A Big Eye-view on Under Water Acoustic Communication using Different Methods

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Abstract- *The shallow water acoustic communication a typically high bit error rate channel characterize by poor communication quality and propagation delay, is one of the most challenging environment for transmission of signal. In this survey paper we have will focus on the different modulation schemes for Underwater Acoustic Communication(UWAC). Numerous characteristics are coding technique, modulation method, bandwidth, frequency, bit error rate (BER).In this literature survey we discuss different reviews of Underwater Acoustics communication. The comparison of different method is based on modulation technique, coding scheme, bandwidth, frequency and bit error rate. The whole summary of different method is proposed in this literature survey.*

Keywords- SWAC, UAC, FER, BER.

I. INTRODUCTION

The area of UWAC has experienced significant research over the last decades, which led to recent progress in this endeavor. This interest started many years ago when Jean Daniel Colladon, a physicist/engineer, and Charles-Francois Sturn, a mathematician, performed an experiment, back in 1826, which can be thought as the starting point for underwater communications. The experiment took place in the Geneva Lake, in Switzerland, and they used a church bell to prove that sound travels faster in water than in air. One of them lighted a gunpowder flash and at the same time struck the church bell that was underwater. The other started the clock when he saw the gunpowder flash and only stopped it when he heard the noise made by the church bell (to do so he used a trumpet placed underwater as can be seen in figure 1.1). The distance that separated the two boats in this experiment was around 10 miles. Despite their simple instruments, they obtained a sound speed in water of 1435 m/s. This measurement was remarkably accurate, considering that the value obtained is not too far from currently known values, approximately 1500 m/s. Going further back in time, Leonardo Da Vinci, a genius in several fields, imagined how one would be able to produce acoustic waves in water and then see what would happen at a distant place, when trying to listen to those waves. Nowadays, fortunately, we have ever-better means and knowledge basis to explore underwater acoustic communications and, not surprisingly, this field of research is now very active. Underwater acoustics is the study of the propagation of sound in water and the interaction of the mechanical waves that constitute sound with the water and its boundaries. The water may be in the ocean, a lake or a tank. Typical frequencies associated with underwater acoustics are between 10 Hz and 1 MHz .The propagation of sound in the ocean at frequencies lower than 10 Hz is usually not possible without penetrating deep into the seabed, whereas frequencies above 1 MHz are rarely used because they are absorbed very quickly. Underwater acoustics is sometimes known as hydro acoustics.

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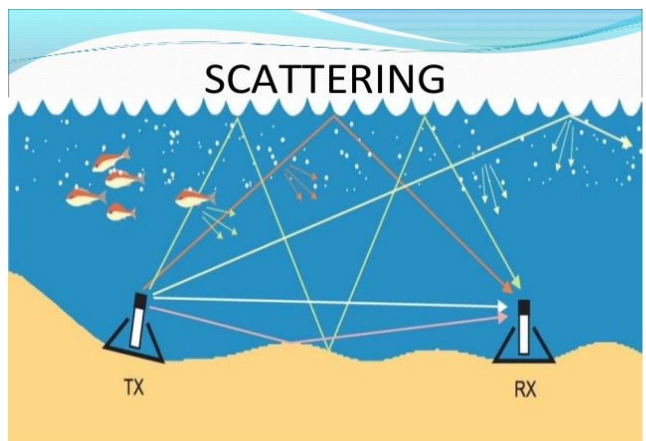

Fig. 1 – Shows the UWAC Waves

II. REVIEW OF DIFFERENT METHODS

1. Yougan Chen, Xiaomei Xu, LAN Zhang and Zheguang Zou, "Design and Application of Dynamic coding in Shallow Water Acoustic Communications" [1] - In fast temporal variations shallow water acoustic (SWA) channels, versatile channel coding rate ought to be desired within the design of practical error control SWA communication system. Herein, as one of the dynamic coding schemes, rate compatible LDPC (RC-LDPC) codes combing OFDM technique are projected to enhance the system reliability for SWA communications. Based on the automatic repeat request (ARQ) mechanism, the projected SWA OFDM system consists of three vital preprocessing: channel state information (CSI) estimator, signal-to-noise ratio (SNR) estimator and RC-LDPC pattern. The planning of RC-LDPC codes and SWA channel profile are described. A look-up table (LUT) of RC-LDPC performances for ARQ-SWA system is constructed via statistical simulation test. For the projected scheme, authors define and derive the sensitivity to channel time variations and the effects of various performance target BER threshold that are additional confirmed via numerical results. It's shown that RC-LDPC codes have good performances with wide range of rates in SWA channels. Finally, coding rate distributions of RC-LDPC codes in numerous SNR at BER below 10-4 for Xiamen harbor SWA channel are investigated.

