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RESEARCH ARTICLE

Confronts and Applications in Marine Sensor Networks

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Abstract
Most of the researches of sensor network work on terrain but there is lot of scope in transforming communications in underwater. The marine environment is heterogeneous and vast in both surface area and volume. The sensors equipped in oceans help in gathering of scientific data, monitoring disasters and pollution. The protocols developed face multiple challenges limited processing capability and memory, power conservation, marine fowling of equipment, communication difficulties and limited accessibility of updating sensors. The cost of deploying underwater sensor is high when compared to other regions. This makes deployment in underwater very challenging. This paper seek to identify the key issues and application aspects faced in marine based communication of sensor network platform, which are not much highlighted or emphasized in underwater survey.

1. Introduction

Wireless sensor networks (WSN) have little or no infrastructure. It consists of a number of sensor nodes working together to monitor a region to obtain data about the environment. There are two types of WSNs: structured and unstructured. An unstructured WSN is one that contains a dense collection of sensor nodes. Sensor nodes may be installed in an ad hoc manner into the underwater. Once installed, the network is left unattended to perform monitoring and reporting functions. The network maintenance in managing connectivity and detecting failures is difficult since there are so many nodes.
The Structured network has fewer nodes deployed in pre-planned manner. They have lower network maintenance and low cost. They are planned in such manner that no region is left uncovered.
The wireless Sensor technology is with unlimited numerous application area including environmental, medical, military, transportation, crisis management defense. Autonomous underwater vehicles are used for exploration and gather data from sensor nodes. When compared to a dense deployment of sensor nodes in a terrestrial WSN, a sparse deployment of sensor nodes is placed

underwater. The underwater uses acoustic wave communication. The underwater acoustic communication faces the limited bandwidth, signal fading and long propagation delay.

Another challenge in underwater sensors failure is because of environmental conditions. They have to adapt to harsh ocean environment conditions and should be able to self configure. They cannot be replaced or recharged which requires efficient underwater communication and networking performance.

2. Basic Component of Wireless Sensor Network

The WSN is built by group of nodes – from a few to several hundreds or even thousands, where each node is connected to one (or sometimes several) sensors. Each such sensor network node has typically several parts: a radio transceiver with an internal antenna or connection to an external antenna, a microcontroller, an electronic circuit for interfacing with the sensors and an energy source, usually a battery or an embedded form of energy harvesting. A sensor node might vary in size from that of a shoebox down to the size of a grain of dust, although functioning "motes" of genuine microscopic dimensions have yet to be created. The cost of sensor nodes is similarly variable, ranging from a few to hundreds of dollars, depending on the complexity of the individual sensor nodes. Size and cost constraints on sensor nodes result in corresponding constraints on resources such as energy, memory, computational speed and communications bandwidth. The topology of the WSNs can vary from a simple star network to an advanced multi-hop wireless mesh network. The propagation technique between the hops of the network can be routing or flooding.

