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Technologies Used In Underwater Wireless Communication

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ABSTRACT: This paper hereby deals on topic underwater wireless communication and various technologies applied on that. Wireless communications in underwater medium has got its flourishing importance- in the recent times. This paper thereby discusses the overall-framework like how basically underwater wireless communication is done the technical ideas used behind and also their drawbacks.
This paper also views on the importance of underwater wireless communication, a view over acoustic channel their hardware structures and working, different ways of architecture in communication involving the sensor networks and also the scopes of underwater communication like AUVs, oceanographic data collections.

KEYWORDS: wireless, acoustic, underwater medium, AUV, sensor, oceanographic

I. INTRODUCTION

Before theimplementation of underwater wireless communications, cables submersibles were used to discover the remains of antique and hydrothermal vents. Due to the immiscible cost of cables there is importance for a high-speed communication between the remote end and the surface. To overcome such impediments, underwater wireless communication has come into existence.
Wireless communication, or sometimes simply wireless, is the transfer or information or power between two or more points that are not connected by an electrical conductor. Usually, in wireless electromagnetic waves are used in transmission of information o from one point to other. But in underwater communication we use acoustic waves to propagate over large distances.

UNDERWATER wireless communication

What is underwater wireless communication?

Underwater acoustic communication is a technique of sending and receiving messages below water. There are several ways of employing such communication but the most common is by using hydrophones. Compared to terrestrial communication, underwater communication has low data rates because it uses acoustic waves instead of electromagnetic waves.

Necessity for underwater communication

Wired underwater is not feasible in all situations as shown- be-low:

- Temporary experiments
- Breaking of wires
- Significant cost of deployment

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- Experimenting over long distances.

To cope up with above situations, we require underwater wireless communication.

Types of modulation used for acoustic communication

Same methods that are developed for radio communications can be implemented here they are,

- Frequency Shift Keying (FSK)
- Phase Shift Keying (PSK)
- Frequency Hopped Spread Spectrum (FHSS)
- Direct Sequence Spread Spectrum (DSSS)
- Frequency and Pulse-position modulation (FPPM and PPM)
- Multiple Frequency Shift Keying (MFSK)
- Orthogonal Frequency-Division Multiplexing (OFDM)

II. TECHNOLOGIES USED IN UNDERWATER WIRELESS COMMUNICATION

IM-PORTANCE:

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. The major discoveries of the past decades, such as the remains of Titanic, or the hydro-thermal vents at bottom of deep ocean, were made using cabled submersibles. Although such systems remain indispensable if high-speed communication link is to exists between the remote end and the surface, it is natural to wonder what one could accomplish without the burden (and cost) of heavy cables. Hence the motivation, and our 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.

EXPLANATION

The signals that are used to carry digital information through an underwater channel are not radio signals, as electro-magnetic waves propagate only over extremely short distances. Instead, acoustic waves are used, which can propagate over long distances. However, an underwater acoustic channel presents a communication system designer with many difficulties. The three distinguishing characteristics of this channel are frequency-dependent propagation loss, severe multipath, and low speed of sound propagation. None of these characteristics are nearly as pronounced in land-based radio channels, the fact that makes underwater wireless communication extremely difficult, and necessitates dedicated system design. At shorter distances, a larger bandwidth is available, but in practice it is limited by the that of the transducer. Also in contrast to the radio systems, an acoustic signal is rarely narrowband, i.e., its bandwidth is not negligible with respect to the centre frequency.
Within this limited bandwidth, the signal is subject to multipath propagation, which is particularly pronounced on horizontal channels.

In shallow water, multipath occurs due to signal reflection from the surface and bottom. In deep water, it occurs due to ray bending, i.e. the tendency of acoustic waves to travel along the axis of lowest sound speed. The channel response varies in time, and also changes if the receiver moves. Regardless of its origin, multipath propagation creates signal echoes, resulting in inter symbol interference in a digital communication system. While in a cellular radio system

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multipath spans a few symbol intervals, in an underwater acoustic channel it can spans few tens, or even hundreds of symbol intervals! To avoid the inter symbol interference, a guard time, of length at least equal to the multipath spread, must be inserted between successively transmitted symbols. However, this will reduce the overall symbol rate, which is already limited by the system bandwidth. To maximize the symbol rate, a receiver must be designed to counteract very long inter symbol interference.

