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An Enhanced STSL Based Mobile UWSNs Using DA-Time Sync Scheme

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Abstract— Time synchronization is the major problem in distributed network system. In this proposed system, time synchronization problem in under water sensor network is solved. In existing system lot of time synchronization protocols are used for wireless sensor network but it is not directly used for underwater sensor networks. These protocols are not considered the propagation delay and senor node movements but these are the main attributes in under water sensor networks. To solve these problems the Doppler assisted time synchronization (DA-sync) scheme has been proposed. This scheme estimate the Doppler shift which caused by sensor mobility and to estimate the relative velocity and achieve the synchronization accuracy kalman filter is used. DA-sync achieves the accuracy and energy efficiency compared than other existing time synchronization scheme. But the information gathered from the mobile nodes to the user does not achieve the accurate time synchronization. To solve these problems we propose a new innovative time synchronization scheme by enhancing existing DA-sync called as STSL based DA-SYNC. It achieves accurate time synchronization between user and mobile node.

Keywords: wireless sensor network , Doppler assisted time, Doppler shift,

I. INTRODUCTION

UWSNs provide a wide range of aquatic applications,such as coastal surveillance, environmental monitoring, undersea exploration, disaster prevention, and mine reconnaissance. UWSNs provide a wide range of an aquatic application, such as coastal surveillance, environmental monitoring, undersea exploration, disaster prevention, and mine reconnaissance. However, due to the high attenuation of radiowaves in water, UWSNs have to rely on acoustic communications. The same characteristics of underwateracoustic communications, such as lowavailable bandwidth, long propagation delays, high errorprobability, and sensor node mobility leads to grand challenges to almost everylayer of network protocol stack and applications. In this paper, we solve the time synchronization problem, which plays major roles in UWSN design issues.Normally underwater sensor networks needs time synchronization schemes. Because informationcollected by sensor nodes need global time stamps to make data fusion to make it meaningful. All medium access control protocols including TDMA require good synchronization among sensor nodes. Furthermore, time synchronizationis essential in most of the localization algorithms, inboth underwater sensor networks andterrestrial sensor networks. Number of time synchronization protocols have been proposed for terrestrial wireless sensornetworks. Most of them claim to beable to achieve high accuracy with reasonable energyexpenditure. However, these algorithms cannot be directlyapplied toUWSNs.This is because most of theseapproaches assume negligible propagationdelays amongsensor nodes, which is not true in UWSNs. UWSNs oftenfeature long propagation delays due to the low transmission speed of sound in water (about 1500 m/s). Inaddition, for mobile UWSNs, propagation delays betweennodes are time-varying because of sensor node mobility. It brings new challenges in UWSNs.Time synchronization algorithms, such asTSHL, MU-Sync, Mobi-Sync, and D-Sync have been proposed for UWSNs. In these algorithms, theissue of long propagation delays is often well addressed.However, they all ignore one issue or another. For example,TSHL assumes that nodes are fixed, which makes it notsuitable for mobile networks. While MU-Sync is designed formobile underwater networks, it is not energy efficient, andMobi-Sync can apply only in densed network. In this paper we propose a new innovative time synchronization scheme by enhancing existing DA-sync called as STSL based DA-SYNC with high accuracy andhigh energy efficiency as its major design goals.

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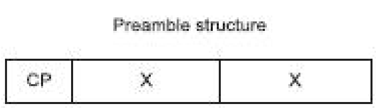
II. RELATED WORKS

Although there are significantly growing interests inUWSNs over the past several years, the research on timesynchronization for UWSNs is still relatively limited. TSHL is designed for high latency networks, whichcan manage long propagation delays and remain energyefficient simultaneously. TSHL combines one-way and two-way MAC-layer message delivery. One-way communication is used to estimate the clock skew and two-way is usedfor clock offset. TSHL works well for static underwatersensor networks, but it cannot handle mobile scenarios as itassumes constant propagation delays among sensor nodes. Particularly when nodes move fast, Mobi-Sync applies spatial correlation of nodes velocitiesto estimate the time varying propagation delay. It is anassumed hierarchal structure in which surface buoys areequipped with GPS to obtain global time reference andsuper nodes can communicate directly with them tomaintain synchronization. While being effective in estimating the time varying delay, this protocol needs to know theexact correlation model between nodes, which is very hardto obtain. In addition, for Mobi-Sync, the network has to bedensely deployed to ensure that each ordinary nodemaintains connectivity to at least three or more super nodes to have a good estimate of velocity. D-Sync [29], is the first work thatleverages the Doppler shift in underwater environments todo time synchronization. InD-Sync, by estimating and compensating for the Doppler shift, the calculation accuracyof propagation delay and synchronization are improved.