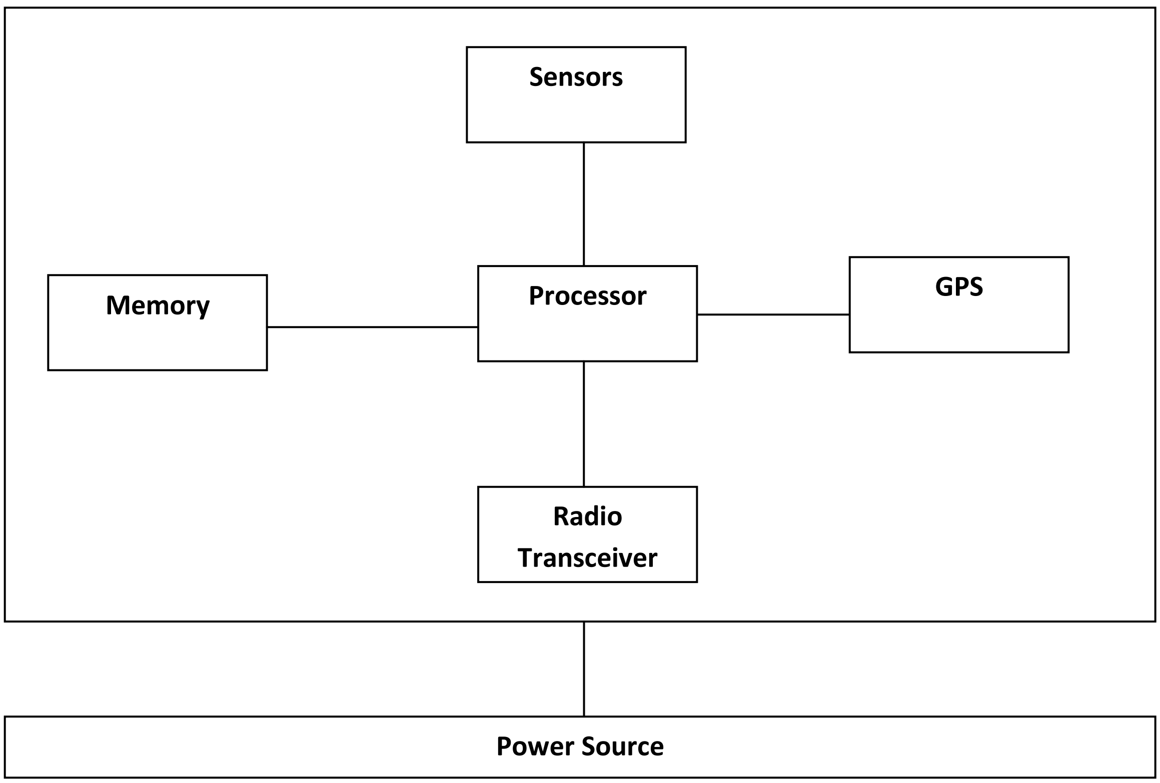

Fig1. Components of WSN Node

Figure 1 shows the components of a sensor node. Each node consists of processing capability, may contain multiple types of memories, have RF transceiver with antenna, have power source and accommodate various sensors and actuators.

Underwater wireless sensor nodes consist of a number of sensor nodes and vehicles deployed underwater. Classic underwater wireless systems are established through acoustic waves.

