# Architectures and Localization Scheme For Underwater Acoustic Sensor Network

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*Abstract*— Underwater Wireless Sensor Networks (UWSNs) provide a new opportunities to examine and predict the activities of aquatic environments. Some applications such as target tracking , disaster prevention etc where sensed data is worthless without any location information. Localization is the process of estimating the location of each node in a sensor network. In underwater sensor networks (UWSNs) determining the location of each sensor is of critical importance. Various localization algorithms have been proposed for terrestrial sensor networks, there are comparatively few localization schemes for UWSNs and even fewer for polar environments under ice. Numerous localization protocols currently exist for terrestrial applications. However, there are prohibitive obstacles which prevent the application of terrestrial-oriented localization techniques to an underwater environment. In this paper, for extending the field in underwater environments, we study various sensor localization technique for underwater wireless sensor networks (UWSNs). In underwater environments, radio frequency (RF) signal is not suitable for underwater usage because of extremely limited propagation. Since for that reason UWSNs should be constituted with acoustic modems. This work is about improving Localization mechanisms in Underwater Sensing Networks and node traceback.

***Key words:*** wireless sensor networks, underwater acoustic communication, underwater sensing Networks, localization problem, sensing networks..

## I. INTRODUCTION

UWSNs are deployed in the oceanic environment that consists of hundreds or thousands sensors operational with acoustic modems that facilitate them to communicate wirelessly with one another. Sensor localization is the process for each sensor node to locate its position in the network. Recent advancement in hardware and network technology had enabled wireless sensor networks capable of sensing, data processing, and communication. A collection of wireless sensor nodes, which have a limited sensing capacity, processing power, and energy, can be arbitrarily deployed in an ad-hoc fashion and connected to form a network in order to examine a extensive area.In underwater acoustic sensor networks (UASNs) predictable large, costly, individual ocean monitoring equipment units are replaced by moderately small and less expensive underwater sensor nodes that are able to converse with each other via acoustic signals. In underwater, radio signals attenuate rapidly, therefore they can only travel to short distances while optical signals scatter and cannot travel far in adverse conditions, as well [2].Further, acoustic signals attenuate less, and they are able to travel further distances than radio signals and optical signals. Consequently, acoustic communication emerges as a convenient choice for underwater communications. However there have been several challenges. The bandwidth of the acoustic channel is low, hence the data rates are much lower than they are in terrestrial WSNs. Moreover, the acoustic channel has low link quality [3] which is typically due to the multi-path propagation and the time-variability of the medium. Therefore the data rates are much lower than they are in terrestrial WSNs. Moreover, the speed of sound is slow (approximately 1500 m/s) yielding large propagation delay.

### A. STRUCTURE OF UWSN:

Basically there are four different types of nodes in the UWSNs. At the lowest layer, a large number of sensor nodes have been deployed under the sea floor. They gather the data through attached sensors and converse with other nodes through short-range acoustic modems. They operated on batteries, and to work for longer periods, they spend most of their life at sleep condition. At the top layer there are one or more control nodes connected to the Internet. These control nodes may be positioned on an off-shore or on-shore; these nodes may have a large storage capacity to buffer data, and an access to ample electrical power. Control nodes can communicate directly with the sensor nodes. The third type of nodes, called reference (sink, buoy) node.

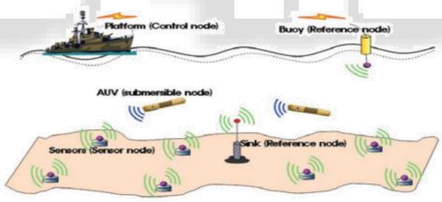


Fig. 1 : Structure of UWSN

They can access to the high speed networks, and can relay data to the base station very efficiently. Reference nodes allow much richer network connectivity, creating several data collection points for the underwater acoustic network. Lastly the forth type of nodes, called submersible node (AUV), which are likely to move around the network, are interacting with our system via acoustic communications.

### B. UWSN APPLICATIONS:

#### 1) Ocean Sampling Networks

Networks of sensors and AUVs can do synoptic, cooperative adaptive sampling of the 3D coastal ocean environment. It brings together the complicated new robotic vehicles with advanced ocean models to progress our ability to observe and predict the characteristics of the oceanic environment.

