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Editorial

Underwater Wireless Sensor Networks 2015

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Recently, the research in Underwater Sensor Networks (UNWSNs) has gained a noticeable pace due to their vast variety of applications. Moreover, the 75% of earth's surface is covered with water in the form of rivers, canals, seas, and oceans. To explore and make use of this vast unexplored aquatic environment, new technologies provide us with a number of applications such as pollution monitoring, disaster prevention, and tactical surveillance for scientific, environmental, and military purposes. For this purpose, we came across enormous research and development efforts being made in UNWSNs that are a fusion of wireless technology with extremely small micromechanical sensors having smart sensing, intelligent computing, and communication capabilities. UNWSN is a network of autonomous sensor nodes, which are spatially distributed deep underwater to sense the water-related properties such as quality, temperature, and pressure using acoustic channels. Therefore, applying terrestrial WSN protocols into UNWSN is not straight forward and therefore researchers and industrials are still looking for more suitable and serious efforts to bring UNWSN into a complete reality.

This special issue presents recent schemes for underwater networks, especially featuring current and future research waypoints in the field of underwater wireless sensor networks.

In the paper titled "Proteus II: Design and Evaluation of an Integrated Power-Efficient Underwater Sensor Node," the authors have designed and evaluated an integrated low-cost underwater sensor node with the capacity of reconfigurability. The proposed type of underwater sensor nodes allows constant operations running on a small rechargeable battery over the time period of a month. The designed node uses a host CPU for the network protocols and processing sensor data and a separate CPU performs signal processing for the ultrasonic acoustic software-defined Modulator Demodulator (MODEM). Furthermore, a Frequency Shift Keying (FSK) modulation scheme supporting the configurable rates of symbols, the Hamming error-correction, and estimation of Time-of-Arrival (ToA) enabling underwater positioning is presented in this paper. From the application perspective, the on-board sensors, an accelerometer as well as a temperature sensor, can be utilized to measure or sense the various environmental conditions. For the evaluation purpose, several test results were obtained to validate the low-power operations. Experimental results show that the node achieves the one-month lifetime and is able to perform communication in high-reflective environments and performs estimation with an accuracy of about 1-2 meters.

E. Felemban et al. presented a detailed survey on various applications supported by the underwater sensor communications in the paper entitled "Underwater Sensor Network Applications: A Comprehensive Survey." The authors have classified underwater communication applications into five categories. These include applications for monitoring, disaster prevention, military objectives, navigation, and supporting sports events offshore and onshore. Furthermore, the authors subclassified these classes. Currently, the pace of research in the area of Underwater Sensor Networks (UNWSNs) is slow due to the difficulties in applying most of the terrestrial WSNs state-of-the-art to the underwater

environment. Most of the underwater deployments depend on acoustic signals for enabling communication combined with special sensors having the capacity to take on various environmental changes of the oceans. However, sensing and subsequent transmission tends to vary as per different subsea environments; for example, deep sea exploration requires all together a different approach for communication as compared to shallow water communication. In this survey, the authors provide most recent developments in UNWSN applications and their deployments for monitoring and control of underwater conditions. Finally, the challenges and opportunities faced by recent deployments of UNWSN are provided for researchers and other relevant personnel to follow the research roadmap.

The authors in "High Throughput Receiver Structure for Underwater Communication" highlighted the effect of long multipath spreads in underwater acoustic channels. Those extended paths may cause intersymbol interference as well as resulting in Doppler shift due to the relative source-receiver motion. Therefore, in order to improve the system performance and throughput in the presence of these major hindrances, this paper proposes consecutive and iterative BCJR equalization for a long packet size. For this purpose, the long packet has been divided into small consecutive packets, and previous packets are used to estimate channel information required for compensation of the subsequent packets. Simulation results show that, in comparison with various decoding schemes, the proposed work gets less error rates. Moreover, the simulation scenario is based on real experimental data measured on a lake in Mungyeong city.

C.-H. Hwang et al. in their paper titled "Doppler Estimation Based on Frequency Average and Remodulation for Underwater Acoustic Communication" proposed the more reliable Doppler estimation method based on the existing technique. Furthermore, this paper also proposed a remodulation method that is able to estimate the time-varying channel parameter during the payload. The authors further compared the performance of the proposed remodulation method with the conventional method in the simulation environment with white Gaussian noise and the Doppler effect. It has been reported that the uncoded BER of the proposed method was lower than that of the conventional packet method. The communication performance got improved when the recursive frame length was shorter. The results of the sea experiment illustrated the prospective for an improvement in the performance, when the communication system used the proposed remodulation method. When recursive frame length is 250 symbols, communication performance with the previous frequency estimation method depreciated, whereas the proposed frequency average method presented stable performance. In particular, it is evident from the results that the communication performance is improved by up to significant levels using the two proposed methods.

As we have seen so far, in Underwater Sensor Networks (UNWSNs), few key problems have attracted more and more attention, including, but not limited to, the power consumption, performance of multiple access, and complexity of the node. The authors in a paper titled "Design and Detection of Multilinear Chirp Signals for Underwater Acoustic Sensor Networks" got motivations by finding reduced power consumption and improved performance of multiple access in UNWSNs and proposed a Multilinear Chirp-Code Division Multiple Access (MLC-CDMA) scheme. To be specific, the differences between single slope chirp signal and multilinear chirp signal are analyzed in the paper. For example, a new detection technique called mixing-change rate along with fractional Fourier transform (MCR-FrFT) is proposed at the receiving end, to detect the multirate chirp (MRC) signal and reduce complexity of the node. Moreover, the authors have presented two steps to detect MCR-FrFT. Extensive simulation results are presented at the end of the paper. By using the MCR-FrFT, the computation of detection can be decreased to 50% compared with direct FrFT. Moreover, by using the MCR-FrFT technique, the different users' signal can be rapidly detected and separated.

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