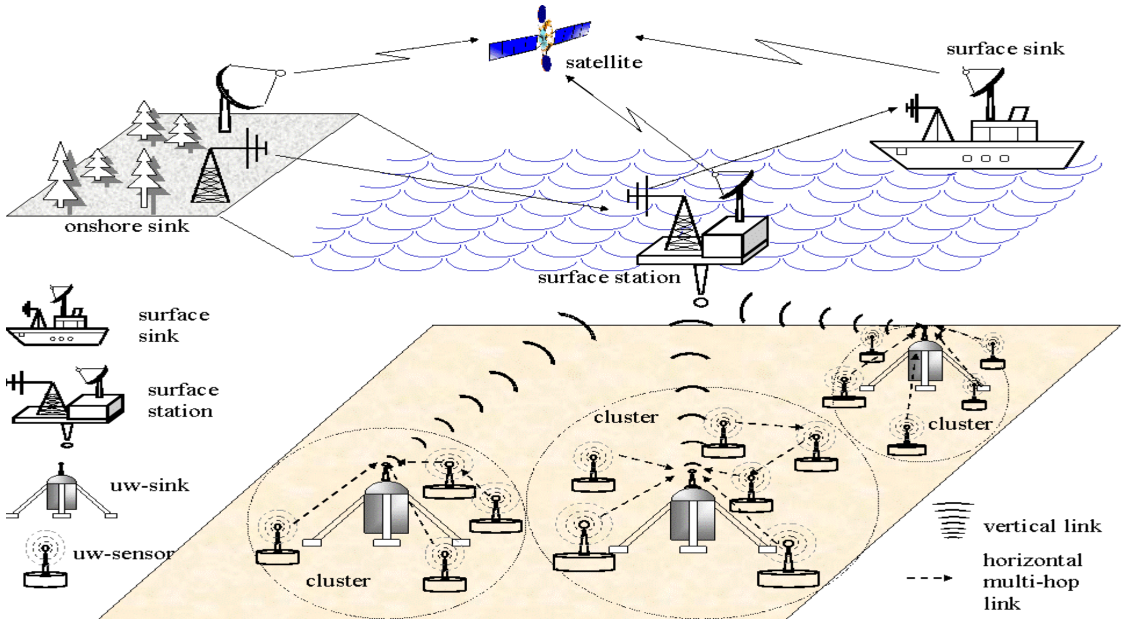

Fig2. Architecture of 2D underwater sensor networks REF- Georgia Institute of Technology

The above figure2 is reference architecture for two-dimensional underwater networks. A group of sensor nodes are anchored to ocean bed with deep ocean anchors. The Underwater sensor nodes are interconnected to one or more underwater (UW) sinks by means of wireless acoustic links. Uw-sinks, as shown in Fig. 4, are network devices in charge of relaying data from the ocean bottom network to a surface station. To achieve this objective, uw-sinks are equipped with two acoustic transceivers, such as a vertical and a horizontal transceiver. [3]The horizontal transceiver communicates with sensor nodes which send commands and configures the data. The data so collected are monitored. The vertical transceiver is used relay data to the surface station. Sensors are connected to uw- sinks using direct link or multihop paths.

Table 1. Comparison between Underwater and Terrestrial Wireless Sensor Network

	Sensor	Energy	Communication Module	Speed	Communication Signal	Manner of Working	Hardware Configration	Cost
UWSN	Pressure, Ray, Acoustical, Magnetic Sensor	Battery, Solar Energy, Tidal Energy	Sound MODEM	slow	Acoustical Signal	Reactive	Higher order and Path overhead	Relatively expensive
Terrestial Sensor Network	Light, Temperature, Humidity, Shock Sensor	Solar, Wind energy, Electricity	Radio Frequency Module	fast	Electromagnetic wave, RF, Acoustical Signal	Proactive	Low	Relatively Low

3. Confronts in Under waters

The underwater communication is currently rapidly growing research area. But it has many hurdles, which produces big gap between the communication technology for terrestrial and underwater application. It has to deal with interferences of dynamic nature of water. There are many issues to be considered such as attenuation, transmission distance, SNR ratio, symbol interference, power consumption, bit error, modulation strategies, underwater interferences and error coding.

a) Optical Wave

The optical wave produces high data rate transmission. But the signal can be easily absorbed in water and suffers from scattering effect **[1-3].** This will affect data transmission accuracy.

b) Acoustic wave

This is most used signal as carrier for many applications, since it as characteristic of low absorption, needed for underwater communication. The data transmission is slower compared to signals.

The propagation speed of sound in water is typically 1500 m/s, five orders of magnitude lower than light speed. The acoustic links have low bandwidth and low quality due to the chemical-physical properties of the water medium such as temperature, salinity, density and spatio-temporal variations.

c) Energy problem

Most of the sensor network applications both terrestrial and underwater suffer energy consumption. There are ongoing researches which focus on the ways to reduce radio cycle to save energy. The energy constraint is more important constrain than in terrestrial networks because recharging few kilometers below the sea is difficult and expensive. The underwater wireless acoustic networks protocols are designed to minimize energy consumption through sleep modes and local synchronization. The research community is still concerned with maximizing lifetime of networks from finite electro chemical primary cells.

In underwater acoustic networks, transmit power is about 100 times more than receive power. A standard acoustic modem currently uses about 0.2W for incoming packets, between 0.2W and 2W for equalizing and decoding packets (depending on the packet's data rate), and typically 50W for transmitting [7].

Although energy on AUVs is clearly limited, there will be important underwater networks for which network communication energy efficiency is not a primary concern. For many AUVs, the propulsion power dominates network communication power. For many AUVs, the propulsion power dominates network-communication power. For high-speed AUV missions, network communication energy can be neglected, whereas it is critical for long-duration glider missions [8].

d) Deployment

The problem is most challenging for deep water applications because it is very difficult to deploy a lot of anchor nodes in accurate locations. We can also use remotely operated underwater vehicle (ROV) to be remotely suspended into sea with respect of ship position based on the application.

