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A ROBUST METHOD OF SELF-EVALUATION FOR UNDERWATER ACOUSTIC LOCALIZATION

Rohini.S. Nair, V.Gopi

Abstract— **Underwater localization (UWL) is one of most important technologies in Underwater Wireless Sensor Networks (UWSNs) since it plays a critical role in many applications. The variable speed of sound and the long propagation delays under water in addition to bandwidth limitations all pose a unique set of challenges for localization in UWSN. The nodes assigned are anchor and Unlocalized (UL) nodes, these nodes are permanently moving due to ocean current or self motion. In this paper, a new sequential algorithm for time synchronization and localization named as partial markov decision process. The time synchronization is calculated by analyzing the packet exchange between anchor and UL node. The localization accuracy is improved by self evaluating of UL node using Accelerometer and Compass. The complexity in localization can be improved by self evaluation of nodes. In the simulation part, the performance can be evaluated by comparing the algorithm with two benchmark localization methods and is done by using Cramer- Rao bound (CBR) method. The results show that the algorithm attains localization accuracy and time synchronization using only two anchor nodes.**

Index Terms— Anchor node, Cramer-rao bound, Localization Propagation delay, Time synchronization, Unlocalized node.

1. Introduction

MOre than 70% of our planet is covered by water it is widely believed that the underwater world holds ideas and resources that will fuel much of the next generation of science and business. The unique characteristics of the aquatic environment, namely huge propagation delay, absence of GPS signaling, floating node mobility, and limited (acoustic) link capacity, are very different from those of ground sensor networks.

The UWSN (under water sensor networks) relies on low-frequency acoustic communications because RF radio does not propagate well due to underwater energy absorption .The underwater acoustic link features extremely large latency and low bandwidth. Second, most of the nodes in ground sensor networks are stationary. For effective sensing, most of the underwater sensor nodes are constantly moving, except for some fixed fraction of nodes mounted on the sea floor. Even if the mission does not require motion and relocation, untethered underwater nodes will move due to water currents.

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In underwater sensor networks (UWSNs) [1], determining the location of every sensor is important and the process of estimating the location of each node in a sensor network is known as localization. Underwater applications ranging from early warning systems for natural disasters (like tsunami), ecosystem monitoring, oil drilling, military surveillance etc. The GPS signals are attenuated highly in underwater condition, difficult due to factors like multi-path propagation, time variations of the channel, small available bandwidth and strong signal attenuation, especially over long ranges. UWAL is difficult methods which is similar to indoor localization [2].

There have some method obtained for self-localization which is based on speed and direction measurement [3], [4].and some methods obtained performs better navigation capabilities for a short duration (accuracy about one meter for ten minutes of circular motion [3]).It have low accuracy as the period of duration increases, [5].In 2-dimensional underwater acoustic localization the node depth can be estimated using pressure probe and is used, thus requires 3 reference nodes in known location. It can be called as Anchor nodes. The node used should be capable of measuring the range of signal from the source. The motion due to water current and permanent movement of nodes causes change in nodes position [6]. The method is light weight and inexpensive, The UL node includes unmanned underwater vehicles (AUV), remotely operated underwater vehicles (ROV), manned vehicles and divers. Due to the MAC

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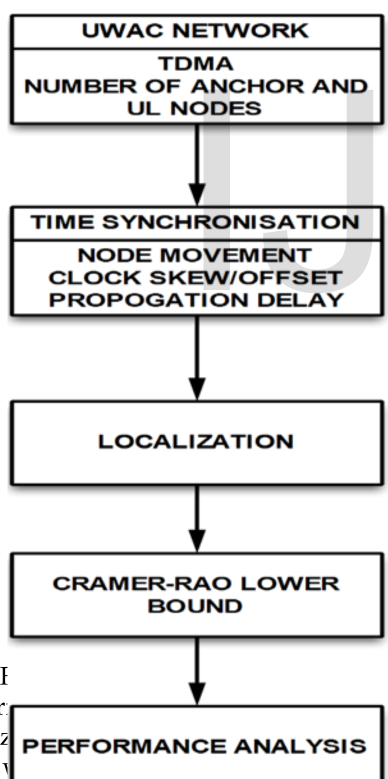
delays in packet exchange the anchor node is not capable to respond with the localization time [8],[9],[10].

In this paper, suggested a new algorithm to overcome the challenges caused in the UWAL. The algorithm suggested a self-evaluation method named partial markov decision process in sparse networks for joint time-synchronization and localization for underwater networks where already localized nodes often serve as anchor nodes. The main intuition behind algorithm is the use of relative speed and direction information available at the mobile UL node to compensate for node mobility. More specifically, instead of using designated localization packet exchange (which is necessary if node mobility is not compensated), we rely on periodic packet exchange between the network nodes.

