Conflict Free Packet Scheduling For Underwater Communication

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Abstract- This concept has the multiparty crisis of sachet preparation and self-localization in an underwater auditory antenna system with arbitrarily scattered nodes. In packet scheduling, we should concentrate to diminish the localization instance; we consider two package transmission schemes explicitly a clash-free of charge scheme (CFS), and a conflict-tolerant scheme (CTS). The mandatory localization moment is formulate for these schemes, and in the course of systematic domino effect and statistical examples and implementation are revealed to be reliant on the conditions. When the sachet period is diminutive (as per the result in the localization package), in the service region is huge (above 3 km in at any rate one aspect), and the typical prospect of packet-thrashing is not lock to zero, the conflict-liberal scheme is originate to involve a minimum localization instance. Simultaneously its accomplishment intricacy is inferior to that of the conflict-free scheme, because in CTS, the anchor works autonomously. CTS consume to some extent more force to composition for package collision, but it is exposed to afford a better localization precision.

Index Terms—Underwater acoustic networks, localization, scheduling.

I. INTRODUCTION

The emergences of autonomous underwater vehicles (AUVs) lead to the evolution of computer systems and networking which made the expansion of autonomous underwater acoustic sensor networks (UASNs). These underwater vehicles are self-automated and they are required to perform a large no complex tasks without human intervention, so such systems should be well equipped and well organized. For the monitoring of Oceanic events and occurrences, these sensor nodes are required to Measure different environmental parameters. After collecting such data, these nodes encapsulates that is encodes the data into data packets, and exchange these packets with the neighboring sensor nodes or collectively send them to a fusion center. The Key attributes that are measured by these sensor nodes are the Time and Location constraint; these two parameters are very important to correlate the occurrence of an event. Therefore, this sensor node collectively or separately gathers sensed data and helps in the underwater communication. The implementation of such system is shown in the Figure 1.

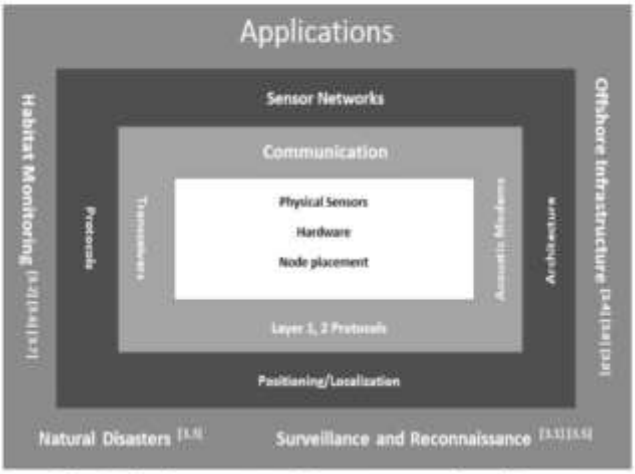


Fig. 1. Underwater acoustic sensor network architecture.

Figure.1

II. CHALLENGES OF UNDERWATER COMMUNICATION

The key challenges of underwater acoustic communication are low data rates, delay in propagation with variable sound speed, we analyze a variety of localization algorithms in the literature survey. In land based systems we use the well-known Global positioning System (GPS) are combined with the wireless sensor networks (WSNs) to determine the location of an object in a terrestrial environment. But when it comes to an underwater communication the applications GPs based system is not reliable. In such situations we use the underwater acoustic sensor networks (UASNs).Major challenges faced in the design of underwater acoustic sensor networks are as follows.

- Mobility is one of the major concerns of the underwater acoustic sensor networks (UASNs), unlike the land based networks which has its nodes in a static position the UASN must have a highly mobile system design.
- Since the radio communication cannot propagate in the deep water the underwater communication uses acoustic waves, in which speed of sound is a problem.
- Data rate is extremely low in underwater due to the limitation of bandwidth in underwater.

- Multipath and Fading is another concern in underwater, propagation delay in underwater is higher in some perspective than in Radio Frequency (RF) terrestrial networks.
- Energy and Cost are two important constraints to be considered while the implementation of such systems.