2. Andreja Radosevic, Rameez Ahmed, Tolga M. Duman, John G. Proakis, and Milica Stojanovic, "Adaptive orthogonal frequency division multiplexing Modulation for Underwater Acoustic Communications: design considerations and Experimental Results" [2] (2014) **-** during this work, authors explore design aspects of adaptive modulation based on orthogonal frequency-division multiplexing (orthogonal frequency division multiplexing) for underwater acoustic (UWA) communications, and study its performance using real-time at-sea experiments. The second strategy is found to offer better performance, as it requires significantly fewer feedback bits. Numerical and experimental results that are obtained with recorded channels and real-time at-sea experiments, respectively, show that the adaptive modulation scheme provides vital output improvements as compared to traditional, non-adaptive modulation at identical power and target bit error rate. This work leads US to conclude that adaptive modulation strategies are also viable for reliable, high-rate UWA communications. To our knowledge, this is the first paper that presents adaptive modulation results for UWA links with real-time at-sea experiments.

3. Adriana F. de A. Oliveira, Eduardo R. Vale, Julio C. Dal Bello, "Multiple input multiple output Systems using orthogonal frequency division multiplexing in Underwater Communications" [5] (2014)**-** This work presents an underwater acoustic communication mechanism that has not been a lot of explored however. The most goal of this paper is to present educational studies during this subject and check out to implement communication systems which will be wont to attend modern market wants. The implementation of next level multiple input multiple output systems, sort of a pair of x 2 configuration (two projectors and 2 hydrophones) and then on, will be future step to undertake to enhance the system given during this add order to realize terribly low error rates for a high speed and a reliable knowledge transmission.

4. Hamada Esmaiel, Danchi Jiang "Multicarrier Communication for Underwater Acoustic Channel," [07] (2013)**-** In past decades, there has been a growing interest within the discussion and study of victimization underwater acoustic channel because the physical layer for communication systems, starting from point-to-point communications to underwater multicarrier modulation networks. Doppler estimation and un- dewater channel estimation difficult discuses and techniques used evaluated and summarized. Performance analysis for various channel coder used for underwater acoustic multicarrier modulation. Dynamical and used techniques for top speed image and video trans- mission over UWAC additionally summarized and mentioned.

5. Lan Zhang, Taehyuk Kang, H.C.Song, W.S. Hodgkiss, and Xiaomei Xu, "Multiple input multiple output - orthogonal frequency division multiplexing Acoustic Communication in Shallow Water" [8] (2013) **-** As another to typical single-carrier approaches, multi-carrier Orthogonal Frequency Division Multiplexing (orthogonal frequency division multiplexing) communications has been explored in underwater acoustic channels with an oversized delay unfold. particularly, the performance of the 2IMO and 4IMO cases with 2 modulations (quadrature part shift key and 16-QAM) was analyzed mistreatment 3 totally different detectors: ZF detector, MMSE leveling, and MMSE-SINR-OSIC. additionally, the impact of diversity combining on performance with density verification decryption was given. Error-free performance was achieved mistreatment 2048-quadrature part shift key packets at a knowledge rate of twenty one kb/s.

6. Zorita, E.V., Stojanovic, M. "Space-Frequency Coded orthogonal frequency division multiplexing for Underwater Acoustic Communications" [12] (2012)**-** This work proposes associate degree adaptative receiver for the space-frequency block secret writing theme, within which Alamouti secret writing is applied over the carriers of an orthogonal frequency division multiplexing system with the aim of getting transmit diversity in an underwater acoustic channel. The receiver depends on the idea that the channel transfer perform doesn't modification a lot of over 2 consecutive carriers, which the channel is slowly time-varying. Building on these assumptions we have a tendency to propose an adaptative channel estimation technique supported physicist prediction and time-smoothing, that effectively reduces the pilot overhead. System performance is incontestable mistreatment real information transmitted over a shallow water channel within the 10-15 kilocycle acoustic band from a vehicle moving at zero.5-2 m/s, mistreatment construction part Shift Key and a varied variety of carriers starting from sixty four to 1024. Results demonstrate a standardized gain over the single-transmitter case.

