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UNDER WATER COMMUNICATION CHANNEL

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ABSTRACT

There is a high demand for underwater communication systems due to the increase in current human underwater activities. Underwater communication systems employ either acoustic or electromagnetic waves as a means of transferring signals. These waves are different in physically and electrically, and thus the systems that employ them also differ in their design architecture, wave propagation and devices used for emission and reception. The objective of our work is to develop an underwater communication channel. The channel utilizes the propagation of underwater acoustic waves. The design starts with the making of the most critical component, the transducers for the transmitting and receiving. The transducers are made with the piezoelectric discs which are commercially available. The channel has the ability to transmit and receive digital signal by using a developed unique communication protocol. This paper presents the implementation and experimental results of the communication channel.

Keywords: Acoustic,piezoelectric,transducer,underwater

1. INTRODUCTION

The need for advanced researches in underwater communication encompasses many applications including diver communications, environmental monitoring, marine activities, disaster prevention and resource detection. Nowadays, there are extensive ongoing research activities relating to underwater communication and underwater sensor networks. The main goals of each research activities are based on increasing the communication distance and the increasing the bandwidth. In underwater environment typical radio frequency based communication is not appropriate because of two facts. One fact is the radio waves require large antenna and the other one is the high transmission power[1]. Thus we have concluded that the most suitable way of underwater communication is the acoustic waves. Normally in the fresh water velocity of the acoustic signal is around 1480m/s[2].

The objective of our research is to develop underwater acoustic communication channel which can utilize digital signals. Apart from that our attention is paid towards the energy awareness, low cost and the simplicity of the system. To accomplish these targets homemade transducers and simple circuitries are used. The overall idea of the research is depicted in following Figure1.

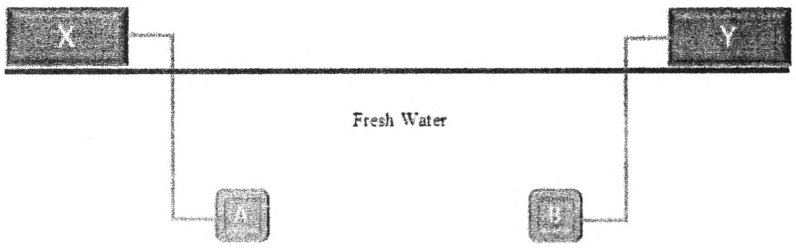


Figure 1: Overall Idea of the Research

As an example, we can consider that X needs to communicate with Y using wireless communication and selected medium as fresh water. In here, A and B are not physically connected. X sends the message signal through cable which is connected to the terminal A which is capable to convert the message signal into an acoustic wave and B receives the message signal from A and sends it to the Y through the cable which connects the B and Y. Therefore th

communication channel is a point to point communication channel which is tested in shallow water.

2. METHODOLOGY

The system consists of transducers, transmitting and receiving circuitry and the software platform to prepare data into usable format. The first task of this research is to initialize the analogue communication link between the two transducers. After initializing this link the further experiment can be done by transmitting digital signal under the water. The most important parameter is the frequency of the signal that the transmitter transmits. The selection of frequency depends on the transmission distance. With higher frequencies lower the distance and the smaller the frequency higher the distance[3]. Therefore the 44 kHz is selected as the frequency of the transmission signal.

The components of the transmitting side can be shown in the following block diagram in its simple configuration.