The sensor node in the UASNs determines its location by measuring the time of flight (ToF) to numerous anchors with well-known positions, and performing multi alteration. Other than the Noise, the number of anchors, their arrangement and their position, propagation losses and fading also affect the location accuracy. More or less of these parameters can be attuned to improve the localization correctness.

Even though a number of researches are being done in the underwater localization algorithms, only a miniature work has been done to define how the anchors should communicate their data to the underwater sensor nodes. The long base-line (LBL) systems transponders are fixed on the sea floor; an underwater node cross-examines the transponders for round-trip delay assessment. In the underwater Localization scheme, a master anchor sends a beacon signal once in a while, and other anchors communicate their packets in a given order after the response of the signal from the preceding anchor. The localization algorithm speaks about the problem of joint node detection and collective localization without the assistance of GPS.

The algorithm begins with a few anchors as primary seed nodes, and as it advances, appropriate sensor nodes are changed to seed nodes to help in discovering more sensor nodes. The algorithm functions by broadcasting command packets which is used by the nodes for time-of-flight evaluation. The performance of these algorithms is evaluated by measuring the average network set-up time and coverage. We also study packet scheduling algorithms in which there is no need for a fusion center. Even though the synchronization of the anchors which are fitted with GPS is not difficult, the suggested algorithms can work with A-synchronized anchors, if there is a request signal from a sensor node. The Placement of the anchor and nodes which are localized or un-localized are shown in Fig.2

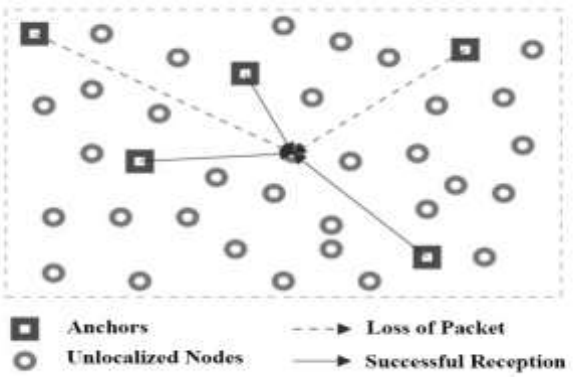


Figure .2

II. SYSTEM MODEL

We consider an underwater acoustic sensor networks consisting of N sensor nodes and M anchors. The indexing of the anchor starts from 1, and the indexing of the sensor node starts from M+ 1. Each anchor in the network consists its unique identity (ID), its location, time when the packet has been transmitted, and a prearranged training progression for the time of flight assessment. The obtained location of the packet is broadcast into the network using an efficient protocol, e.g., occasionally, or whenever a sensor node request for it. The structure of the system is defined as follows.

- Anchors and sensor nodes are fitted with half-duplex (they cannot transmit and receive simultaneously), audio modems (acoustic modems).
- Anchors are placed at random on the plane, and have the capability to be in motion within the operating region. The anchors are well equipped with Global Positioning System Monitors which can locate their positions and that helps each node to broadcast its location to other sensor nodes. It is understood that the PDF of the distance between any two anchors is known.
- It is additional understood that the sensor nodes are positioned randomly in an operating plane, according to some probability density function (PDF). The sensor nodes can move around in the given area, but within the localization procedure, their positions are to be constant. The PDF of the distance between a one sensor node and another anchor is calculated.
- These probability density function (PDF) can be estimated from the experiential data gathered during previous network operations.
- Since each and every node is in the range of communication with one another, we can state this system as a Single hop network.
- The received signal strength which is determined by the attributes such as path loss, fading and shadowing, is a function of transmission distance. As a result, the probability of a packet loss is a function of distance between any two nodes in the network.

