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Research paper

Improving BER and data throughput using adaptive modulation level MC-CDMA technique in underwater wireless communication

Jaya.T [1] *, P. Vijayalakshmi [1], V. Rajendran [1]

[1] Department of Electronics and Communication and Engineering, School of Engineering, Vels Institute of Science Technology & Advanced Studies (VISTAS), Vels University, Chennai, Tamil Nadu, India
**Corresponding author E-mail: jaya.se@velsuniv.ac.in*

Abstract

Underwater communication has a wide range of applications like environmental monitoring to predict the natural disasters, underwater ex-ploration and military applications. The need for effective underwater communication is the high demand in the present scenario. The im-plementation of precise modulation technique is also important because the underwater channel environment is time variant due to various noises present in the underwater like natural and vehicle noise (mechanical noises). The bandwidth is also highly limited in underwater communication. The existing method is adaptive modulation based OFDM system. This method has low spectral efficiency, however, each symbol is modulated with different carriers. The proposed method is Adaptive Modulation Level MC-CDMA (Multi carrier Code Division Multiple Access). The CDMA techniques share the same carrier frequency to multiple number of users. It adapts the modulation scheme according to the present channel conditions in the underwater. The performance of the proposed system improves the Data Throughput and Bit Error Rate.

Keywords: *Multi Carrier Code Division Multiple Access (MC-CDMA); Underwater Communication, Adaptive Modulation; Bit Error Rate (BER); Data Throughput; OFDM.*

1. Introduction

Underwater acoustic (UWA) channels are the most challenging communication media in the present scenario. Underwater acoustic channels are characterized by limited bandwidth, strong attenuation, low propagation speed of sound in water (Nominally 1500 m/s), limited bandwidth and randomly time variant multipath propagation which results in frequency - selective fading. The UWA signal are mostly affected by ocean interference and ambient noise disturbance (background sound) during its propagation in ocean, i.e., the signal reveal random process and time varying characteristics[1]. In order to distinguish the weakened signal caused by the loss of long distance propagation, the received signal must be processed. Improvement of bandwidth depends upon 'N' number of transmitters and receivers used.

In this proposed work we are using MC-CDMA technique for underwater communication, because while comparing to other techniques, MC-CDMA most effective. The MC-CDMA technique is more advantageous because it provides more channel for communication. Hence, there will be less interference of signals. And the attenuation of the signal is reduced in underwater communication. It allows multiple users to access the channel at the same time. Hence, this proposed work is more effective for underwater communication [2]. While using MC-CDMA technique there will be more availability of channel and no interference will takes place.

The purpose of this work is to improve Bit Error Rate (BER), data throughput and spectral efficiency using adaptive modulation level MC-CDMA technique [3].

2. Related work

2.1. Adaptive modulation and coding in underwater acoustics

Adaptive modulation is the most commonly used modulation technique in underwater acoustic communication because it helps the system to improve its spectral efficiency by matching the transmission parameters according to the channel condition. By improving spectral efficiency the signal can be transmitted in given time due to this, the delay is reduced and also the BER & throughput can be improved [4].

2.2. MC-CDMA in underwater acoustics

MC-CDM technique is a feasible multi access method of underwater acoustics network. It can be categorized into two types, one is a scheme of parallel transmission of narrow band DS waveforms and the other is a combination of OFDM and CDMA. By considering the underwater channel characteristics and this technique have recently utilized to achieve reliable multiuser. In MC-CDMA, a set of carrier frequencies is employed to achieve frequency diversity. The data sequence is spread in time by a signature code and then is used to modulate carriers. MC-CDMA is chosen as the multiple access strategy in the design of underwater networks [4] [5] [6].

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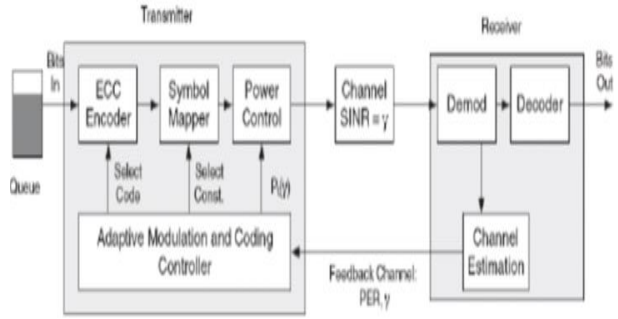


Fig. 1: MC-CDMA in Underwater Acoustics.