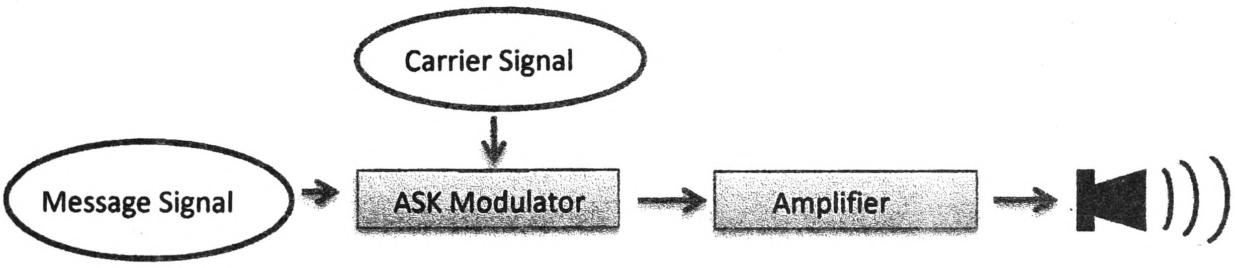


Figure 2: The Block Diagram of the Transmittting Side

In order to transmit a digital signal it should be modulated. The Amplitude Shift Keying (ASK) modulation scheme is used because the demodulation of the ASK signal is easier. A simple transistor ON and OFF method is implemented by using the BC 547 transistor. Then the modulated signal is amplified before transmitted. The amplifier which is having a gain of 23dB is designed with LM384n IC. To generate the message signal an Arduino based program is developed by using our own communication protocol. The sinusoidal carrier signal of 44 kHz is generated by using the signal generator. Finally the amplified signal is fed to the transmitter

through the co axial cables. The receiving side comprises with the amplifiers, filters and demodulator. The block diagram of the receiving side is shown in the Figure 3.

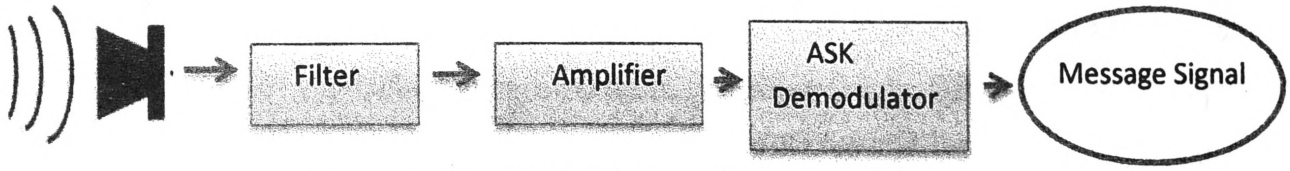


Figure 3: The Block Diagram Receiving Side

The received signal is a noisy signal. The filter is a band pass filter which allows the signals within a certain frequency band to pass. The upper and lower cut off frequencies of the filter is 118 KHz and 12 KHz respectively. Then that signal is amplified for further process by using an amplifier. The same amplifier configuration which is in the transmitting side is used in the receiving side. The ASK demodulator is an arduino based demodulation scheme which monitors the receiving signal by using a threshold voltage.

2.1 . Transducer

In this section the design of the transducers is described. The transducer converts one form of energy into another form of energy. In the case of underwater communication, the function of the transducer is to convert acoustic energy into electrical energy and vice versa. Underwater transducers are typically made from piezoelectric materials such as lead zirconate titanate and certain ceramics. Those materials generate an electrical signal in response to an applied mechanic stress and produce a stress or strain when an electric field is applied. In order to maintain the required frequency (44 KHz) the circular disc shape piezoelectric material is used. The following figure 4 shows the two piezoelectric discs which are used to make the transducers.

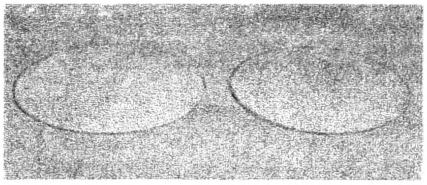
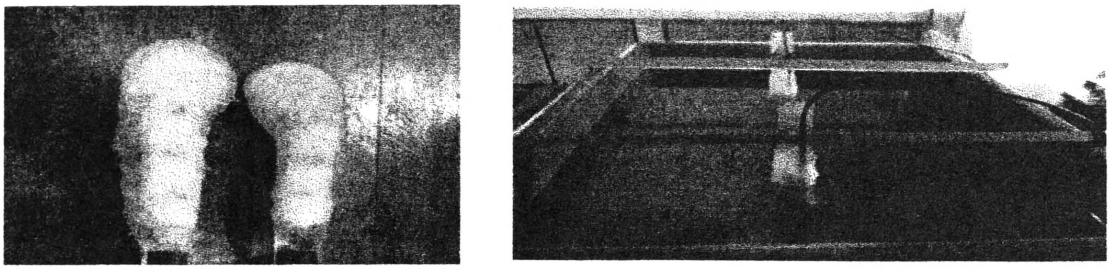


Figure 4: Piezoelectric Discs

The piezoelectric discs have 50mm diameter and 2.1mm thickness. The resonant frequency of the discs is 44 kHz and the resonant impedance is less than 8Ω. The most common method of making transducers is to solder two leads on the two surfaces of the disc.