2. BLOCK DIAGRAM AND ITS WORKING



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Our algor... hat both time-synchroniz... an be readily replaced ... chmarking the STSL perf... uses a two-step approach (shown in fig 1), in which first nodes are time-synchronized and then location is estimated.This characteristic renders our approach more flexible and easy to integrate into a UWAC system and also reduces communication overhead. The STSL algorithm uses a two-step approach, in which first nodes are time-synchronized and then location is estimated.

In both steps, the measured time of flight of packets exchanged between anchor and UL nodes and self localization data obtained at UL nodes are linked to the unknown location, synchronization (clock skew and offset),and propagation speed parameters through linearized matrix equations.

3. THE SEQUENTIAL ALGORITHM

The main intuition behind algorithm is the use of relative speed and direction information available at the mobile UL node to compensate for node mobility. This approach allows us to readily include the localization procedure as part of the operation of a communication network. More specifically, instead of using designated localization packet exchange (which is necessary if node mobility is not compensated), we rely on periodic packet exchange between the network nodes. The sequential algorithm can be sub catagories, Time synchronization and Localization.

2.1 Time Synchronization

Time synchronization is an important requirement for underwater acoustic communication, for delivering packets at specified time. A lot of time synchronization protocols have been proposed for terrestrial Wireless Sensor Networks (WSNs). A synchronization algorithm for UWSNs must consider additional factors such as long propagation delays from the use of acoustic communication and sensor node mobility.

Time Synchronization in wireless networks is extremely important for basic communication, but it also provides the ability to detect movement, location, and proximity. The synchronization problem consists of four parts: send time, access time, propagation time, and receive time. Ranging in wireless networks is usually performed by measuring the time of arrival (ToA), time difference of arrival (TDoA) and angle of arrival. The main objective of time synchronization is to provide estimate the propagation delays. This can be accomplished by sending packet though two way transmission. Due to the permanent motion of nodes the delay obtained may not be same. There should allow quantization mechanism to allow for difference in propagation delay of separate packet.

2.2 Localization

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The unique characteristics of underwater are huge propagation delay, absence of GPS signaling, floating node mobility, limited link capacity etc. Underwater localization is one of the most important technologies since it plays a critical role in many applications such as target tracking. If the Sender cannot obtain the accurate location information, the related applications cannot be accomplished. The main idea behind localization is to identify the position of unknown node using known coordinates. The sensor node transmits beacons with their coordinates in order to help other nodes localize themselves. The nodes commonly provided are Anchor node and unlocalized (UL) node. Anchor node act as reference node at known location and one or more unlocalized node, whose location is to be estimated. Thus assuming that the UL nodes are equipped with self evaluating their speed and direction using accelerometer and compass.

2.3 Partial markov decision process

A partially Markov decision process is a generalized form of Markov decision process (MDP). A POMDP models an agent decision process in which it is assumed that the system dynamics are determined by an MDP, but the agent cannot directly observe the underlying state. Instead, it must maintain a probability distribution over the set of possible states, based on a set of observations and observation probabilities, and the underlying MDP.

Nodes Description

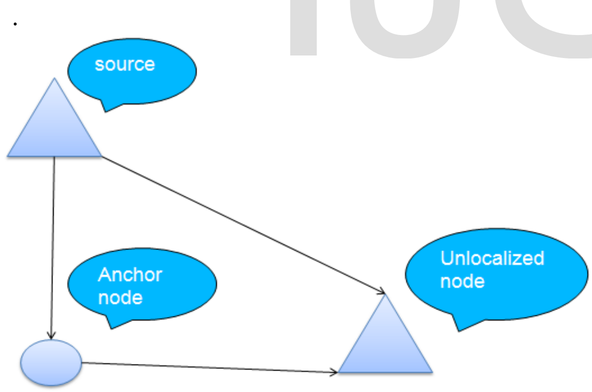

Fig.2. Schematic representation of nodes.

The Fig.2 shows the types of nodes used in the underwater localization. The nodes can be of two types Anchor node and unlocalized node. The anchor node is the permanent node fixed on the sea floor. It act as reference node for detecting unlocalized node. Due to the continuous motion of ocean water the position of node changes. The anchor node position can be estimated using pressure probes in 2D UWAL. During the unknown node localization process All the neighboring nodes which receive this beacon message can estimate their distances to this node using measurement techniques, such as ToA.

4. CRAME'R-RAO LOWER BOUND

The performance of STSL algorithm is analyzed by this method. It develop analytical expressions to lower bound the performance of any unbiased UWAL estimator, assuming nodes not to be time-synchronized and propagation speed unknown. In its simplest form, the bound states that the variance of any unbiased estimator is at least as high as the inverse of the Fisher information. An unbiased estimator which achieves this lower bound is said to be (fully) efficient.