2.3. Adaptive modulation based MC-CDMA

The schematic of Adaptive modulation and coding based wireless communication is shown in figure 1. MC-CDMA combined with adaptive modulation technique is a promising way to increase data rate that can be continuously transmitted over wireless channels. In future MC-CDMA will be the most high scoped technique in wireless communication. Because the need for fast data transmission along with multipath transmission will be increased [7], [8].

3. Proposed work

3.1. System model and block diagram

Figure 2 shows the block diagram of MC-CDMA based adaptive modulation technique [9], firstly the binary data formations are spreaded into several numbers of packets, then it is followed by serial to parallel convertor to produce data stream with low bit rate in order to avoid the inter symbol interference.

Then each stream is modulated with adaptive modulation technique by suitable digital method, in this work we used BPSK, 8PSK, and 16PSK. Depending on the current channel, signal to noise ratio estimates the information provided by the receiver. After this process the modulated bit streams are passed through MC-CDMA system transmitter then it is up covered by RF- amplifier and finally transmitted through the channel. At the receiver side reverse operations are performed to de-modulate and de-spread the original information.

3.2. Method of execution

Figure 3 shows the execution method of adaptive modulation based MC-CDMA. Firstly we are creating four input node for signal transmission and receiving process. Then under water channel in created in addition with some of the noises like scattering noise, absorption noise etc. After that the underwater channel condition is predicted to find whether the environment is good to transmit the signal.

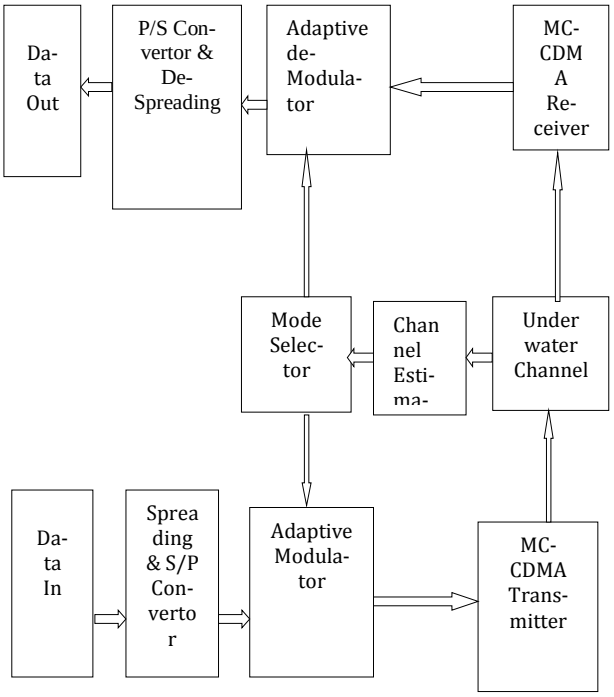


Fig. 2: Block Diagram of MC-CDMA Based On Adaptive Modulation System

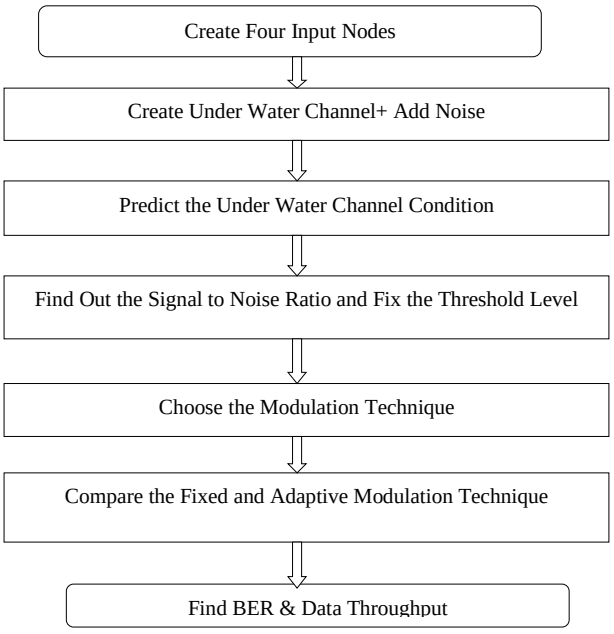


Fig. 3: Flow Chart for MC-CDMA Execution.

After predicting the channel condition we should calculate and find signal to noise ratio and the threshold level should be fixed. Then the required modulation will be chooses, in this we are choosing adaptive modulation. After that fixed modulation and adaptive modulation techniques are compared to show the improvement in signal transmission by using adaptive modulation. Then finally BER and data throughput value will be found and the spectral efficiency will be calculated.