The underwater instruments such as modems, sensors, robots or batteries are not cheap or disposable. There are several types of acoustic movements available providing few kbps in kilometers but they are still in experimental research.

Mobility and density are two parameters that vary in deployments of underwater. The underwater sensors can be deployed as static or mobile. In static the individual nodes are attached to docks and anchored to seafloor.

The mobile underwater are suspended from buoys that are deployed by ship and they are temporally used and left in place for hours or days. The battery powered static deployments are energy constrained. Mobility of sensor maximizes coverage with limited hardware but it raises challenges of localization, maintaining topology and connected network. When compared to terrestrial network density, coverage and number of nodes are less dense, longer range with fewer nodes [4].

In deep water installation, the manifolds and resolution have to be installed accurately in specified spatial positions and compass within right limits, which include rotational, vertical and lateral measurements. The signal from under water sensor node is relayed to the bridge of the installation vessel for overall strategy.

Metrological measurements have to be performed after the positioning of the structures on the seabed to measure the dimension between adjacent templates. The anchor nodes on the seabed help in positioning automated underwater vehicle. Underwater deployments will be harsh and requires periodic maintenance.

e) Environment condition Problem

A challenge in underwater wave propagation is different from terrestrial application. The water will itself be a main source for signal interference. The deployment showed, the variability in conditions in environmental area, type of water, dissolved impurities, depth pressure, water composition and temperature affect sound propagation. Other prodigy facts of terrestrial like scattering, refraction, reflection also occurs.

f) Data rate

There is tradeoff between power and channel bandwidth. The acoustic communications provide low data rate. The requirement is to communicate than ability to send large data.

g) Multipath

Another challenge in communication over water is multipath reflected from water surface which interfere with waves directly. The orientation of the antenna changes in bad or wavy weather condition. Multi-path propagation may be responsible for severe degradation of the acoustic communication signal, since it generates Inter-Symbol Interference (ISI). Multipath interference is common in underwater acoustic networks, causing frequency range of the channel. This frequency-dependent interference is generally caused due to surface waves or vehicle motion, causing fading. The multi-path geometry depends on the link configuration.[2] Vertical channels are characterized by little time dispersion, whereas horizontal channels may have extremely long multi-path spreads, whose value depend on the water depth.

h) **Noises**

The noises can be man-made noise or Ambient Noise. The man-made noise are caused by machinery noise (pumps, reduction gears, power plants, etc.), and shipping activity (hull fouling, animal life on hull, cavitations). The ambient Noise is related to hydrodynamics (movement of water including tides, currents, storms, wind, rain, etc.), seismic and biological phenomena.

4. Applications

Underwater study is platform used for long-term seismic monitoring, monitoring of coral reefs and fisheries. They are widely used in military surveillance, leak detection, hazardous environment exploration and support for underwater robots. Design constraints are based on the monitored environment.

a) Seismic monitoring

The seismic monitoring helps in oil extractions from underwater area. Similar to terrestrial oil fields which are monitored in frequent period basis, frequent seismic monitoring is required for oil extraction in underwater also. The problem is unlike terrestrial frequently monitoring is challenging in underwater because it is difficult to deploy a permanent sensor in underwater fields. Here the ships with hydrophones and air cannons are used as actuators. This increases the both capital the operational cost [7].

b) **Monitor and Control of equipments**

Underwater equipment monitoring is another example application. Long term monitoring is done for the existing infrastructure. The temporary monitoring is used when the equipment is first deployed in sea, to confirm successful deployment. Temporary monitoring requires low power and wireless communication. Once successfully connected it is easy to control and remotely operate the equipment with acoustic sensor networks.

c) Robots in underwater

A robot or group of robots supports to coordinate pollutions, equipment monitoring, oil leaks and chemical leaks. The coordinated action is needed monitor above operations along with study of biological phenomena. Generally the underwater robots are autonomous and coordinate the deployment .the data rates in robots coordination is low which reduces the delivery of commands. The robots coordinate chemical.

d) Military Security

This is an important application, which requires secured protocols and mechanisms to maintain data confidentiality and integrity. It includes monitoring of port facilities, communications between ships and submarines. The existing mechanisms are not sufficient which are mostly based on the terrestrial wireless sensor networks. Underwater suffers from interferences multipath propagation, limited bandwidth, low data rates, signal fading and long transmission delays.

