Performance Analysis Of Fast And Slow Moving Vehicles Using CDMA Techniques For Underwater Wireless Communication Network

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Received 7 June 2016; Accepted 12 October 2016; Available 20 October 2016

ABSTRACT
Underwater acoustic networks are formed by acoustically connected ocean-bottom sensors, autonomous underwater vehicles, which can travel in underwater and surface stations. High speed communication in the underwater acoustic channel has been challenging because of limited bandwidth, extended multipath, refractive properties of medium, severe fading, rapid time variations and large Doppler shifts. Hence there is need for advanced communication techniques and networking for efficient underwater communication in ocean monitoring and exploration applications. Limited energy and communication resources available to underwater devices make protocol optimization of prime importance. The proposed work deals with detailed comparison of the performance BER vs. SNR for fast and slow moving underwater vehicles using CDMA techniques in underwater communication.

KEYWORDS: Keyword 1: underwater acoustic communication Keyword 2: DSS-CDMA Keyword 3: wireless sensor network Keyword 4: fast and slow moving nodes

INTRODUCTION

The earth surface is filled with two thirds of the water compare to land [1], there many un-explored areas in underwater. This needs significant research efforts. The research of Underwater Acoustic Networks (UANs) is becoming more significant with many underwater applications [2]. Electromagnetic waves are not used as they propagate over short distances in Underwater and over the past decades, heavy cables were used to establish a high speed communication between remote end and the surface. To overcome these difficulties [3], underwater wireless communication has come into existence in which acoustic signals carry digital information through an underwater channel and data transmission through the ocean is one of the most enabling technologies for the future development of Ocean-observation systems and sensor networks [4].

Challenges In Underwater Communication:
Various parameters affect the underwater communication like the sound produced by the underwater living organism and autonomous underwater vehicle causes interferences with the transmitted signal that causes NOISE [5]. The high frequency signals are easily absorbed by the sea water so bandwidth available for...
communication is severely limited. Sensors are limited by the capacity of the onboard storage device (memory, hard disk) is again a big challenge in Underwater Communication.

Some of the parameter is discussed below

- **Path Loss**: Due to attenuation and geometric spreading.
- **Noise**: Manmade noise and ambient noise (due to hydrodynamics).
- **Multipath propagation**: Multipath is responsible for severe degradation of the acoustic communication signal, since it generate inter symbol interference.
- **The propagation speed in the underwater channel is lower than in the radio channel in order 5 of its magnitude causes high delay.**
- **Doppler frequency spread**: This can be significant in underwater channels, causing degradation in the performance of digital communication.

The proposed simple network architecture model for underwater communication is shown in Fig. 1. This consists of cluster of sensor nodes, UW Sensors & UW Sinks, base station, sea offshore station, etc.

![Fig. 1: Underwater network architecture](image)

**Related Work:**

1. “Efficient Communication Protocols for Underwater Acoustic Sensor Networks” (2013) by Dario Pompeii. Underwater Acoustic Sensor Networks (UW-ASNs) consist of sensors and Autonomous Underwater Vehicles (AUVs) deployed to perform collaborative monitoring tasks. This work aims in achieving high network throughput, low channel access delay [6], and low energy consumption.

2. A CDMA-Based Medium Access Control for Underwater Acoustic Sensor Networks paper is presented by Dario Pompeii, Tommaso Melodia and Ian F. Akyildiz focused on achieving all these three objectives like high network throughput [7], low channel access delay and low energy consumption. For shallow water using DSSS and FHSS using UW-MAC is the first protocol and CDMA is the most promising physical layer and multiple access technique to achieve multiple accesses to underwater bandwidth.

3. DSSS-Based Channel Access Technique DS-CDMA for Underwater Acoustic Transmission proposed a new approach for high transmission rate using CDMA technique. This divide the channels into sub channel through which data passes which spreads in frequency domain result in signal with wider bandwidth [8]. As it is important to have the frequency high to pass through the channel but in underwater acoustic communication Signal with all the restriction can't increase communication capacity because UWAC uses a very low carrier frequency in the ultrasonic band compared with terrestrial radio communication due to media characteristics [9]. From the Result using for DSSS four steps achieved-1 QPSK, 2PN sequence, 3m sequence, 4 Reverse filtering and CDMA increases the number of to reuse channel and decrease the number of the packet retransmission.