7. Lei Wan Zhaohui, Wang Shengli Zhou, T. C. Yang and Zhijie Shi "Performance Comparison of Doppler Scale Estimation Methods for Underwater Acoustic orthogonal frequency division multiplexing" [15](2012) Doppler scale estimation is one important step required by the resampling operation in acoustic communication receivers. during this paper, we have a tendency to compare completely different physicist scale estimation ways mistreatment either Cyclic-Prefixed (CP) or Zero-Padded (ZP) orthogonal frequency division-multiplexing (orthogonal frequency division multiplexing) waveforms. Blind ways utilizing the underlying signal structure work all right at medium to high SNR ranges, whereas cross-correlation-based ways will work low SNR ranges supported the total or partial information of the transmitted wave. All of those ways are viable selections for sensible orthogonal frequency division multiplexing receivers. during a distributed multiuser situation, cross-correlation approaches ar additional strong against multiuser interference than blind ways.

III. PROBLEMS IN UWAC

As terrestrial communication the medium of transmission is Air but in case of underwater acoustic communication the medium is differs which is water. Therefore various problems have to face for communication inside the water.

There are following problems which occurs in underwater acoustic communication

(1) The density of water and especially in sea water is more than air. Water itself has become the main source for the signal interference. The type of water (freshwater/sea water), depth pressure, dissolved impurities, water composition and temperature affect the sound propagation.
(2) Propagation delay inside the water is long. The transmission speed of acoustic signals in salty water is around 1500 meter/s, which is a difference of five orders of magnitude lower than the speed of Electromagnetic wave in free space. Correspondently, propagation delay in an underwater channel becomes significant. This is one of the essential characteristics of underwater channels.
(3) Multipath propagation occurs because of different objects (fishes or aqua animal), rocks, shallow or deep water. In shallow water unwanted waves are generated but refraction and reflection of signals occurs, in deep water ray bending occurs.
(4) With more pressure transmitters, one can have a multiple-input multiple-output (MIMO) system also.

Acoustic Channel

The underwater acoustic (UWA) channel is quite different from the terrestrial radio channel in many aspects and has more challenges. The UWA channel is affected by noise, multipath, Transmission loss, Doppler spreading and variable delay. This makes underwater acoustic communication challenging and in next sections the limitations that affects the communication will be discussed.

Noise

The noise sources in an UWA channels can be divided into ambient noise and man-made noise. The ambient noise is caused by biological creatures, seismic phenomenon and movement of water such as waves. The ambient noise often follows some curves called Knudsen curves. These Knudsen curves show that the ambient noise is being reduced as the frequency increases. According to the curves the ambient noise will be reduced with about 17 dB per decade of frequency, [14]. For high frequencies the thermal noise can be very dominating, especially over 100-200 kHz, where the thermal noise increases

Doppler spreading:

Doppler spreading occurs because of Doppler shift of frequencies of different signal components. This may occur because of movement by the transmitter and the receiver. Signals reflected by the surface may also encounter this effect because of movement in the surface cause by waves. Doppler spreading will give a change of the transmission frequency and a continuous spreading of the frequencies, [3]. The change of the transmission frequency can be compensated for in the receiver, but the general spreading is harder to deal with. Doppler spreading is considered to be a huge challenge for the modulation techniques and the multi-channel access methods.

Multipath and time-delay:

Multipath is a huge problem that might affect the communication severely, and will give inter Symbol interference (ISI). How much the multipath will occur depends on many physical factors, but the depth depended sound velocity is most important. In this is illustrated for 5 an depth depended sound velocity that will give a bending of the sound rays in the horizontal direction, as described in [14]. The choice of spacing size between the sensors needs to take this effect into account. Another problem is that the depth depended sound velocity changes through the season and thereby change the multipath through the season making it harder to de sign the UWA-SN system. This may lead to constructive or destructive interference. The received signal may be amplified or it may be reduced depending on the phase of different multipath. Multipath occurs because of reflection of waves from the surface and the bottom. The receiver will receive multiple signals, both direct, and reflected signals from the surface and the bottom. But there may also be several direct waves that may arrive at different times depending on how much the waves have been bend. Large time delay is caused by the fact that the sound speed under water is in the area of 1500 m/s, which is much lower than the speed of radio waves that is approximately 3×10^8 m/s. In terrestrial radio communication multipath and reflection will not be a problem since the delay is so little, but in UWA communication these delays may arrive very late and cause problem for the communication. This is further complicated by the fact that the delays may vary a lot. Multipath may reduce the data transmission data severely, depending on how the receiver deals with different multipath.