The present localization algorithms are based on the sensor nodes determination of the distance to other sensor nodes through Round-trip-time (RTT). Each and every sensor node can determine its location only when it receives at least K localization packets from K number of different anchors. The value of K is determined from the on the geometry (2-Dimensional or 3-Dimensional), and other attributes such as the availability the depth of the sensor, or if the sound speed assessment is required. The value of K is generally three for a 2-Dimensional operating plane with recognized sound speed and four for a 3-Dimensional plane. In a condition where the underwater nodes are set with pressure sensing indicators, three various successful packets would be enough for a 3-Dimensional localization algorithm.

The localization process is initiated either occasionally for a prearranged duration (in a synchronized network), or after receiving a request from a sensor node (in any synchronous as well as asynchronous network).The Localization time of each and every sensor node is calculated with the help of the adjacent or nearby anchor. These anchors are ordered from one to m and they are well organized in a one hop communication mechanism. The signal tone from the senor places the anchor in either the receiver mode (Rx), default modes of the anchor are the inactive mode or the sleep mode. The anchor sends its localization packet to a sensor node upon the request of the sensor node.

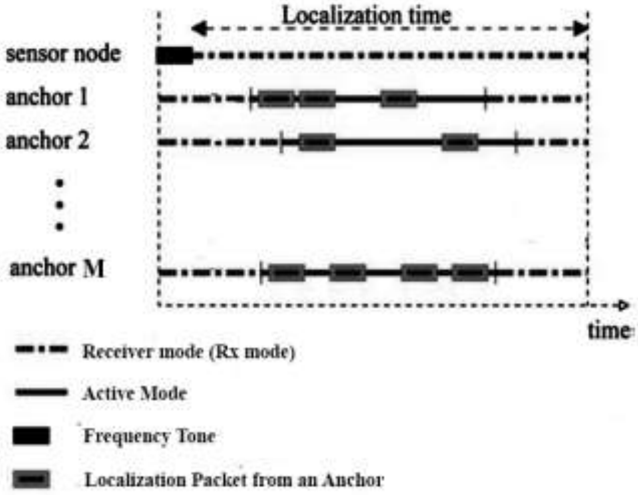


Figure.3 System Model

III.LOCALIZATION STRATIGIES

There are two different Localizations that are used to determine the current position of the sensor node in an operating environment.

- **Periodic localization**:

This type of localization is used in the case where all the (the sensor nodes and the anchor nodes) are in a well synchronized manner. In this method, the senor nodes estimates the distance from the anchor (say Ai) only when a packet is received Ai. The estimated Time E_T at which the sensor node receives a packet from an anchor node is also calculated. The departure time D_T is calculated by decoding the received packet (the anchor encapsulates this information within the localization packet), and the arrival time A_T is obtained by compared with the received signal with the acknowledged training sequence (or related procedures),the distance between the anchor Ai and the sensor node is represented as D_{is}. P_0 the path-loss factor (spreading factor), is also calculated and k is a constant that depends on certain system parameters (such as signal bandwidth, sampling frequency, channel attributes, and noise level). In this localization, sensor nodes are not necessarily essential to be synced with the anchors. If they are not synced, they can calculate the Time-Differences of Arrival (Thomas) that is obtained from the ToFs.

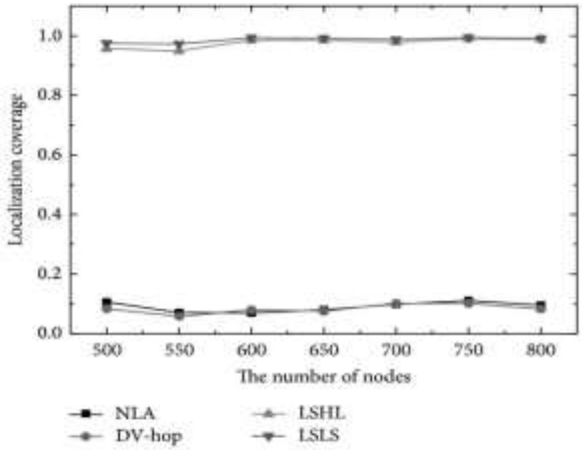


Figure.5

- **On-demand localization**:

This is an open Localization process in which can be applied to both synchronous and asynchronous network. The localization is initiated by the sensor node. It send outs a high-power frequency signal instantly, before the request packet. The signal is known as a Wake up signal because, it wakes up the anchors from their idle or inactive mode, and sets them into the listening mode. The request packet can also be used for a more accurate calculation of the arrival time A_T, which is being used in the periodic localization. We consider that all the anchors have been properly notified by this frequency signal. Once the anchors receives the wake up signal, they Acknowledge it with localization packets. The time of reception of the packet by an anchor and the time at which a localization packet is transmitted are incorporated in the localization packet. These parameters will be used by each and every sensor node to determine its round-trip-time (which is proportional to twice the distance) to the anchor.

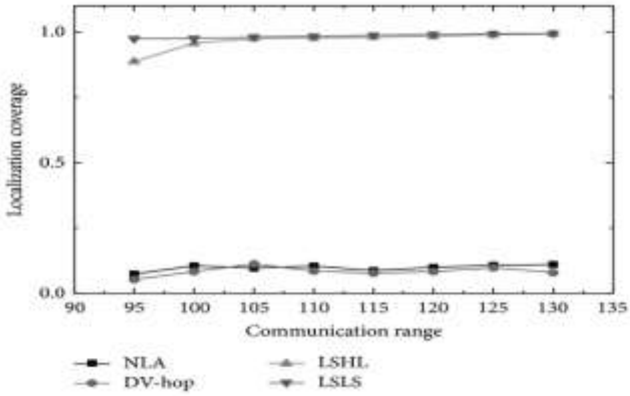


Figure.4

Once the sensor have calculated their positions or locations with the above two methods, these nodes now broadcasts their positions to all the other nodes in the network. This process will be very helpful for some nodes that have a overhead in initialing the Localization or Location discovery process. The time taken for an underwater node to obtain at least a minimum number of packets from a minimum number of anchors is known as the Localization time. If there is a packet loss during the communication, a succeeding anchor will not know when to transmit the packet. If an anchor does not receive a packet from a preceding anchor, it waits for a particular time (starting from the starting time of the localization course), and then transmits its packet, likewise as introduced.

IV. PACKET SCHEDULING

A. Collision-Free Packet Scheduling

Collision-free localization packet transmission is examined, where it is presented that, in a fully-connected (single hop) network, centered on a given arrangement of the anchors keys, each anchor has to transmit instantaneously after receiving the preceding anchor's packet. Additionally, it is displayed that there exists a finest ordering structure which diminishes the localization time. Conversely, to obtain that sequential structure, a fusion center is mandatory to know the locations of all the anchors. In circumstances where this information is not accessible or available, we may take up that anchors simply transmit in order of their ID numbers. In the occurrence of a packet loss, a successive anchor will not be aware of the state and when to transmit.

If an anchor does not receive a packet from a preceding anchor, it waits for a predefined particular amount oftime, and then transfers its packet. With a small adjustment of the result from, the waiting time for the jth anchor which has not received a packet from its preceding anchor, could be as short as $t_k + (j-k)(T_p + \frac{D_{aa}}{c})$, where k is the index of the anchor whose data packet is the last one which has been received by the jth anchor, t_k is the time at which this packet, where $\frac{D_{sa}}{c}$ is supplemented to guarantee that the last transmitted packet from the Nth anchor get to the farthest point in the operating environment.