#### 2) . Environmental Monitoring:

Pollution monitoring , monitoring of ocean currents and winds, understanding and improved weather forecast, detecting climate change predicting the effect of human activities on marine ecosystems, biological monitoring like tracking of fishes or micro-organisms, are other likely applications.

*3) Disaster Prevention:*

Sensor networks that measure seismic activity from remote locations offer tsunami warnings to coastal areas and keep below surveillance submarine volcanoes. Frequent seismic monitoring is of great importance in oil extraction, since its challenging nature.

*4) Assisted Navigation:*

Sensors can be used to place dangerous rocks or shoals in shallow waters, and submerged wrecks, mooring positions.

*5) Distributed Tactical Surveillance:*

AUVs and fixed underwater sensors can collaboratively watch areas for surveillance, targeting and intrusion detection systems reconnaissance.

*6) Mine Reconnaissance:*

The simultaneous operation of numerous AUVs with acoustic and optical sensors can be used to do rapid environmental assessment and notice mine like objects.

### *C. C. LOCALIZATION ALGORITHMS:*

The authors classify localization algorithms into two categories [7]: range-based algorithms and range-free algorithms. The earlier contains the protocols which calculate locations of unknown nodes by estimating absolute point-to-point distances or angles, while the later makes no assumption about the availability or validity of such range information. Though range-based schemes can provide more accurate position estimations , they need an additional hardware for distance measurement, which leads to the raise in the network cost correspondingly. Comparatively, range-free schemes do not require additional hardware support. Though, range-free schemes can only provide coarse position estimations. Localization algorithms also can be classified into distributed and centralized [8].In distributed algorithms, each unknown node plays an important part in localization information collection and runs a distance estimation algorithm individually. While in centralized localization algorithms, central unit is responsible for estimating the location of each unknown node, due to which the burden of the central unit increases and further reduces the lifetime of the whole networks. Different techniques are available to calculate distances to other nodes like: Time of Arrival (TOA), Time Difference of Arrival (TDOA), Angle of Arrival (AOA) or Received Signal Strength Indicator (RSSI), while range-free localization schemes do not use range or bearing information. In contrast, range-free location estimation methods are based on connectivity information instead of distance or angle measurements [11].

## II. THEORETICAL FOUNDATION OF RESEARCH

Localization is known as location estimation of ordinary sensor nodes in a network. Mainly localization schemes need the location of some nodes to be known. These location-aware nodes are well-known as anchor or beacon nodes. A high energy Source node trace-back specifically designed for mobile UWSNs is proposed here. The distinguishing attribute of node trace-back is how it utilizes information about the spatial correlation of mobile sensor nodes to estimate the long dynamic propagation delays among nodes by tracking them hop by hop simultaneously.

Following are the Objectives of my work:

(1) To study various localization mechanisms in UWSNs, as UWSNs are very different from usual sensor Networks most of the algorithms do not apply to UWSNs, determining the location of each sensor is of critical importance and is often done by utilizing localization techniques.
(2) To formalize node trace-back procedure including all phases of the localization process. The node trace-back procedure consists of three phases: distance and delay estimation considering mobility between objects, linear regression, and calibration. Delay estimation acquires information about the spatial correlations of the mobile sensor nodes to accurately estimate the propagation delays.
(3) To design Implementation of the proposed method using appropriate tools, for example OMNET++, The implementation will model Node Localization in Underwater wireless sensing networks and help in target tracking etc, considering all the constraints of underwater sensing network.
(4) Generation of actual Underwater Scenario for testing the UWSN node Localization, the system will utilize the inbuilt mechanisms of the simulation tool for each node in the scenario. Each UWSN will be simulated individually.
(5) Finally, we will evaluate the performance in terms of various parameters which will test the localization of underwater sensing nodes.
(6) The results will be evaluated using appropriate plotting tools, if used OMNET++ inbuilt deep packet analyzer will be used.