4. Underwater acoustic Sensor network: Research challenges proposed by author Ian F. Akyildiz, Dario Pompeii, Tommaso Melodia explain the exploration using unmanned vehicle with sensor for monitoring mission [10]. Thus obtaining different 2D and 3d architects. That the result in overcoming main challenges and forming effective network assisted for navigation and tactical surveillance.
Underwater Acoustic Modulation Techniques:

A CDMA system has no restriction for both time and bandwidth, but limited by a multiple access interference (MAI), as well as inters symbol interference (ISI). Spread spectrum multiple accesses applied in this work as it can entirely use entire allocated bandwidth.

CDMA modulation is obtained by

1. Spread the signal
2. Encryption is in handy for the waveform is demodulated at the receiver

![Fig. 2: CDMA Modulation scheme](image)

The CDMA Modulation scheme is shown in fig 2. This modulation technique is commonly used in areas like commercial communication systems radar, navigation and telecommunication etc. Such CDMA are widely classified into direct sequence CDMA, Frequency Hop CDMA, Time Hop CDMA whose techniques are use for specific advance in specific area.

Advantages of CDMA:

1. Higher channel efficiency thus having higher throughput.
2. This is effective even for multipath interference and any interference that appears deterministic.
3. Channel without either accurate time scheduling or individual allocation to specified frequency bands can also be achieved in CDMA like in TDMA and FDMA.
4. Switching signal to signal for a transmitter or receiver by changing spread codes is flexible.
5. This provides security protection for transmitting information.

Proposed Methodology:

Direct Sequence-Code Division Multiple Access which is used in many commercial communication systems and is said to be first type of code division is proposed in this work, for its capability for dynamic allocation of bandwidth. These modulation techniques are introduced to overcome the limited natural wireless resource.

Development of unmanned vehicle for keeping track of AUV is important. Due to their ability to work in the world’s deepest underwater area to even to the depth of polar ice sheets and for its mapping and monitoring in shallow and deep water among this interface it is essential to collect information of high-resolution data which is technologically challenging. In the beginning unmanned vehicle were used only for naval operation but through researches changes have brought in the field of communication to the field of operational demand. These systems are unmanned because they are programmable with advance in autonomous software's remotely-controlled ground vehicle benefit of being human operated. Operational AUV that communicates through acoustic modem in wireless sensor network and the speed of AUV is comparatively low to the unmanned vehicle. AUV move at the speed of $1.5$–$2.0$ m/s$^{-1}$. The disturbance caused by the tidal waves is greater than this velocity and thus AUV is less suited for shallow water setting. Acoustic signals are less susceptible to sea particle so widely used for underwater communication. Thus for directional signal transmission and reception, a technique called beam forming is used. This specifically controls the phase and amplitude, thus while receiving from sensor array the information get combined to expected pattern.
RESULT AND DISCUSSION

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The Performance of proposed technique is presented and summarized for two UW-AS architectures. The various output and comparison of BER vs. SNR with respect fast and slow moving nodes are shown below.

Fig. 3: BER vs SNR for 2 knot - Slow

AUV in Fast moving knots:

Fig. 4: BER vs SNR for 5 knot – Medium Speed

Fig. 5: BER vs SNR for 10 knot- Fast moving node
Comparison of Slow and fast moving nodes:

Fig. 6: BER vs SNR for 10 knot- Fast moving node

Table 1: Comparison Between BER Vs Fast for Different Knots

<table>
<thead>
<tr>
<th>SNR (DB)</th>
<th>2 knots</th>
<th>5 knots</th>
<th>10 knots</th>
</tr>
</thead>
<tbody>
<tr>
<td>-5</td>
<td>2.00E-05</td>
<td>3.00E-05</td>
<td>0.0003</td>
</tr>
<tr>
<td>-10</td>
<td>0.002338</td>
<td>0.00685</td>
<td>0.0111</td>
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<tr>
<td>-15</td>
<td>0.00772</td>
<td>0.01915</td>
<td>0.0399</td>
</tr>
<tr>
<td>-20</td>
<td>0.0092</td>
<td>0.0249</td>
<td>0.0462</td>
</tr>
<tr>
<td>-25</td>
<td>0.00978</td>
<td>0.02425</td>
<td>0.0497</td>
</tr>
<tr>
<td>-30</td>
<td>0.0085</td>
<td>0.024</td>
<td>0.0465</td>
</tr>
</tbody>
</table>

From the tabulation the results shows the improving BER even with negative SNR. Fast and Slow moving nodes are simulated and the SNR vs BER performance is compared with for different Knot speed.

Conclusion and Future Work:

The proposed method is able to achieve an improving BER for different SNR and moving nodes. The future work is focused to achieve better throughput and also to enhance Bit error rate for different SNR with fast Moving nodes. The proposed algorithm designed for underwater communication should perform better even for worst channel conditions like long and variable propagation delays.

REFERENCES