VI. CONCLUSION

In this paper, we studied the basic system model of underwater acoustic channel communication in which the transmitter, channel capacity and estimation, receiver, main characteristics of acoustic channel losses in underwater acoustic communication as transmission loss, absorption, attenuation noise (ambient & Gaussian). Low frequency is less than 500 Hz and high frequency is more than 500 Hz. The importance of each effect for system design depends on both its impact on communication performance and frequency of occurrence. We should take more values reported propagation effects and channel characterizations should be adopted as being typical for underwater acoustic communication channels.

REFERENCES

[1] Yougan Chen, Xiaomei Xu, Lanzhang, Zheguang Zou "Design and application of dynamic coding in shallow water acoustic communication" IEEE 2013.

[2] Andreja Radosevic, Rameez Ahmed, Tolga M. Duman, John G. Proakis, IEEE, and Milica Stojanovic, "Adaptive OFDM Modulation for Underwater Acoustic Communications: Design Considerations and Experimental Results" IEEE Journal Of Oceanic Engineering 2014.

[3] Salvador Climent, Antonio Sanchez, Juan Vicente Capella, Nirvana Meratnia and Juan Jose Serrano, "Underwater Acoustic Wireless Sensor Networks: Advances and Future Trends in Physical, MAC and Routing Layers", Sensors ISSN 1424-8220, Vol 14, PP 795 – 833 (39), Dec. 2014.

[4] John Heidemann1, Milica Stojanovic And Michele Zorzi, "Underwater sensor networks: applications, advances and challenges" Journal of the Royal Society Phil. Trans. R. Soc. A (2012), Vol. 370, PP 158–175, December 28, 2014.

[5] Adriana F. de A. Oliveira, Eduardo R. Vale, Julio C. Dal Bello, " MIMO Systems using OFDM in Underwater Communications ", IOSR Journal of Electronics and Communication Engineering (IOSR-JECE). e-ISSN: 2278-2834,p- ISSN: 2278-8735.Volume 9, Issue 1, Ver. IV (Jan. 2014), PP 53-56

[6] Taisaku Suzuki, Hai Minh TRAN Tomohisa Wada "An Underwater Acoustic OFDM Communication System with Shrimp (Impulsive) Noise Cancelling" Computing, Management and Telecommunications (Com Man- Tel), 2014 International Conference on 27-29, April 2014.

[7] Hamada Esmaiel, Danchi Jiang "Multicarrier Communication for Underwater Acoustic Channel," Int. J. Communications, Network and System Sciences, vol. 6, pp. 361-376, Apr. 2013.

[8] Lan Zhang, Taehyuk Kang, H.C.Song, W.S. Hodgkiss, and Xiaomei Xu, "MIMO-OFDM Acoustic Communication in Shallow Water", Oceans - San Diego IEEE, Page(s)1-4, 23-27 Sept. 2013

[9] Kai Tu, Tolga M. Duman,, Milica Stojanovic, John G. Proakis,"Multiple-Resampling Receiver Design for OFDM Over Doppler-Distorted Underwater Acoustic Channels" IEEE Journal of Oceanic Engineering, Vol. 38, No. 2, April 2013.

[10] Tadashi Ebihara, Koichi Mizutani, "Underwater Acoustic Communication With an Orthogonal Signal Division Multiplexing Scheme in Doubly Spread Channels" IEEE Journal Of Oceanic Engineering, Vol. 30, NO. 4, P.P.-695-707, MAY 2013

[11] Lei Wan ZhaohuiWang, Shengli Zhou, T. C. Yang, and Zhijie Shi" Performance Comparison of Doppler Scale Estimation Methods for Underwater Acoustic OFDM" Hindawi Publishing Corporation Journal of Electrical and Computer Engineering Volume 2012, Article ID 703243, 11 pages doi:10.1155/2012/703243.