5. RESULTS

We surveyed the UWAL and Time-Synchronization plays a critical role in UWAC. The variable speed of sound and the long propagation delays under water in addition to bandwidth limitations all pose a unique set of challenges for localization in UWSN. In this section, we summarize the main properties of these localization techniques, compare their performances and point out the open research problems. The simulation result represents the performance of the STSL.

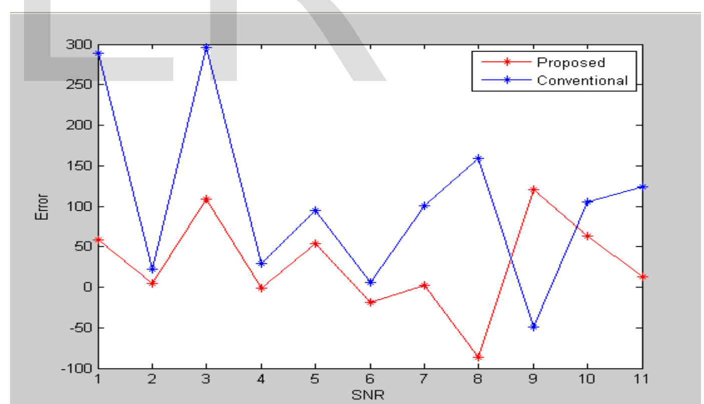

Fig.1. Comparison of Existing method as well as Proposed method

The figure shows the performance comparison of existing as well as proposed system. The existing system we analyze UL node Error in JLS method with proposed method STSL algorithm with respect to different channel SNR. The graph shows that the error rate is higher for existing system. The STSL method adopts more accurate signal transmission than JLS method.The signal to noise error depends on the channel disturbance. The figure above shows the different error estimation of nodes such as anchor node and unlocalized node. The error in the anchor node is called Anchor node error.

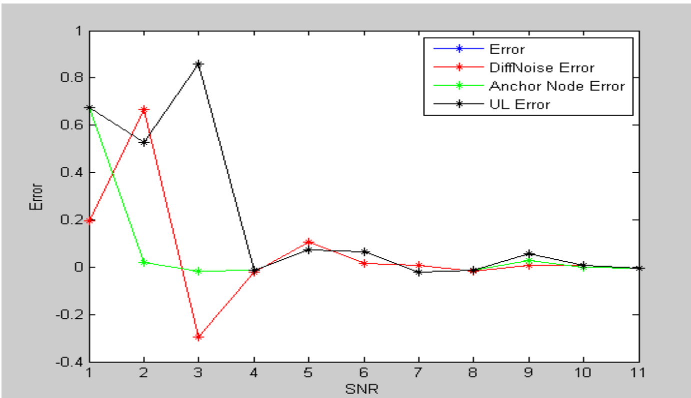

Fig.2. The error estimation of nodes under different channel condition.

The figure above shows the different error estimation of nodes such as anchor node and unlocalized node. The error in the anchor node is called Anchor node error. The unlocalized noise error is produced in unlocalized node. The difference noise error is compared difference between anchor node and unlocalized node. The graph estimates the error analysis between error and signal to noise ratio.

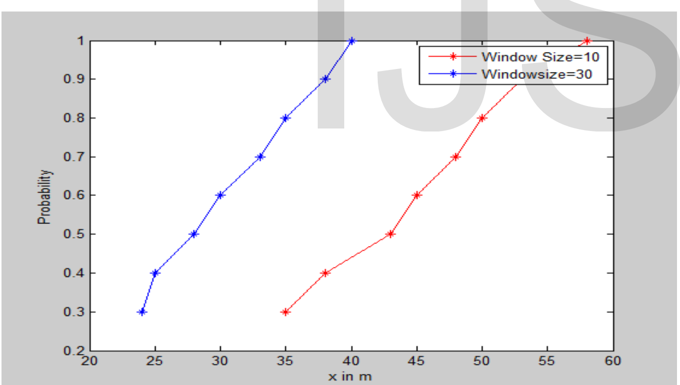

Fig.3.Probability Average Vs Node Distance.

The figure shows the probability average of two nodes for STSL algorithm. Here the slot size W=10, 30.In a single localization the average number of packet transmission

6. CONCLUSION AND FUTURE WORK

In this paper, we implement a new sequential algorithm for time synchronization and localization named as STSL algorithm. The time synchronization is calculated by analyzing the packet exchange between anchor and UL node. The localization accuracy is improved by self evaluating of UL node using accelerometer and compass. The complexity in localization can be improved by self evaluation. For evaluating performance, compare the algorithm with previous localization methods is done by using Cramer- Rao bound (CBR) method.

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