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Submarine Wireless Sensor Network and Ocean Pollution Avoidance

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ABSTRACT: There are various uses, such as oceanographic data collection, emissions control, flood management, aided navigation, tactical surveillance applications, and discovery of natural underwater marine resources, to be able to accurately communicate underwater. In this paper, for the identification of ocean emissions, we have established a fully decentralized ad hoc wireless sensor network. In order to optimize the lifespan of the network and also to boost its quality of operation, we priorities the implementation of sensors, protocol stack, the synchronization algorithm and the routing algorithm.There are various uses, such as oceanographic data collection, emissions control, flood management, aided navigation, tactical surveillance applications, and discovery of natural underwater marine resources, to be able to accurately communicate underwater.

KEYWORDS: Autonomous Underwater Vehicles (AUV), Buoys, Unmanned Undersea Vehicles (UUVs), Underwater Wireless Sensor Network (UWSN)

INTRODUCTION

There is a tremendous opportunity for the deployment of wireless sensor networks to the aquatic domain to track the health of the river and marine ecosystems. 70% of our world is protected by the ocean alone, and rivers and lakes are vital to our well-being. The quest for offshore oil deposits is moving into deeper and deeper waters, and more and more massive tankers are shipping crude oil and oil products across the globe[1]. As a consequence, oil emissions pose a significant danger to the biodiversity of the seas around the world. Worldwide, the volume of oil spilled annually has been measured at over 4.5 million tonnes.Operational discharges from tankers are the main contributor to oil emissions in the waters of the world (about 45 per cent) (i.e. oil dumped during washing operations). Via such activities, nearly 2 million tonnes of oil are introduced annually, similar to one full-tanker tragedy per week[2]. Just 7% of the oil in the sea can be traced specifically to spills. A major contributory factor is land-based sources, such as urban waste and industrial discharges, which enter the ocean through rivers.It is difficult and costly for humans to track the underwater environment: divers are limited in the hours and depths at which they can work and need a boat on the surface that is expensive to operate and subject to weather. Some Underwater wireless network models have been proposed in recent papers, where Autonomous Underwater Vehicles (AUV), Unmanned Underwater Vehicles (UUVs) and Buoys are used to periodically accept and send sensor data to the base station. We say that, in most situations, this is not the correct solution[3]. They are expensive, require a great deal of resources and cannot be used effectively for time-critical applications such as ocean emissions monitoring.

Compared to the current literature, the key contributions of our work are the following:

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1. We have introduced a truly decentralized ad-hoc wireless sensor network model where the nodes interact by neighbors (ad hoc network paradigm).
2. Currently in use, we prefer short-range acoustic communication (50-500 m) to long-range communication (1-90 Km).
3. For almost uniform battery waste by the deployed sensors, we have developed a novel node synchronization protocol.
4. The Underwater Wireless Sensor Network (UWSN) has several big obstacles due to the different existence of the underwater environment and the applications of its terrestrial counterpart:

    - instead of satellite, acoustic communication;
    - costly relative to terrestrial sensor nodes, and thus sparse sensor deployment;
    - Bandwidth limited;
    - higher & complex delay of propagation;
    - it cannot be recharged by underwater solar power;
    - fault-prone due to fouling and corrosion;
    - the underwater channel, especially due to multi-path and fading, is seriously impaired; hence, high bit error rate & transient communication losses;
    - includes topology which is self-configurable;
    - The GPS system doesn't function well under water. To counter all these issues and boost the performance, we have created a new protocol stack for the UWSN.

The Protocol Stack for UWSN:

A UWSN protocol stack can integrate power knowledge and control, and facilitate communication between the sensor nodes. It can consist of the features of the physical layer, data communication layer, network layer, transport layer, and device layer[4]. A power control plane, a communication plane, and a localization plane could also be included in the protocol stack.