5. Conclusions

The sensor networks are gaining popularity due to various applications in spite of technical challenges. The need of applications drives the development of underwater sensors and networks. Though there is advancement in underwater sensors in recent years, still numbers of issues remain to be solved. We have summarized practical problems that are to be addressed and difficulties over terrestrial sensors. The Underwater network protocols will have to adapt to various different optimization measures for each regime of different applications. They have the potential to ease the deployment and provide real-time access to databases and remote resources. New models which use analytical and computational are needed. The usage of test beds and field experiments is crucial, which will support accurate performance analysis and its characterization.

Wireless Sensors operates on insecure transmission medium and environment. The security in Wireless Sensor network is more challenging and complex to provide application to military in underwater. Knowledge of security vulnerabilities is important steps in overcoming the limitations. In this paper we have summarized the research challenges in underwater sensor including its potential applications.

In addition, it can be further broadening the field to consider different options, across from high-performance (and cost) to low-cost (but lower performance), and including mobile (human-supported or autonomous), deployable and stationary configurations.

References

[1] Liu,L et al. (2008). Prospects and Problems of Wireless Communication for Underwater Sensor Networks, Invited Paper Wiley WCMC, pp 977-994

[2] J. Heidemann, W. Ye, J. Wills, A. Syed, Y. Li, Research challenges and applications for underwater sensor networking, in: Proceedings of the IEEE Wireless Communications and Networking Conference, IEEE, Las Vegas, NV, USA, Vol 1,2006, pp. 228-235

[3] W. S. Burdic. Underwater Acoustic Systems Analysis. Prentice-Hall, 1984.

[4] Hainan Chen, Xiaoling Wu, Yanwen Wang, Guangcong Liu, Lei Shu, Xiaobo Zhang , Dynamic Underwater Sensor Network Architecture Based on Physical Clustering and Intra-cluster Autonomy, Springer-Velag Berlin Heidelberg Volume 418, 2014

[5] Liu, L., Wang, R., Xiao, F.: Topology control algorithm for underwater wireless sensor networks using GPS-free mobile sensor nodes. Journal of Network and Computer Applications 35(6), 1953–1963 (2012)

[6] Park, M. K. & Rodoplu, V. 2007 UWAN-MAC: an energy-efficient MAC protocol for underwater acoustic wireless sensor networks. IEEE J. Oceanic Eng. 32, 710–720. (doi:10.1109/JOE.2007.899277)

[7] J. Heidemann, Y. Li, A. Syed, J Wills and W. Ye, “Research Challenges and Applications for Underwater Sensor Networking”, Proceedings of the IEEE Wireless Communications and Networking Conference (WCNC2006), April 3-6, 2006, Las Vegas, Nevada, USA.

[8]http://www.ece.gatech.edu

[9] L.Freitag, June 2006. Personal communication.

[10] R.Stokey et al. Enabling Technologies for REMUS Docking: An Integral Component of an Autonomous Ocean-Sampling Network. IEEE J. Oceanic Eng., 26(4):487–497, Oct. 2001.

[11] J. Garcia, “Positioning of sensors in Underwater Acoustic Networks”, Proceedings of the MTS/IEEE OCEANS Conference, Sep 19-23, Washington DC, USA.

[12] Z. Zhou, J.-H. Cui and A. Bagtzoglou, &ldquo,Scalable Localization with Mobility Prediction for Underwater Sensor Networks,&rdquo, Proc. IEEE INFOCOM ',08, 2008.

