

VELOCITY ESTIMATION OF AN OBJECT MOVING IN UWSN USING REVERSE LOCALIZATION SCHEME

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Abstract-- Underwater sensor networks (UWSNs) has drawn considerable attentions from both academy and industry areas. Traditionally, the time synchronization algorithms are used for UWSNs to identify the localization and mobility of objects in under water as well as terrestrial. The algorithms such as TSHL, MU-Sync, and D-Sync are used in terrestrial and also in underwater sensor networks to address the long propagation delays but they all exhibits particular shortcomings because those algorithms assumes only negligible propagation delays among sensor nodes, the velocity of an object is not estimated and the efficiency is not up to considerable level. Hence, in UWSN, a new method called novel time synchronization is used to overcome the above said short comes. This method is more suitable for time synchronization, propagation delay analysis and improving mobility of objects. In Novel time synchronization, an algorithm called Reverse Localization Scheme is used for the sensor nodes to calculate the velocity and mobility of an object and time synchronization. With this method, very high accuracy with relative low message overhead and high efficiency can be achieved.

INTRODUCTION

Underwater sensor networks (UWSNs) have drawn considerable attentions from both academy and industry. On the one hand, UWSNs facilitate or enable a wide range of aquatic applications, including coastal surveillance, environmental monitoring, undersea exploration, disaster prevention, mine reconnaissance and so on. On the other hand, due to the high attenuation of radio in water, UWSNs have to mainly rely on acoustic communication. The unique characteristics of underwater acoustic communications and networking, such as low communication bandwidth, long propagation delays, high error probability, and sensor node (passive or proactive) mobility (in mobile networks) pose grand challenges to almost every layer of network protocol stack. In this paper, we tackle the time synchronization problem, which is very critical to many UWSN design issues.

In fact, most UWSNs applications either benefit from or require time synchronization services. For instance, data collected by underwater sensor nodes need global time stamps to make data fusion and processing meaningful. TDMA, one of the commonly used medium access control (MAC) protocols, often requires good synchronization among nodes. Further, time synchronization is indispensable in most of the localization algorithms, both for underwater sensor networks and terrestrial sensor networks. A large number of time synchronization protocols have been proposed for terrestrial wireless sensor networks.

Most of them claim to be able to achieve high accuracy with reasonable energy expenditure. However, these algorithms cannot be directly applied to UWSNs. This is because most of these approaches assume negligible propagation delays among sensor nodes, which is not the case in UWSNs however.

UWSNs often feature long propagation delays due to the low propagation speed of acoustic signals (about 1500 m/sec in water). In addition, for mobile UWSNs, propagation delays between nodes are changing because of sensor node mobility. Further, acoustic transmissions are very power hungry, which requires high energy efficiency. All of these features in UWSNs bring new challenges for time synchronization algorithms. In proposed system, we also investigate other approach to estimate node moving velocity and further examine how the accuracy of Reverse Localization Scheme will be affected.

In the literature, a large number of time synchronization protocols have been proposed for terrestrial wireless sensor networks. Most of them claim to be able to achieve high accuracy with reasonable energy expenditure. However, these algorithms cannot be directly applied to UWSNs. This is because most of these approaches assume negligible propagation delays among sensor nodes, which is not the case in UWSNs however. UWSNs often feature long propagation delays due to the low propagation speed of acoustic signals (about 1500 m/sec in water). In addition, for mobile UWSNs, propagation delays between nodes are changing because of sensor node mobility. Further, acoustic transmissions are very power hungry, which requires high energy efficiency. All of these features in UWSNs bring new challenges for time synchronization algorithms.

Recently some time synchronization algorithms, such as TSHL [20] and MU-Sync [5], have been proposed for UWSNs. In these algorithms, the issue of long propagation delays is often well addressed. However, they often ignore one issue or another. For example, TSHL assumes that nodes are fixed, which makes it not suitable for mobile networks. While MU-Sync is designed for mobile underwater networks, it is not very energy efficient. In this paper, we propose a novel time synchronization scheme, called “Reverse Localization Scheme”, which is specifically designed for mobile UWSNs, with high energy efficiency as one major goal.