I. Power Management Plane :

In order to increase the network lifespan, the power management plane is responsible for using the proper synchronization protocol. Since the coverage range of each node is r, it is unnecessary for a total of m ∗ (a / r) 3 nodes to stay operational throughout the entire network lifespan. The nodes are regularly in active mode and sleep mode with a time span of T sec. With regard to the Dominant-Pruning Algorithm, developed by Dai and Wu, as the basis, we modelled our synchronization protocol for the UWAN. But, because of three major difficulties, we cannot use the Dominant-Pruning Algorithm in its original form:

- In particular, the Dominant- Pruning algorithm was optimized for Static Nodes. But nodes from UWSN are mobile.
- The associated dominant set of sensors in this algorithm tracks the other nodes in their neighborhood. But, we need absolute volume coverage instead of maximum node coverage.
- The algorithm also determines node priority exclusively by node identifiers. But the protocol for synchronization needed for our UWAN must also be energy-efficient.

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II. Coordination Plane:

Time synchronization of both sensors is the duty of the Coordination Aircraft. Synchronization is performed over each time interval of t sec. Because synchronization is done after each time interval of T sec, the nodes do not need to be synchronized correctly with regard to real time; synchronization with regard to each other will serve our function instead[5]. We use the receiver-to-receiver synchronization technique here, rather than sender-to-receiver synchronization.This method utilizes the property of the physical transmitted medium that if any two receivers transmit the same message in a single-hop transmission, they receive it roughly at the same time. Instead of interacting with the sender, the receivers communicate with each other and calculate their offsets depending on the difference in receiving times. The apparent gains are the reduction in message overhead and even the decrease in variation in message latency. We may also opt to construct a table of parameters that connect the local clock of each node to the local clock of any other node in the network, instead of correcting the clock time of each sensor.Using the table, local timestamps are then compared[6]. In this way, thus making the clocks run undisturbed, a global timescale is maintained. It is possible to conserve a significant amount of electricity in this manner.

III. Localization Plane:

In order to send a data packet to the sink, the localization plane is responsible for reminding each node about its neighbors and also allows a node to choose its best neighbor. The function of this plane is thus aligned with that of the network layer and is discussed in the sub-section of the Network Layer.

IV. *Physical Layer:*

Since electromagnetic waves are unable to transmit in seawater over long distances, acoustics offer the most obvious option of medium to allow contact underwater. The carrier frequency in this domain is comparatively low, i.e. the synchronization signal is transmitted over the transmission line, and the Doppler shift will be immediately compensated if the Doppler shift synchronization signal automatically compensates for the Doppler shift data signal. For situations where the two modems are in more or less continuous contact, the Extended Kalman Filter (EKF) may be used to detect the Doppler change of the peer modem in real time.

V. Data Link Layer:

Time-varying multi-path propagation and non-Gaussian noise are two of the key factors in shallow water that restrict acoustic contact. The multi-path transmission of time-varying increases inter-symbol interference (ISI) and induces frequency-dependent fading, thus limiting the speeds of communication data[7][8]. We suggest that to boost underwater acoustic communications, Direct Sequence Spread Spectrum (DSSS) communication can be implemented with Chaotic Synchronization techniques. The benefits are:

- Spectral density with low power,
- Limited service by intervention,
- Due to unknown random codes & excellent anti-jam results, anonymity,
- robustness against different channel imperfections, e.g. multi beam scattering or muffling,
- solutions for random access,
- The propagation of the data-signal frequency spectrum using code not associated with the signal results in much higher bandwidth occupancy than necessary, appropriate for UWSN's restricted bandwidth acoustic communication.

VI. Network Layer:

In two steps, our routing protocol runs.

Localization: The sink transmits an interest over each t-sec time cycle. The entry of interest involves a gradient field. A gradient is an answer link to a neighbor from whom the interest was derived from. Several pathways may be defined by using interests and gradients. Also, each node becomes conscious of its neighbors in this way.

Routing: If a U node has a data packet to transmit, its next neighbor will be picked.

CONCLUSION

Underwater connectivity is comparatively older with long-range (1-90 Km) acoustic modem. But such processes are power hungry and costly. In this article, using short-range (50-500 m) low-cost sensors, we have listed a novel alternative possibility of time-critical underwater communication. Our key objective is that to make it possible to buy and install several underwater sensor nodes, the modem should be cheap. Multi-hop routing over multiple individual nodes may achieve long-range connectivity.Focusing on short-range communication, in particular, ensures that we can expand the usable acoustic bandwidth and eliminate many of the long-range underwater communication difficulties, thus significantly simplifying the architecture of the modem. In addition, we have proposed a new synchronization protocol that will ensure complete volume coverage, boost QoS, and increase the lifespan of the entire network.

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