(a) (b)

Figure 5: (a) Trasducers and (b) the Final Set up of the System

The test tank is about 1m long and the distance between the transmitter and the receiver is kept around 60cm. Fresh water is used as the transmission medium.

2.2. Communication Protocol

An arduino based coding is done in order to develop the communication protocol. To represent a letter in the English alphabet six bits are needed. The following figure illustrated the overall picture of the protocol.

Master Data Packet consists of two portions to distinguish the message signal properly. Every message begins with a null portion; therefore it is easy to analyse the received message signal through water. The data rate is 10bps.

3. RESULTS AND DISCUSSION

The first step is initialized by sending a sinusoidal signal through the channel. The received signal is a small amplitude and noisy signal. Therefore the system is further improved by

introducing amplifiers and filters. After that the communication of digital signal is tested. The ASK modulation identifies whether the signal is sent or not, and generates the signal according to that. To test the channel, digital clock signal is used as the message signal. The various message signal frequencies are tested through the channel. The following figures show the results of the experiment.

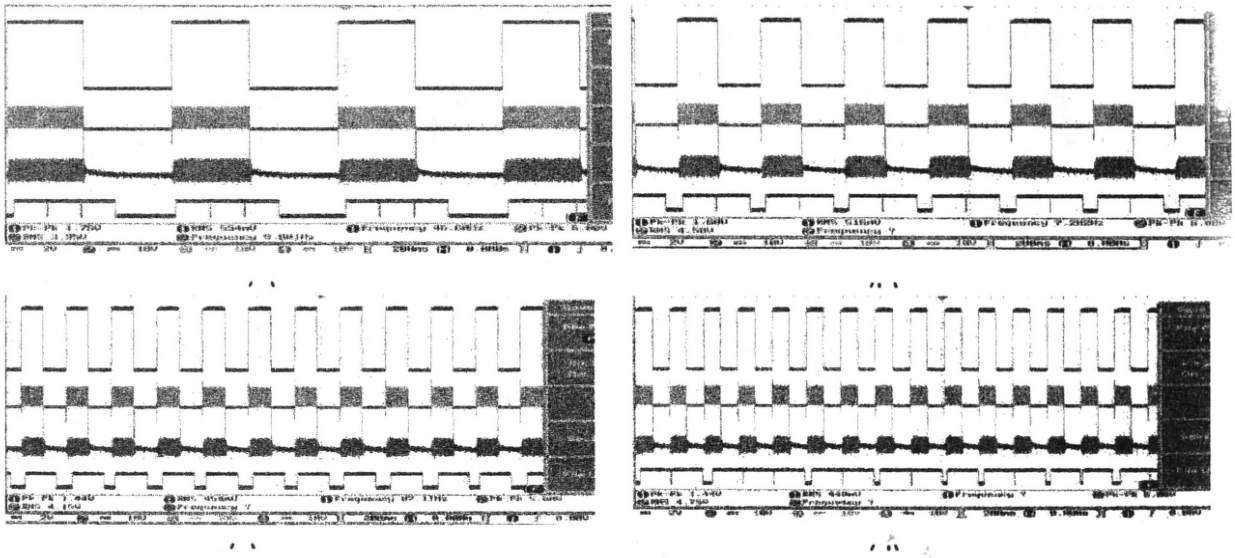


Figure 6: Comparison of Waveforms (a) 2Hz, (b) 4Hz, (c) 7Hz, (d) 9Hz; (Purple-Message Signal, Green-Modulated Signal, Blue-Received Signal, Red-Demodulated Signal)

When increasing the frequency of the message signal demodulated signal gets problematic. This is due to the delay introduced in the arduino based demodulation scheme. Therefore with the current demodulation scheme we can use message signals upto 8Hz. By utilizing a successfu' demodulation scheme we can go for higher frequencies.

To check the communication protocol the letter 'b' is sent over the software interface. Th following figure shows the comparison of the waveforms.

4. CONCLUSİONS

Underwater acoustic communication is the most suitable way to communicate under water. B enhancing the features of the transducers, the communication distance can be increased. Thi work developed a short distance acoustic communication channel as hardware to perfor

acoustic communication. There are several advantages. Thus, the advantages of our acousti communication channel are as follows. First, our acoustic channel is a low-cost based acousti modem with the capability of digital data communication which is having a rate of 10bps Because there had been no prior existing communication channel with this capability based on low-cost, our communication channel is significant in this regard.

ACKNOELEDGEMENTS

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