4. Simulation results

The simulation process done by using aquasim software and it is applied in NS2. The underwater acoustic wireless sensor networks are created with more numbers of nodes , which can transfer packets among them. The underwater wireless network is created by using aquasim software using Vector based protocol as show in figure 4. [10-11]

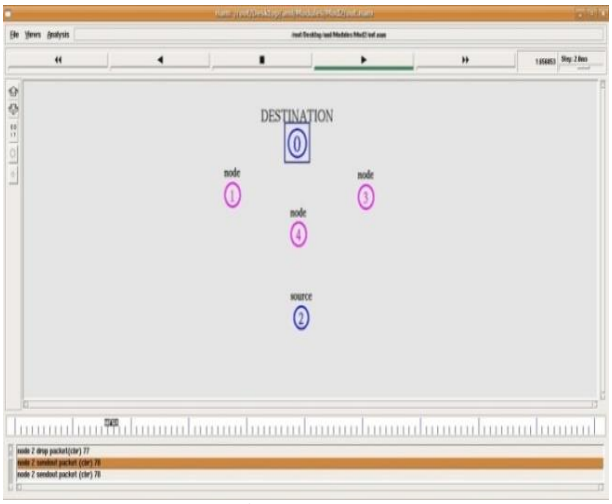


Fig. 4: Creation of Underwater Wireless Network.

By implementing MC-CDMA technique, the data can be transmitted from the sender node to sink node without any disturbance. MC-CDMA technique is an alternative to overcome excess delay. It is the most promising physical layer and multiple access technique for Underwater-Acoustic Sensor Networks (UW-ASN) because, it is robust to frequency-selective fading. It compensates for the effect of the multipath at the receiver by rake filters, which can collect the transmitted energy spread over multiple rays and it allows the receivers to distinguish among signals simultaneously transmitted by multiple devices. For these reasons, MC-CDMA increases channel reusability and reduces packet retransmissions, which decreases energy consumption and increases network throughput.

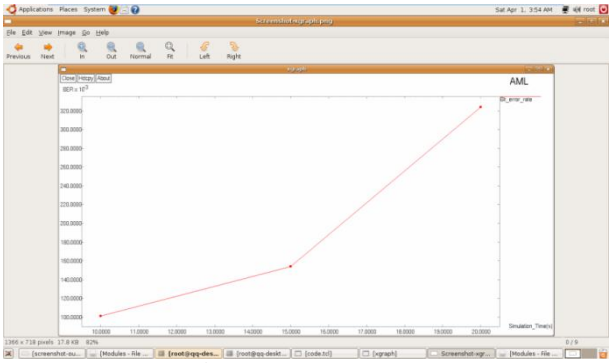


Fig. 5: Bit Error Rate of Adaptive Modulation Level Based Underwater Wireless Network.

The improved Bit Error Rate of Adaptive modulation level based underwater wireless network is depicted graphically in figure.5. The x-axis shows the transmitting time values of the signal and in y-axis the improved throughput values are plotted as shown in Table.1.

Table 1: Time vs BER for Adaptive Modulation Based Underwater Acoustic Wireless Network

TIME(s)	BER($x10^{-3}$)
10	100
15	150
20	320

The improved data throughput of Adaptive modulation level based Underwater acoustic wireless sensor network is depicted graphically in figure 6.

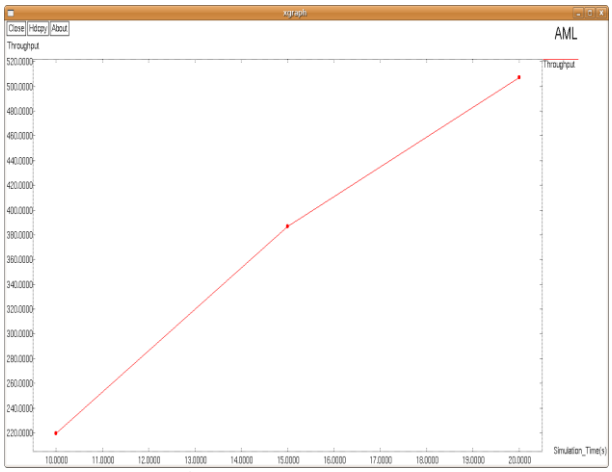


Fig. 6: Throughput of Adaptive Modulation Level Based Underwater Wireless Network

The x-axis shows the transmitting time values of the signal and in y-axis the improved throughput values are plotted as shown in Table.2.

