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`Chapter1

1. INTRODUCTION

While wireless communication technology today has become part of our daily life, the idea of wireless undersea communications may still seem far-fetched. However, research has been active for over a decade on designing the methods for wireless information transmission underwater. Human knowledge and understanding of the world's oceans, which constitute the major part of our planet, rests on our ability to collect information from remote undersea locations.

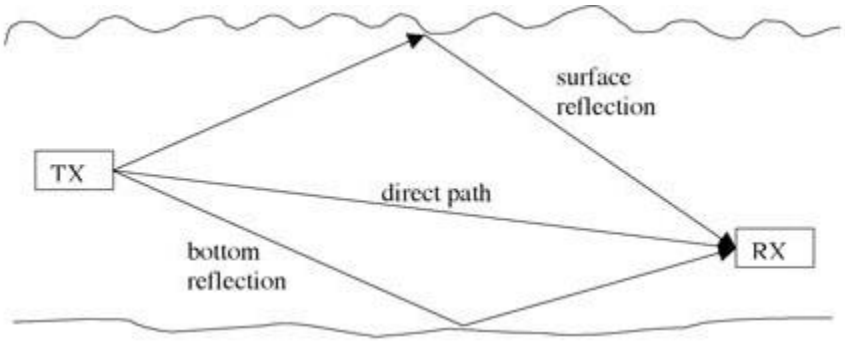


Fig.1.1.Basic underwater communication system

It's is extremely difficult to achieve a high data rate communication link underwater due to various constraints such as poor propagation of electromagnetic signals underwater, high attenuation of acoustic signals , lack of accurate mathematical models of the underwater acoustic channel etc. Also, some of the wired underwater communication links would be prone to attacks by aquatic animals. Also, these wired links have problems related to dispersion and low data rate due to extreme pressure underwater.

Hence the motivation and interest in wireless underwater communications. Together with sensor technology and vehicular technology, wireless communications will enable new applications ranging from environmental monitoring to gathering of oceanographic data, marine archaeology, and search and rescue missions, emergency Communications from a ship - Wired Media, mobile communication from a submarine, AUV with other stations that include ships, land based stations and other submarines – wireless acoustic media and many more.

The primary research goal of this project is to investigate various algorithms for underwater communication systems and hence enhance the performance.

Since, low data rate is the major bottleneck in successfully implementing an underwater communication system. The project aims to address the data rate issue by investigating numerous novel algorithms customized for underwater systems. This would be done by studying and optimizing the modulation schemes and the communication parameters for an underwater channel. The underwater channel model would be adopted from published literature and used for simulations. Then for this channel various studies would be performed to explore for better performance.

Chapter 2

2. LITERATURE SURVEY

In recent years, underwater acoustic (UWA) communications have received much attention as their applications have begun to shift from military toward commercial. Digital communications through UWA channels differ substantially from those in other media, such as radio channels, due to severe signal degradations caused by multipath propagation and high temporal and spatial variability of the channel conditions. The design of underwater acoustic Communication systems has until recently relied on the use of non-coherent modulation techniques. However, to achieve high data rates on the severely band-limited UWA channels, bandwidth-efficient modulation techniques must be considered, together with array processing for exploitation of spatial multipath diversity. The new generation of underwater communication systems, employing phase-coherent modulation techniques, has a potential of achieving at least an order of magnitude increase in data throughput. The emerging communication scenario in which the modern underwater acoustic systems will operate is that of an underwater network consisting of stationary and mobile nodes. Current research focuses on the development of efficient signal processing algorithms, multiuser communications in the presence of interference, and design of efficient modulation and coding schemes[1].

Acoustic propagation is characterized by three major factors: attenuation that depends on the signal frequency multipath propagation and low speed of sound. The channel has a spars impulse response, where each physical path acts as a time varying low pass filter, and motion introduces additional Doppler spreading and shifting. Because propagation is best supported at low frequencies, acoustic communication systems are inherently wideband. The way in which these facts influence the design of signal processing methods is considered for single-carrier and multi-carrier systems. Moreover the facts that the available bandwidth and transmission power depend heavily on the distance, and that channel latency is high, bear important implications on the design of the network architectures and related protocols[2].

As more and more people started using the communication equipments, the demand for high data rate increased quickly. Orthogonal Frequency Division Multiplexing (OFDM) is one of the latest modulation techniques used in order to combat the frequency-selectivity of the transmission channels, achieving high data rate without inter-symbol interference. The basic principle of OFDM is gaining a wide spread popularity within the wireless transmission

community. Furthermore, OFDM is one of the main techniques proposed to be employed in 4th Generation Wireless Systems. Therefore, it is crucial to understand the concepts behind OFDM[3].

