column format, or frames, using a buffer. The output data stream's frame rate decreases as the frame size increases. When the frame rate slows down, the random interleaver is provided the signal so it can execute original combinations on the data stream. Only intended receivers are able to deinterleave it because of the way it is interleaved. Userdefined bit-mapping is utilised with 64-QAM modulation. Signals are converted from the time domain to the frequency domain using the FFT procedure.

Due to the comparatively simpler computation of FFT, it is favoured over DFT. Because the signals that must be conveyed must be discrete, we need frequency domain signals. Following transmission, this data stream travels across the AWGN channel.

Although there are other options, The most popular one is AWGN because it closely resembles numerous random processes found in nature. The input signal receives a white Gaussian noise addition. The transmit procedure is exactly the opposite of the receiving procedure. Signals were converted the original time domain using IFFT. The period gram approach is used to calculate a non parametric

approximation for a spectrum using the FFT magnitude block.

The output is produced as binary symbols using a Viterbi decoder. To provide speedier performance, it processes many symbols at once. The input of the transmitter and the input of the receiver are compared in the error rate computation to determine the error. Divided by the overall amount of input data items from a single source, the maximum amount of mismatched pairs of data pieces is calculated. To view the bit error rates, a display box was added near the end.

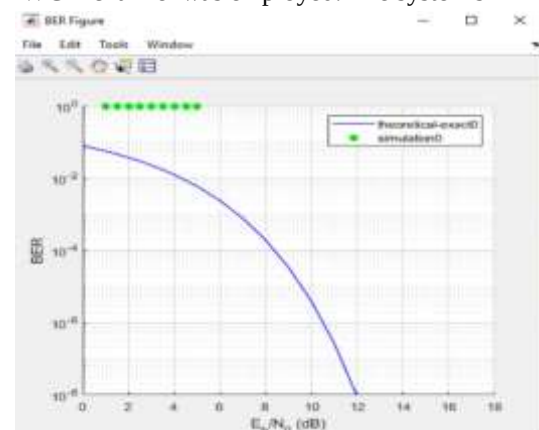
IV .RESULT

Analysis of the BER plots with different configurations of signals from workspace:

Sl.No	BER	Random interleaver size	Buffer Size
1	1	25	25
2	0.5000	25	50
3	0.6667	50	75
4	0.5000	50	100
5	0.6000	75	125
6	0.6667	100	150

Results of proposed model simulated using Matlab are as shown below,

Using the BER tool, the BER graph of the system's performance was observed. To simulate the characteristics of the external world, an AWGN channel was employed. The system's



BER plot is as shown below.

Fig. BER v/s SNR graph

The BER plot's clear results are presented in Table. The table shows that the error rate reduces when N rises, as can be observed. Ideally, errors under 0.5 can be ignored, while errors over 0.5 must be taken into account because they are significant.

V.CONCLUSION

We acquire signals with a small error when we encode and decode the signals using a convolutional encoder and Viterbi decoder combination. The performance of BER increases as N is increasing. Utilising higher order advanced modulation techniques will result in further improvement. In this paper, an IDMA-OFDM paradigm for setting up an underwater link for communication was proposed.

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