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# Proposed Adaptive channel coding technique for underwater Communication

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Abstract :The underwater acoustic communication is very important mode of communication. The establishment of a network link is one of the biggest challenges in this mode of communication as the water current varies randomly at a faster rate resulting in low signal to noise ratio. Hence to overcome this drawback we propose an adaptive channel coding algorithm to maintain the signal to noise ratio irrespective of change in water current. In the proposed algorithm the channel coder will be selected depending on the water current. We know that the spreading of the signal basically is the function of flow of water resulting in variation of S/N. In this proposed algorithm we use two channel coding techniques to maintain the S/N irrespective of the channel quality. The algorithm also overcomes the fading effect in the channel.

**Keywords- $E_b/N_o$, MAP, SOVA, Turbo code.**

## I. Introduction

The underwater communication has gained high importance in the past few years. The main drawbacks in this mode of communication are due to

- The variation in channel characteristics
- RF signals cannot be used for under water communication instead acoustic signals are used.
- Low bandwidth is available in acoustic channels.
- Low S/N ratio

This mode of communication is designed using the acoustic signals and acoustic sensor nodes [1]. These nodes are randomly placed in the channel. These nodes communicate with other establishing a network called the acoustic sensor network. Unlike the ground nodes the position of the acoustic nodes continuously varies with respect to time resulting in dispersion. This results in deterioration in the quality of the channel causing latency. The propagation speed of acoustic signal in underwater channel is very slow compared to the RF signal in the ground communication [2] .The available bandwidth basically depends on the distance between the transmitter and the receiver in acoustic channels and the frequency of the acoustic signals.

The characteristic of the acoustic channel mainly depends on the path-loss factor, noise, multi-path fading and variable propagation delay [3]. In case of acoustic channels as the distance increases the bandwidth reduces and as the bandwidth increases the distance between the transmitter and the receiver reduces hence resulting in low bit rate. To minimize this drawback we propose an algorithm using joint coding technique. The flow of the paper is as given below

- Introduction
- Acoustic Sensor nodes
- Adaptive Channel coder
- Modulator
- Proposed Methodology
- Results
- Conclusion & future work

## II. Acoustic Sensor nodes

The Acoustic sensor nodes are randomly placed in the shallow water. These acoustic sensor nodes are basically used to transfer the packets from source to destination. The sensor nodes are programmed to transfer the packet in forward direction through the nearest node. The nearest node is predicted by the source node by comparing the power dissipated by the nodes in forward direction .The node with highest power will be programmed to receive the packet .This procedure continues till the packet reaches the destination. In this proposed paper we use adaptive channel coding techniques depending on the current of the water.

## III. Adaptive Channel coder

The channel coders are basically used for error detection and correction. We know that the bit error rate varies with the variation water current.

If the current is low the senor nodes will not be dispersed hence resulting in low path-loss factor, hence we propose simple convolutional coder.The channel coding techniques widely used are block coding technique and convolutional coding technique.

In case of block codes the information is divided into blocks and each block is encoded independently using generator matrix but the disadvantage of this technique is due to its limited error detecting and correcting capability, hence to overcome this drawback we prefer to use convolutional coder.

The convolutional coder are basically designed using the flip-flops .The representation is done as(k,m,n) where **k** is the total number of inputs, **m** is the total number of flip-flop's used and **n** is total number of output terminals. The complexity of the code can be varied depending on the constraint length. The advantage of using the convolutional coder is that it can detect and correct any number of random Gaussian errors.

The convolutional codes [6] can be used to construct the systematic codes or non-systematic codes. The systematic codes are preferred as this code prevents the propagation of errors. At the receiver the decoding is done using maximum-likelihood algorithm as we have considered only the random errors occurring at different instants of time. Here the decoding can be started instantaneously without any delay. But the decoding becomes very complex and processing time increases with increase in error. Hence to overcome this drawback at high water current we propose to use turbo coding [11] technique.