Table 2: Time Vs Data Throughput for Adaptive Modulation Based Underwater Wireless Network

Time(s)	Throughput(kbps)
10	210
12	290
15	350
18	440
20	470

The delay is reduced by using adaptive modulation it is depicted graphically in figure 7.It shows the end to end delay during transmission time in seconds.

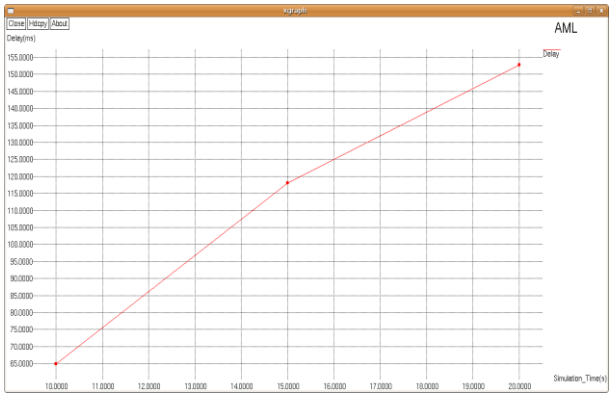


Fig. 7: End To End, Delay of Adaptive Modulation Level Based Underwater Wireless Network.

4.1. Comparison between fixed modulation and adaptive modulation

While comparing the MC-CDMA technique using fixed modulation and using adaptive modulation. We can prove that the adaptive modulation technique is more effective than other modulations. Because it helps in denoting the matching of the modulation and it prevents the signal from fading. Therefore, the data signal can be transmitted quickly within the given time. The comparison of Throughput between existing and AML method for is depicted in figure 8 and the values are in Table 3.
Comparing the Existing and AML method for end to end delay is given in figure 9.

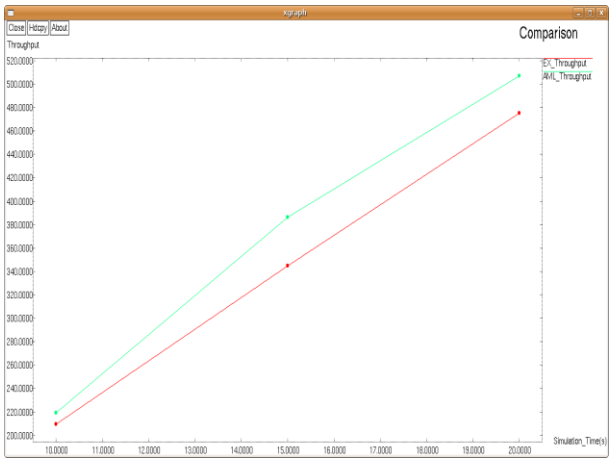


Fig. 8: Throughput Comparison between Existing & AML Method.

Table 3: Time vs Data throughput for fixed and Adaptive Modulation based Underwater Wireless Network

Time(s)	Throughput using fixed modulation	Throughput using adaptive modulation
10	210	220
15	350	380
20	470	510

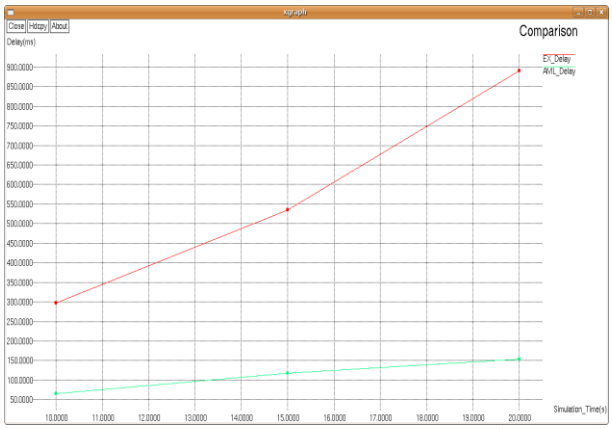


Fig. 9: Comparison between Existing & AML Method for End-to-End Delay.

Table 4: Time vs Delay of Fixed and Adaptive Modulation Based Underwater Wireless Network

Time(s)	Delay in fixed modulation	Delay in adaptive modulation
10	300	70
15	530	120
20	890	150

5. Conclusion

The simulation results comparing the Fixed Modulation and Adaptive Modulation Level MC-CDMA Technique. Adaptive modulations provides the better signal transmission by increasing the throughput and improving the BER by reducing the delay time. Thus the performance of the proposed system was improved by using Adaptive Modulation level technique.

6. Future work

The adaptive modulation and coding based underwater wireless sensor network also considered for better communication in future. The Bit Error rate will be improved by using effective denoising algorithms in future.

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