B. Collision-Tolerant Packet Scheduling

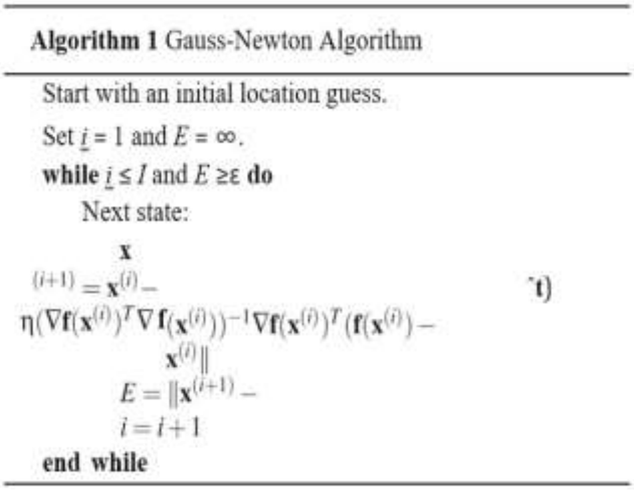
In Order to avoid the necessity for coordination between the anchor nodes, in this packet scheduling, anchors work independently of each other, that is no anchor has a control over another or depends on another anchor. During a localization period or after receiving a request from a sensor node, they transmit in an unordered or a random sequence, example, as stated by the Poisson distribution with a mean transmission rate value of λ packets per second.

The Packets transmitted from various different anchors may now collide at a single sensor node, and now the problem arises as to which point is the probability of positive reception is present. This problematic situation is the exact type of problem addressed in our survey, where the UASN sensor nodes transmit their data packets to a mutual fusion center. And in another study, where the sensors are well aware of their location, and the power control completely compensates for the well-known path-loss, path-loss is not recognized in the current scenario, and there is no power control mechanism. The mean value of the received signal strength is different for different number of links.

V. SELF-LOCALIZATION PROCESS

We have understood that a sensor node needs at least K different packets (or time-of-flight quantities) to evaluate its location. Although, it may receive additional different packets, and also some replicas, that is, $q_{j\ data}$ packets from anchor j, where j = 1... M. In such a scenario, a sensor makes use of all the information for the purpose of self-localization.

We have to note that, in this collision-free scheme, the value of q_j is either 0 or 1; however, in this collision-tolerant scheme q_j can take the value of more than 1. Packets that are received from the jth anchor can be used to calculate the sensor node's distance to that particulate anchor, and the repeated packets add variety (else reduce measurement noise) for this estimation. We show how all of the properly received packets can be correctly used in a localization algorithm, and how the CRB of the location estimation can be derived for the projected scheduling systems.



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Algorithm 1 Gauss-Newton Algorithm
Start with an initial location guess.
Set $i$ = 1 and $E = \infty$.
while $i \le I$ and $E \ge \varepsilon$ do
    Next state:
        $\mathbf{x}^{(i+1)} = \mathbf{x}^{(i)} -$                                   t)
    $\eta(\nabla \mathbf{f}(\mathbf{x}^{(i)})^T \nabla \mathbf{f}(\mathbf{x}^{(i)}))^{-1} \nabla \mathbf{f}(\mathbf{x}^{(i)})^T (\mathbf{f}(\mathbf{x}^{(i)}) -$
            $\mathbf{x}^{(i)}\|$
        $E = \|\mathbf{x}^{(i+1)} -$
        $i = i + 1$
end while
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Figure.6

VI. ENERGY CONSUMPTION

The main focus is to evaluate the average energy consumed by all the anchors during the localization process. In CFS, the receiver of anchor j is switched on that is it will be in the state of receiving a data, for t_j seconds, and its transmitter is switched on only for T_p seconds of time. The power that is being consumed in the listening mode is indicated as P_L and the power that is being consumed in the transmitting mode is represented as $P_{T,}$ the average energy consumption is CFS. In the time period of CTS, the anchors does not need to actively listen to the channel and they only transmit the packets at an average rate of λ packets per second in the operating plane. As the size of the operating environment increases, a less operating frequency (with less bandwidth) is used to equalize for the amplified attenuation.