Reverse Localization Scheme does not suffer from mobility. Instead it novelly utilizes the spatial correlation of mobile sensor nodes to estimate the long dynamic propagation delays among nodes. In Reverse Localization Scheme, the time synchronization procedure consists of three phases: Phase I, delay estimation; Phase II, linear regression; and Phase III, calibration. In phase I, the spatial correlation of mobile sensor nodes is effectively employed to help the estimation of the propagation delays. In phase II, based on the MAC layer time stamps and corresponding propagation delays, sensor nodes perform the first linear regression to get the draft clock skews and offsets. And some draft results are applied as input parameters for Phase III, “calibration”, which is designed to further improve the synchronization accuracy. During calibration, by updating certain initial parameters and re-performing delay calculation and linear regression, the final clock skews and offsets are obtained. We conduct extensive simulations. And our results show that Reverse Localization Scheme outperforms existing schemes in both accuracy and energy efficiency.

EXISTING SYSTEM

A novel time synchronization scheme, called “Mobi-Sync”, is used for mobile underwater acoustic sensor networks. The time synchronization algorithms for UWSNs, such as TSHL, MU-Sync, and D-Sync are used here. These algorithms address the long propagation delays but they all exhibit particular shortcomings. Because, TSHL is designed for static networks hence it does not consider sensor node mobility. MU-Sync confronts the mobility issue, but it is not energy efficient. D-Sync overlooks the effect of the skew when estimating the Doppler shift. MU-Sync utilizes the spatial correlation of underwater mobile sensor nodes to estimate the long dynamic propagation delays but not effective. This is because most of these approaches assume negligible propagation delays among sensor nodes and the batteries of sensor nodes are difficult to recharge and it is often impractical to replace due to their relative inaccessibility. This lack of serviceability imposes even more stringent requirements.

PROPOSED SYSTEM

A high energy efficient time synchronization scheme specifically designed for mobile UWSNs. The distinguishing attribute of Reverse Localization Scheme is how it utilizes information about the spatial correlation of mobile sensor nodes to estimate the long dynamic propagation delays among nodes. We investigate other approach to estimate node moving velocity and further examine how the accuracy of Reverse Localization Scheme will be affected.

ADVANTAGE

The Proposed system, estimate node moving velocity and further examine how the accuracy of will be affected. The results indicate that RLS outperforms existing schemes with respect to both accuracy and energy efficiency.

MODULES

MESSAGE EXCHANGE

As the synchronization procedure starts, an ordinary node initializes the synchronization process by broadcasting the synchronization request(SR) message to its neighbor super nodes. SR contains the sending time-stamp , right before it departs from the ordinary node. Super nodes mark their local time as upon receiving SR. Simultaneously, they start to record their moving velocity with the frequency.

DELAY CALCULATION

At the beginning of each run, the ordinary node calculates the initial distance to a super node upon receiving message from it. At this stage, due to lack of information, half of the round trip time is employed to compute one way propagation latency between each pair. some errors are introduced. Since the pre-defined first time interval is very short the errors are supposed to be acceptable at this time.

MULTIPLE REQUESTS:

Next step, the ordinary node asks for multiple runs of synchronization process based on its accuracy requirement. For each time, the ordinary node and super nodes follow the same routine to calculate propagation delays. By doing so, the ordinary node can collect a

set of time stamps for each neighbor super node and corresponding propagation delays for each exchanged message. After this, it gets ready for the linear regression.

LINEAR REGRESSION

The ordinary node performs linear regression to estimate the draft clock skew and offset. It is possible that in some bad cases sample points are far away from what they are expected. In order to reduce the impacts from those outliers, instead of OLSE, an advanced Weighted Least Square Estimation (WLSE) specific for Reverse Localization Scheme is proposed and adopted.