Chapter 3

3. LIMITATION OF THE CURRENT WORK

As for terrestrial application, the underwater wireless communication is not a straight forward process. When considering the underwater communication process, the primary concern that researchers always consider are the channel model(underwater), attenuation, transmission distance, power consumption, SNR ratio, bit error, Inter symbol interference, error coding, modulation strategies, instrumentation and underwater interferences. Dealing with interferences for underwater research is a complex task due to dynamic nature of water. Interferences are mainly caused by three major factors:

3.1. Characteristics of signal carrier

In underwater world, there are 3 types of carrier wave that are most commonly used in wireless communication.

i. Electromagnetic wave

Using electromagnetic wave, the communication can be established at higher frequency and bandwidth. The limitation is due to high absorption/attenuation that has significant effect on the transmitted signal. Big antenna also needed for this type of communication, thus affects the design complexity and cost.

ii. Optical wave

Optical wave also offers high data rate transmission. Nevertheless, the signal is rapidly absorbed in water and suffers from scattering effect. This will affect the data transmission accuracy.

iii. Acoustic wave

Acoustic is the most preferred signal used as carrier by many application, owing to its low absorption characteristic for underwater communication. Even though the data transmission is slower compared to other carrier signal, the low absorption characteristic enables the carrier to travel at longer range as less absorption faced by the carrier.

3.2. Environment/Propagation Medium

Here, the challenges are quite different. 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. Common

terrestrial phenomena like scattering, reflection, refraction also occurs underwater communication.

3.3. Instrumentation System Devices

For effective communication, the communication system design plays a vital role. Factors such as transducer parameters (sensitivity, power consumption, noise immunity, transduction mechanism, directivity, resolution and properly matched impedance) must be taken into account during the design process. One of the important areas that worth focusing on is the receiver (sensor) design. Nowadays, with the advancement in electronic technology, the transducer design (especially receiver) can adopt MEMS technology to overcome several sensor issues that proves to have several advantages compared to the conventional approach. It is found to have many advantages compared to the conventional design.

Chapter 4

4. PROBLEM DEFINITION AND OBJECTIVES

Design of Modulation and Demodulation of any message signal using orthogonal frequency division multiplexing (OFDM) technique for underwater communication.

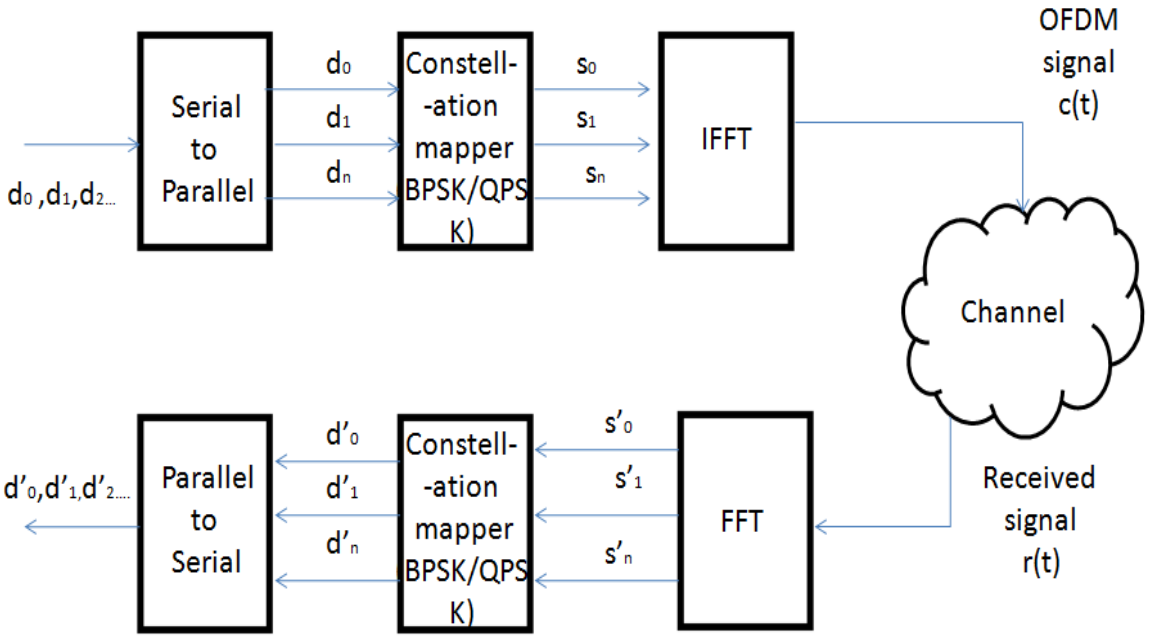
OBJECTIVES:

- **To reduce ISI** :

  To reduce ISI, we are going to use OFDM technique.

Orthogonal Frequency Division Multiplexing (OFDM):

Orthogonal Frequency Division Multiplexing is a multicarrier modulation technique, which employs several carriers, within the allocated bandwidth, to convey the information from source to destination. Each carrier may employ one of the several available digital modulation techniques (BPSK, QPSK, QAM etc.,). OFDM is very effective for communication over channels with frequency selective fading, i.e., different frequency components of the signal experience different fading. OFDM is a special case of FDM (Frequency Division Multiplexing). In FDM, the given bandwidth is subdivided among a set of carriers. There is no relationship between the carrier frequencies in FDM.