[12] Zorita, E.V., Stojanovic. "Space-Frequency Coded OFDM for Underwater Acoustic Communications" Hampton Roads, VA Oceans, conference IEEE 2012.

[13] Sea-Moon Kim, Sung-Hoon Byun, Seung-Geun Kim, and Yong-Kon Lim, "The Effect of Source Power on Statistical Characterization of Underwater Acoustic Communication Channel in Shallow Water", Vol. NO. 978-1-2012

[14] Xiaoping Li, Peter Papson, "Time Reversal in Underwater Acoustic Communications" International Journal of Computer Applications (0975 – 8887), volume 52, pp. no. 20, August 2012.

[15] Lan Zhang, Xiaomei Xu , Wei Feng , Yougan Chen in "HFM Spread Spectrum Modulation Scheme, Shallow Water Acoustic Channels" VOL. NO. 978-1-4673-0831-1/©2012 IEEE

[16] He-Chun Song, "Long-range Acoustic Communication in Deep Water Using a Towed Array: Beam Diversity" VOL. NO. 978-1-4577-2091 ©2012 IEEE

[17] Zheguang Zou, Xiaomei Xu, Zhaotong Zhu, Xingbin Tu, "An Improved Demodulation Scheme for FH-MFSK Underwater Acoustic Communications", IEEE 2011

[18] Aijun Songa and Mohsen Badiey "Time reversal acoustic communication for multiband transmission" Badiey: JASA Express Letters, Published Acoustical Society of America PACS, Vol 2012 March 2011.

[19] Wenyi Zhang, Milica Stojanovic, Urbashi Mitra, "Analysis of a Linear Multihop Underwater Acoustic Network" IEEE Journal Of Oceanic Engineering, IEEE. Oceans 2011

[20] Yonghuai Zhang, Haixin Sun, En Cheng, and Weijie Shen "An Underwater Acoustic Implementation of DFT-Spread OFDM," Hindawi Publishing Corporation EURASIP Journal on Advances in Signal Processing Volume 2010, Article ID 572453, 6 pages, Jan. 2010.

[21] Jian Zhong Huang, Shengli Zhou, Jie Huang, Preisig, J.more "Progressive MIMO-OFDM Reception over Time-varying Underwater Acoustic Channels" Signals, Systems and Computers (ASILOMAR), 2010 Conference IEEE, p.p. 7-10, Nov. 2010,

[22] Jun Ling, Tarik Yardibi, Xiang Su, Hao He, and Jian Lia "Enhanced channel estimation and symbol detection for high speed multi-input multi-output underwater acoustic communications" Acoustical Society of America, vol. 125, no. 2, PP: 3067–3078, May. 2009.

[23] Baosheng Li, Jie Huang, Shengli Zhou, Ball, K. , Stojanovic, M. ,Freitag, L. Willett,P. "MIMO-OFDM for High Rate Underwater Acoustic Communications" Oceanic Engineering, IEEE Journal of Volume :34 , Issue: , Page(s): 634 – 644, Jan 2009.

[24] Jun Tao, Yahong Rosa Zheng, Chengshan Xiao, T. C. Yang, Wen-Bin Yang, "Time-Domain Receiver Design for MIMO Underwater Acoustic Communications " Oceans IEEE, Quebec City, Qc, 15-18 Sept. 2008 pp. 1328–1333

[25] Yonghuai Zhang, Haixin Sun, Fang Xu, Deqing Wang, "OFDM trans-form domain channel estimation based on.MSE for underwater acoustic channel" Anti-counterfeiting, Security and Identification, ASID 2008. 2nd International Conference IEEE, pp 177 – 181, March 2008.

[26] Mandar Chitre, Shiraz Shahabudeen, Lee Freitag, Milica Stojanovic, "Recent Advances in Underwater Acoustic Communications & Networking" Marine Technology Society Journal, vol. Spring 2008, pp. 103-116, 2008.

[27] Zaihan Jiang, "Underwater Acoustic Networks – Issues and Solutions" International Journal Of Intelligent Control And Systems Vol. 13, No. 3, September 2008,152-161