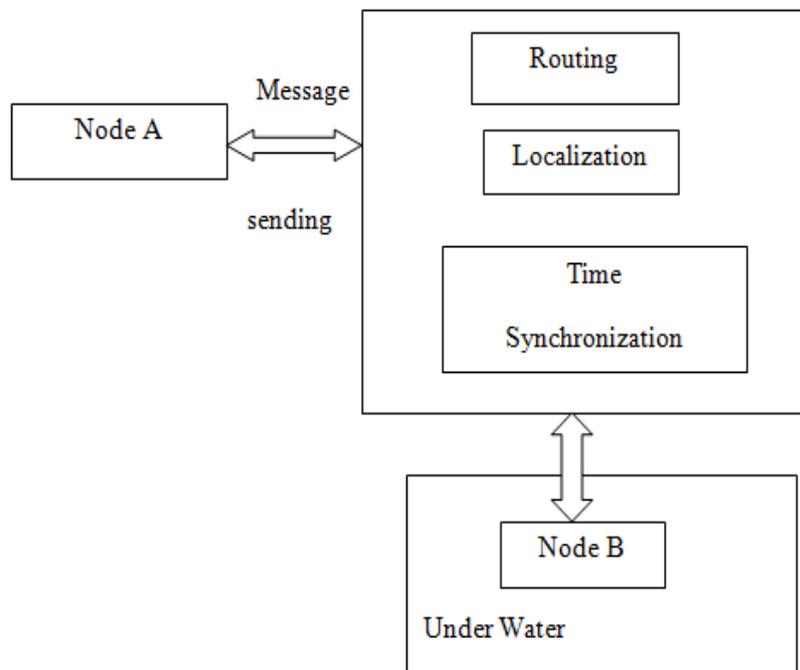
CALIBRATION

For one run, the ordinary node first updates the initial distance. Then with the same speed vectors gathered from super nodes, the ordinary node re-calculates its own speed vector. Next, with new estimated speed vector and the same routine first 3 modules, the ordinary node rebuilds the relative motion relationship with each super node to get updated triangles. Then with the same way in above modules, the ordinary node gets updated. Meanwhile, via updating initial skew, the ordinary node obtains updated round trip distance. With all the updated parameters, the ordinary node re-calculate propagation delay for each exchanged message. By keep performing above for each run, the ordinary node obtains a set of updated propagation delays for exchanged messages. Then with the same time stamps gathered in phase I and the updated propagation delays, the ordinary node re-runs linear regression with WLSE to gain the final skew and offset.

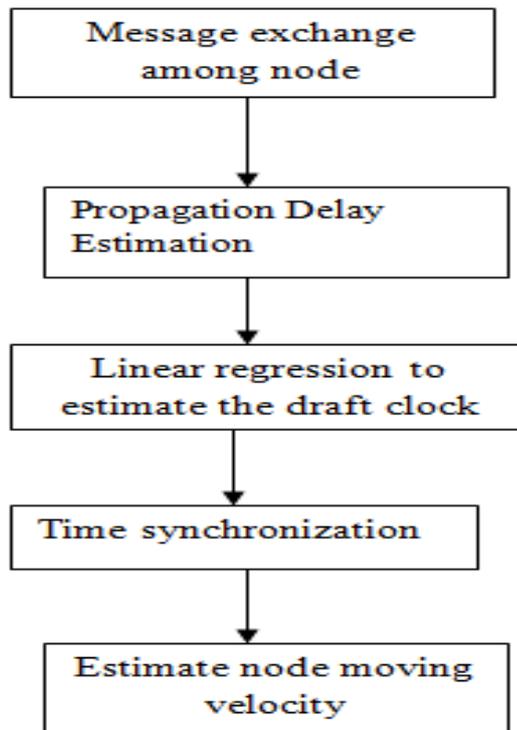
ESTIMATE NODE MOVING VELOCITY

The collection of closest point of approach time stamps are used to calculate the velocity of the object moving through the sensor field. The time stamps are combined with a position estimation vector which contains the approximate location of each of the sensor nodes. A linear regression is performed on the data to fit a constant velocity trajectory to the sensor data. In order to update the location of the individual sensors, a the linear regression is used to determine the relative positioning of the individual sensor nodes. Over time, the position estimation vector will be updated to reflect reality.

ARCHITECTURE DIAGRAM



DATA FLOW DIAGRAM



CONCLUSION

In this paper, we presented Reverse Localization Scheme, a time synchronization scheme for mobile UWSNs. Reverse Localization Scheme is the first time synchronization algorithm which does not suffer but benefit from sensor node mobility and it is also the first one which resorts to geometry knowledge to do time synchronization. Our simulation result shows that this new approach can achieve to estimate node moving velocity and further examined how the accuracy of Reverse Localization Scheme will be affected.

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