- **To obtain accurate communication:**

i. Using Acoustic wave:

Acoustic is the most preferred signal used as carrier by many application, following to its low absorption characteristic for underwater communication. Even though the data transmission is slower compared to other carrier signal, the low absorption characteristic enables the carrier to travel at longer range as less absorption faced by the carrier.

ii. Optimize SNR:

Optimize SNR value until we get accurate transmission of the signal without any loss in the signal amplitude.

iii. By reducing noises and losses as more as possible, this helps us to obtain an accurate communication.

Chapter 5

5. METHODOLOGY

Characterization of underwater channel with a well known mathematical model, to be borrowed from published literature.

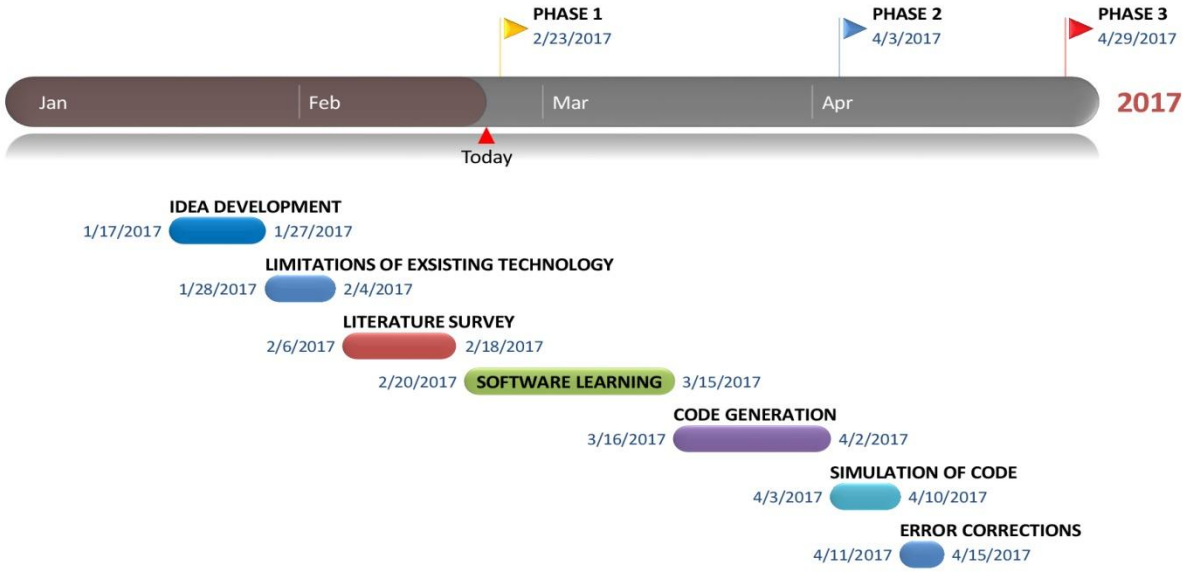
To survey the various novel communication schemes in Digital Communication such as wireless, to study MSE and BER performance: MIMO, OFDM, hybrid solutions would be explored from various journals dedicated to digital communication, the motive behind this is that the underwater acoustic communication channel would be fundamentally a digital communication system, novel ideas in a conventional digital system might be helpful for performance enhancement of underwater communication. Mathematical models for the same would be built using academic softwares. Also, the results published in the literature and simulated results would be compared. The primary difference between a conventional wireless channel and a underwater channel is the impulse response of the channel is quite different in both the cases.

Attempt to implement the same schemes and variations of it for an underwater communication channel in the theoretical domain. First, the mathematical model for underwater channel would be adopted from published literature, assuming realistic parameters. Later, the novel schemes simulated and tested (ideas from typical wireless systems) would be tested for a underwater channel.

Optimize the schemes for better performance. Once, the various schemes for a underwater channel is performed. Tweaking of the scheme or optimization process would be performed to extract suitable results. In other words, the communication system's scheme would be customized for a underwater scenario.

Compare and contrast the new model with previously established schemes

5.1 Plan of Work



REFERENCES

[1] Milica Stojanovic, "Recent Advances in High-speed Underwater Acoustic Communications", In IEEE Journal of Oceanic Engineering, Vol. 21, No. 2, April 1996.

[2] Milica Stojanovic, "Underwater acoustic communication: design considerations on the physical layer", in MIT, cambridge, MA 02139.

[3] Sandeep Kaur, Gurpreet Bharti, "Orthogonal Frequency Division Multiplexing in Wireless Communication Systems: A Review", International Journal of Advanced Research in Computer Engineering & Technology Volume 1, Issue 3, May 2012.