However, D-Sync does not consider theeffect of the skewduring the process of estimating the Doppler scaling factor,which reduces the accuracy of Doppler shift estimation and affects the accuracy of time synchronization. FurthermoreD-Sync completely trusts the measured speed with Dopplershift, which also leads to synchronization errors. The most recent work is DA-Sync. This scheme estimate the Doppler shift which caused by sensor mobility and to estimate the relative velocity and achieve the synchronization accuracy kalman filter is used. DA-sync achieves the accuracy and energy efficiency compared than other existing time synchronization scheme. But the information gathered from the mobile nodes to the user does not achieve the accurate time synchronization.

III. DOPPLER SCALING FACTOR ESTIMATION

The Doppler effect (or Doppler shift) is the change in frequency of a wave (or other periodic event) for an observer moving relative to its source. When the source of the waves is moving toward the observer, each successive wave crest is emitted from a position closer to the observer than the previous wave. Therefore, each wave takes slightly less time to reach the observer than the previous wave. Hence, the time between the arrivals of successive wave crests at the observer is reduced, causing an increase in the frequency. While they are travelling, the distance between successive wave fronts is reduced, so the waves "bunch together". Conversely, if the source of waves is moving away from the observer, each wave is emitted from a position farther from the observer than the previous wave, so the arrival time between successive waves is increased, reducing the frequency. The distance between successive wave fronts is then increased, so the waves "spread out". The Doppler scale estimation has been an interesting topic ever since the appearance of wireless communications, andin the underwater acoustic communication, it plays a morecritical role. In this paper, we consider a novel Dopplerestimation strategy using a bank of autocorrelators with awell-designed preamble.



The preamble structure for Doppler estimation is shownin Fig. 1, in which a cyclic prefix (CP) is added in front oftwo identical waveforms. Defining x(t)as the baseband signal of the waveform, the repetition pattern can beexpressed as

$$x(t) = x(t + T_0), \quad -T_c \le t \le T_0$$

where T0 and Tc denote the time duration of the waveformand the cyclic prefix, respectively. At the receiver side, aftercertain manipulation, it can be shown that the receivedbaseband signal is expressed as

$$y(t) = e^{-j2\pi\frac{\alpha}{1+\alpha}f_c T_0} y\left(t + \frac{T_0}{1+\alpha}\right),$$

$$-\frac{T_c - T_{max}}{1+\alpha} \le t \le \frac{T_0}{1+\alpha}$$

where fc is the center frequency, a is the Doppler scalingfactor we will estimate, and Tmax denotes the channelmultipath delay spread. The discrete time expression of they(t) at a sampling rate of _B is

$$y[n] = y(t) \mid t = n/(\lambda\beta)$$

where B is the signal frequency bandwidth, and is anλnteger representing the time-domain oversampling factor.

IV. PROPOSED SYSTEM

To overcome the problem of existing system here we introduce new algorithm called STSL (sequential time synchronization and localization) algorithm). The intuition behind our approach is the use of relative speed and direction information available at the mobile UL node to compensate for node mobility. In doing so, three or more range measurements obtained at different times and locations can be combined for 2D localization. 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. 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 unknownlocation, synchronization (clock skew and offset), and propagation speed parameters through linearized matrix equations. Our algorithm is modular in the sense that both time-synchronization and localization steps can be readily replaced with alternative solutions (as we do in this paper to benchmark the STSL performance).

A. Unlocalized Node

The unlocalized nodes do not know the location of the nearest node in order to make communication. So the unlocalized nodes first connect with nearest anchor node and then the anchor node sends the information about the nearest unlocalized nodes to that concern node.Then the Unlocalized node start communication with that nearest localized nodes.