## III. PRACTICAL IMPLEMENTATION AND RESULT

Localization mainly refers to the detection of spatial coordinates of a node or an object. Target tracking deals with finding spatial coordinates of a moving object and being able to track its movements. In the location tracking scheme about 400 sensors are deployed in a rectangular fashion in a underwater environment such that the for base stations it is easy to track the nodes. The technique used for detection is the Hop by Hop tracking technique. The object is being tracked by the sensors, distance to it from a other sensors is also being calculated simultaneously. Using the distance information from the other sensors and location of object is predicted for every half second specified in senseInterval = 0.5. The Simulation area is 400m by 400m and the depth of underwater nodes is not considered in this simulation.

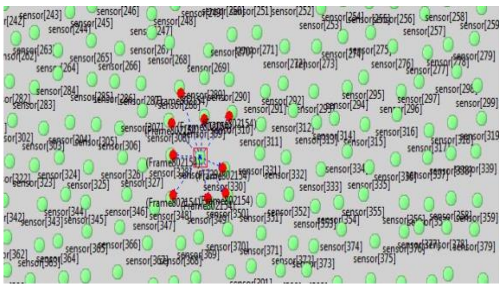

Fig. 2: Node discovery in UWSN

 

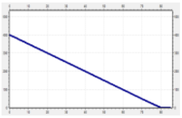

Fig. 3: Total energy vector

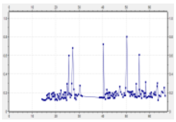

Fig. 4: End to End Delay between nodes in seconds

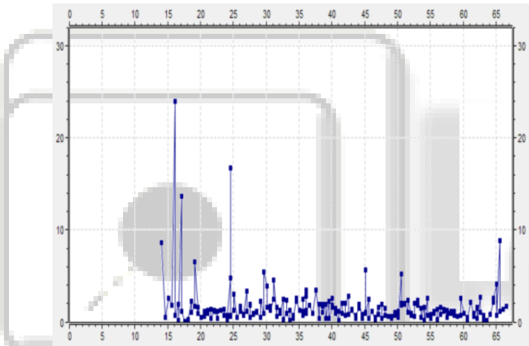

Fig. 5: Error Estimation vector

## IV. CONCLUSION

In UASNs, localization is a fundamental task where the location of a sensor can be used for data tagging, node tracking and target detection. Underwater networks of sensors have the potential to enable unexplored applications. These potential applications will be made viable by enabling communications among underwater devices. Underwater Acoustic Sensor Networks will consist of sensors and vehicles deployed underwater and networked via acoustic links to perform collaborative monitoring tasks. The main objective of this work was to analyze various localization mechanisms in UWSNs, as UWSNs are very different from usual sensor Networks most of the algorithms do not apply to UWSNs, determining the location of each sensor is of critical importance and is often done by utilizing localization techniques. Localization is a fundamental and important task in UASNs. Unlike in the terrestrial positioning, the global positioning system (GPS) cannot work efficiently underwater. The limited bandwidth, the rigorously impaired channel and the cost of underwater equipment all makes the localization problem very challenging. Mostly the current localization schemes are not well suitable for deep underwater environment. We need Trace back mechanisms to effectively find underwater nodes independently moving in underwater .We were able to accurately trace back about 400 UWSN and dealt with collision in the nodes effectively. The simulation results show that Hop by Hop trace back mechanisms is feasible in U-WSN and can provide about 92.67% of throughput .

## V. FUTURE SCOPE

In UASNs, localization is a fundamental task . There are some applications such as data tagging, node tracking and target detection that mostly depend on the location of a sensor. Recently underwater acoustic sensor networks (UASNs) have drawn much attention because of their great value in many underwater applications where human operation is hard to carry out. Due to harsh aqueous environments, non-negligible node mobility and huge network scale, the localization approach for large-scale mobile underwater sensor networks is very challenging. This research work was about Hop by Hop trace back mechanisms, by utilizing the mobility patterns of underwater nodes. Mobility prediction is an important issue even more critical for clustered base routing, which is required to control the network topology. In Future work we can further enhance our approach for different network topologies considering the essential factors such as energy , delay ,mobility , error etc and can also provide a realistic model for better outcomes.

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