The speed of sound underwater varies with depth and also depends on the environment. Its nominal value is only 1500 m/s, and this fact has a twofold implication on the communication system design. First, it implies long signal delay, which severely reduces the efficiency of any communication protocol that is based on receiver feedback, or hand-shaking between the transmitter and receiver.
The resulting latency is similar to that of a space communication system, although there it is a consequence of long distances travelled. Secondly, low speed of sound results in severe Doppler distortion in a mobile acoustic system. Namely, if the relative velocity between the transmitter and receiver is ±v, then a signal of frequency fc will be observed at the receiver as having frequency fc(1±v/c). At the same time, a waveform of duration T will be observed at the receiver as having duration T(1±v/c). Hence, Doppler shifting and spreading occur. For the velocity v on the order of few m/s, the factor v/c, which determines the severity of the Doppler distortion, can be several orders of magnitude greater than the one observed in a land-mobile radio system! To avoid this distortion, a non-coherent modulation/detection must be employed. Coherent modulation/detection offers a far better utilization of bandwidth, but the receiver must be designed to deal with extreme Doppler distortion.

Summarizing the channel characteristics, one comes to the conclusion that an underwater acoustic link combines in itself the worst aspects of radio channels: poor quality of a land-mobile link, and high latency of a space link. In addition, current technology offers limited transducer bandwidth (typically a few kHz, or few tens of kHz in a wideband system), half-duplex operation, and limited power supply of battery-operated instruments.

III. ACOUSTIC MODEM TECHNOLOGY

Acoustic modem technology today offers two types of modulation/detection: frequency shift keying (FSK) with non - coherent detection and phase-shift keying (PSK) with coherent detection. FSK has traditionally been used for robust acoustic communications at low bit rates (typically on the order of 100 bps). To achieve bandwidth efficiency, i.e. to transmit at a bit rate greater than the available bandwidth, the information must be encoded into the phase or the amplitude of the signal, as it is done in PSK or quadrature amplitude modulation (QAM). For example, in a 4-PSK system, the information bits (0 and 1) are mapped into one of four possible symbols, ±1±j. The symbol stream modulates the carrier, and the so-obtained signal is transmitted over the channel.

To detect this type of signal on a multipath-distorted acoustic channel, a receiver must employ an equalizer whose task is to unravel the inter symbol interference. Since the channel response is not a-prior known (moreover, it is time-varying) the equalizer must “learn” the channel in order to invert its effect.
With advances in acoustic modem technology, sensor technology and vehicular technology, ocean engineering today is moving towards integration of these components into autonomous underwater networks. While current applications include supervisory control of individual AUVs, and telemetry of oceanographic data from bottom-mounted instruments, the vision of future is that of a “digital ocean” in which integrated networks of instruments, sensors, robots and vehicles will operate together in a variety of underwater environments. Examples of emerging applications include fleets of AUVs deployed on collaborative search missions, and ad hoc deployable sensor networks for environmental monitoring.

IV. DATA TRANSMISSION IN MODEM

When no data is being transmitted, the modem stays in sleep mode, it periodically wakes up to receive possible data being transmitted by far end modem. This results in low power consumption. Similarly, when the data is to be

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transmitted, the modem receives data from its link in sleep mode and then switches to transmit mode and data. And advanced modems are also available.

UNDERWATER ACOUSTIC SENSOR NETWORKS

- Group of sensors and vehicles deployed underwater and network via acoustic links, performing collaborative tasks
- Equipment -
- Autonomous underwater- vehicle
- Underwater sensors

APPLICATIONS

Future applications could enhance myriad industries, ranging from the offshore oil industry to aquaculture to fishing industries, she noted. Additionally, pollution control, climate recording, ocean monitoring (for prediction of natural disturbances) and detection of objects on the ocean floor are other areas that could benefit from enhanced underwater communications.

- Environmental monitoring to gathering of oceanographic data
- Marine archaeology

- Search and rescue mission
- Defence
- Seismic monitoring
- Ocean current monitoring

ADVANTAGES

- It can be used to provide the pre-warnings
- Of tsunamis by undersea earthquakes.
- Avoids data spoofing and privacy leakage.
- Can be used for monitoring underwater pollution and changes in habituates.
- Can be used to discover old and lost antiques undersea.

DISADVANTAGES

- Battery power is limited and usually batteries cannot be recharged also because solar energy cannot be exploited.
- The available bandwidth is severely limited.
- Channel characteristics including long and variable propagation delays
- Multi-path and fading problems.
- High bit error rate.

V. CONCLUSION

This paper gives the overall view of the necessity of underwater wireless communication and its applications. Despite much development in this area of the underwater wireless communication, there is still an immense scope so more research as major part of the ocean bottom yet remains unexploded.

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Advanced versions of the existing applications and innovative inventions have become a must in this field. Therefore, the main objective is to imbibe knowledge about this emerging field and thereby encourage research and implementation of advanced technology to overcome the present limitations such as the environmental effects on the noise performance of acoustic systems as mentioned in this paper.

FUTURE WORK

By the further research the mobile underwater communications could be implemented. The problem of channel variability already present in application with a stationary transmitter and receiver becomes the major issues of mobile underwater communication. By making the time synchronization the UWA channel and also by the motion induced pulse compression/dilation the mobile underwater communication can be taken.

$$\alpha + \beta = \chi. \quad (1)$$

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