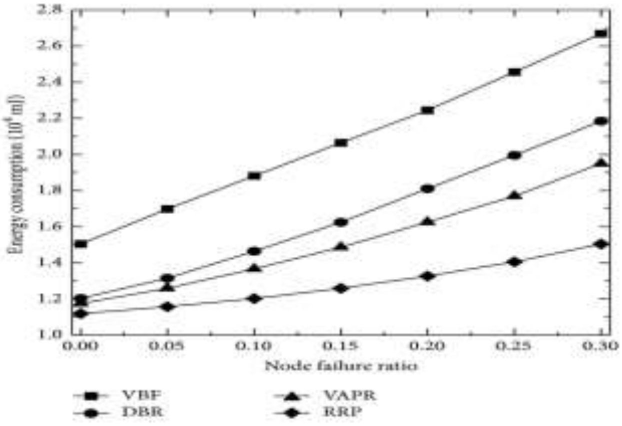

Figure.7

Also, as the distance between the anchor and a sensor increases, the amount of currently available bandwidth for the optimal operating frequency also gets smaller. As it was clearly stated before, the localization data packet is generally short in terms of the number of bits, but its time duration (in seconds) depends on the system bandwidth. We also explore the consequence of packet length (else equivalently system bandwidth) on the localization time. The length of the localization data packet plays a important role in the collision-tolerant algorithm. The least localization time develops almost linearly with T_p in each and every case; however, the rate of the growth is much greater for the collision-tolerant system (CTS) than for the collision-free system one. At the same time, the area size of the operating environment has a major impact on the performance of the collision-free system (CFS), while that of the collision-tolerant system (CTS) does not change very much. It can be reasoned that in a network where the ratio of data packet length to the maximum propagation delay is low, the collision-tolerant algorithm outclasses the collision-free one in the aspect of localization time.

The localization correctness is related to the noise level ratio at which a To F evaluation is taken, and to the anchors' arrangement. If a sensor node in a 2-Dimensional operating system receives data packets from the anchors which are (approximately) located on a line, the sensor node is unable to locate itself (or it gives out a large error).

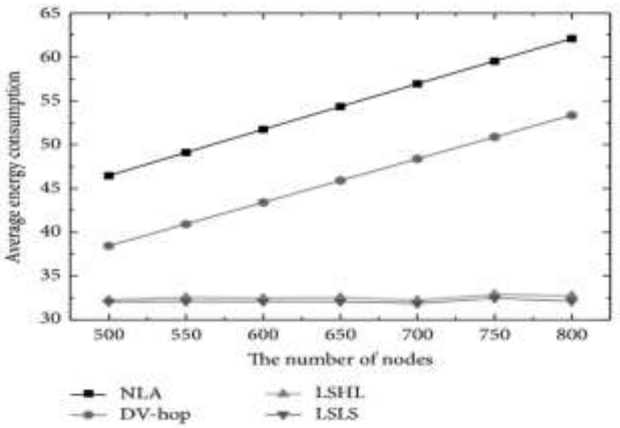

Figure.8

VII. CONCLUSION

We have well-thought-out2 classes of packet scheduling for self-localization in a UASNs, one localization process based on a collision-free design and another localization mechanism based on a collision-tolerant design. In collision-free data packet scheduling, the time that is taken for packet transmission from each and every anchor is set in such a way that any none of the sensor nodes will experience a collision. In contrast, the collision-tolerant systems algorithms are developed in the intention to regulate the probability of collision and to ensure the successful and effective localization with a predefined reliability. We have also used the simple Gauss-Newton localization algorithm for these localization schemes, and evaluated their Cramer-Rao lower bounds. The performance of the 2 classes of algorithms on the basis of the time required for localization was exposed to be reliant on the circumstances. When the proportion of the data packet length to the propagation delay is low, as it is with localization, and the average of the probability of packet-loss is not close to 0, the collision-tolerant protocol needs less time for localization in evaluation with the collision-free one for the similar probability of successful localization. Excluding the average amount of energy consumed by the anchors, the collision-tolerant scheme has numerous advantages. The major one is the simplicity of implementation because, anchors work individually, without the intervention of each other, and as an outcome the system is spatially scalable, with no necessity for a fusion center. Also, its localization accuracy is always superior to that of the collision free scheme because of multiple receptions of anticipated packets from anchors. These characteristics make the collision-tolerant localization scheme reliable for a practical implementation point. In future, we can extend our research to a multi-hop network where the communication range of the acoustic modems is much smaller than the size of the operating zone.

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