If the current is high the sensor nodes will be widely dispersed hence resulting in the multi-path fading and path-loss factor resulting in very low S/N ratio. To overcome this we propose to use turbo coding technique. The turbo coder uses recursive coder and iterative soft decoder. The nature of the recursive coder shortens the constraint length hence minimizing the processing time and the soft decoder improves the estimate of the received message.

The turbo codes are preferred as its performance is very good as the turbo coder is designed with a block interleaver. The turbo codes are designed using concatenation of two convolutional codes with a pseudorandom interleaver. Usually the coder used in the encoder will be identical and the design of the interleaver decides the complexity of turbo code. Different designs of turbo interleaver are in use. The use of interleaver increases the weight of the code as we know that the low weight code reduces the performance of the code. The output code obtained will be random in nature. The output of the first coder will be totally different compared to the second coder. As the input to the second coder is the output of the interleaver.

The two main types of decoding techniques are MAP and SOVA[13]. Both of these decoding algorithms perform in a similar way at high $E_b/N_o$ but at low $E_b/N_o$ MAP is better compared to SOVA. But the constructional feature of MAP is complex compared to SOVA. The working of SOVA is similar to the Viterbi algorithm using maximum likelihood decoding concept. The performance of SOVA is 0.5db better than MAP at the lower values of $E_b/N_o$.

## IV. Modulator

The modulation technique proposed in this algorithm is CDMA technique. The main concept in choosing this modulation technique is that is prevents the loss of data due to water current and the net voltage required for transmission and reception can be minimized.

## V. Proposed Methodology

We know that the current of the water continuously varies with the time; hence in the proposed algorithm we use two channel coding technique to improve the S/N ratio of the received packet. In this algorithm we use handshake packets randomly transmitted between the transmitter and the receiver. These handshake packets are designed with an inbuilt counter and the count will be incremented as and when it encounters the sensor nodes randomly placed between the transmitter and the receiver. Initially handshake packet will be transmitted from the source to destination. At the receiver on receiving the packet the count present on the packet will be checked. Depending on the count either convolution coder or the turbo coder can be selected by the receiver. The same will be informed to the transmitter by transmitting an acknowledgement packet. The acknowledgement packet has a counter in it and is designed to carry the coder information. On receiving the acknowledgement packet the transmitter further verifies the counter value present in the packet along with the data transmitted and selects the coder. This procedure will be randomly done to check the flow of water. If the count value in the packet is high then the bit error rate will be maximum hence we propose to use the turbo coder [4], else if the water current is slow we propose to use the convolution coder [4 5].

## VI Results

**Selection Of channel coders:** The channel coder will be selected depending on the counter value stored in the packet**.** A threshold for counter comparison will be set depending on the region of installation of transmitter and the receiver for underwater communication. The three different conditions checked are tabulated.

**A) Underwater communication designed for lake 150mtr (where the water current is very minimal ).**

| Threshold count value set | Counter value stored on the received packet | Effect of Fading | Channel coding technique selected |
|---|---|---|---|
| 3 | <3 | Less | Convolutional encoder |
| | 3 | moderate | Convolutional encoder |
| | >3 | high | Turbo encoder |

**b) Underwater communication designed for rivers for 150mtr (where the water current is moderate).**

| Threshold count value set | Counter value stored on the received packet | Effect of Fading | Channel coding technique selected |
|---|---|---|---|
| 5 | <5 | Less | Convolutional encoder |
| | 5 | moderate | Convolutional encoder |
| | >5 | high | Turbo encoder |

c) **Underwater communication designed for ocean for 150mtr (where the water current is moderate).**

| Threshold count value set | Counter value stored on the received packet | Effect of Fading | Channel coding technique selected |
|---|---|---|---|
| 7 | <7 | Less | Convolutional encoder |
| | 7 | moderate | Turbo encoder |
| | >7 | high | Turbo encoder |

## VII Conclusion & Future work

The underwater communication is very important mode of communication and the proposed technique aims at minimizing the processing time required to receive the quality signal at the destination irrespective of the underwater condition.

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