The localization of unlocalized nodes is difficult task .Because the nodes are mobile in nature so it causes unpredictable location changes. But in this proposed system we use an specific algorithm. Unlocalized nodes are here localized by the anchor nodes by using an algorithm STSL.For example if we take the cellular communication in which each nodes are mobile in nature. So the user want to communicate with any other user is done by means of Base station and Mobile switching center. First the call is connected to the corresponding Base station of the user's location, and then base station enables the communication if the other end user is also with in that base station. Otherwise the call is forwarded to the nearest mobile switching center and that enables the proper communication with desired user.

Likewise the localization of unlocalized nodes is done by anchor node. The anchor node enables the communication between any two unlocalized nodes, by sending the nearest localized nodes location to the unlocalized node.

B. Anchor Node

Anchor node knows the location about it. But unlocalized node doesn't know the location. So the localization of unlocalized nodes is done by using STSL algorithm.The localization technique follows the upcoming procedure.

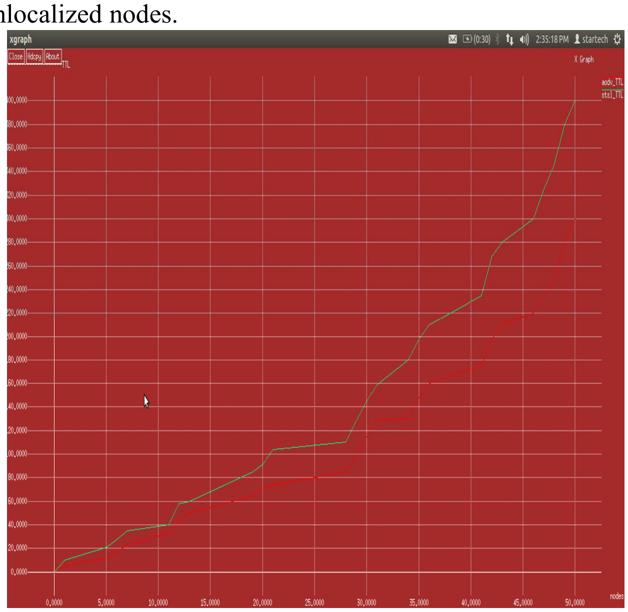
1. Anchor node sends the packets to the nearest unlocalized node.

- Calculate the distance between the Mobility nodes.
- Then calculate the angle between the mobility nodes
- Calculate the transmission rate between the mobility nodes
- Calculate the speed between themobility nodes.

2. After find out this values, thenanchor node sends the following details to the unlocalized node

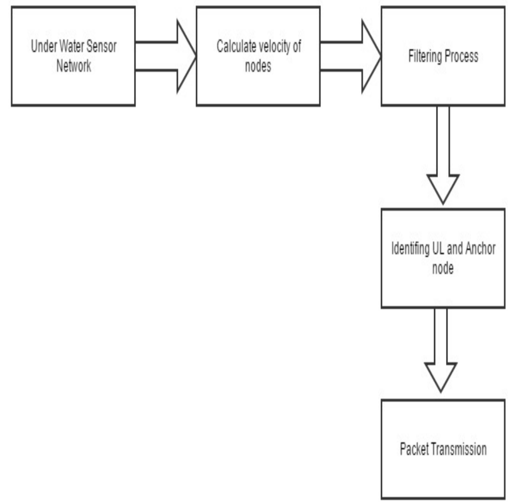
- Location of the unlocalized node.
- Distance between all the nearest unlocalized node.
- Angle between the nearest unlocalized node.

Then the communication became enabled between any two unlocalized nodes.



C. Advantages

- Accurate localization of un localized node
- Time varying location
- Time synchronization and Speed uncertainties
- Reduced number of iteration.



V. PERFORMANCE EVALUATION

The performance evaluation is done by drawing graph for time consumption. Compare to existing system the time consumption is considerably reduced by using an algorithm named as STSL.

VI. CONCLUSION AND FUTURE WORK

In this paper we presented a time synchronization scheme for UWSNs. Here the information gathered from mobile nodes to the user achieves the time synchronization. Our simulation result showed that this new approach can achieve high accuracy.

In the future we plan to implement this STSL base DA-Sync in underwater test beds and explore its performance in real underwater environments.

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