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Underwater Localization with Time-Synchronization and Propagation Speed Uncertainties

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ABSTRACT: Wireless Sensor Networks consisting of nodes with limited power are deployed to gather useful information from the field. In WSNs it is critical to collect the information in an efficient manner Underwater localization is a key element in most underwater communication applications. Since GPS signals highly attenuate in water, accurate ranging based techniques for localization need to be developed. In this paper we describe a sequential algorithm for time-synchronization and localization in the underwater acoustic channel. We consider the realistic case where nodes are not time-synchronized and the sound speed in water is unknown, and formalize the localization problem as a sequence of two linear estimation problems. Simulation results demonstrate that our algorithm compensates for time synchronization and signal propagation speed uncertainties, and achieves good localization accuracy using anchor nodes. We consider the problem of UWAL in a practical setting where the sound speed is unknown, and nodes are not time-synchronized and move permanently. Relying on the assumption that nodes are equipped with self-navigation systems and that these systems are accurate for use in short periods of time, we offer a heuristic solution for this problem, which we refer to as the sequential time-synchronization and localization (STSL) algorithm.

KEYWORDS: Time-synchronization, Underwater acoustic channel, Localization, Wireless sensor network.

I. INTRODUCTION

The advancements in wireless communication technologies enabled large scale wireless sensor networks (WSNs) deployment. Due to the feature of ease of deployment of sensor nodes, wireless sensor networks (WSNs) have a vast range of applications such as monitoring of environment and rescue missions. Wireless sensor network is composed of large number of sensor nodes. The event is sensed by the low power sensor node deployed in neighbourhood and the sensed information is transmitted to a remote processing unit or base station.

To deliver crucial information from the environment in real time it is impossible with wired sensor networks whereas wireless sensor networks are used for data collection and processing in real time from environment. The ambient conditions in the environment are measured by sensors and then measurements are processed in order to assess the situation accurately in area around the sensors. Over a large geographical area large numbers of sensor nodes are deployed for accurate monitoring. Due to the limited radio range of the sensor nodes the increase in network size increases coverage of area but data transmission i.e. communication to the base station (BS) is made possible with the help of intermediate nodes.

A wireless sensor node in a network consists of the following components microcontroller, Radio transceiver, Energy source (battery). Wireless sensor networks have the ability to deal with node failures. Another unique feature is the mobility of nodes. They have the ability to survive in different environmental surroundings. They have dynamic network topology. Further developments in this technology have led to integration of sensors, digital electronics and radio communications into a single integrated circuit (IC) package. Generally wireless sensor network have a base station that communicates through radio connection to other sensor nodes. The required data collected at sensor node is processed, compressed and sent to gateway directly or through other sensor nodes.

A wireless sensor node is capable of gathering information from surroundings, processing and transmitting required data to other nodes in network. The sensed signal from the environment is analog which is then digitized by analog-to-digital converter which is then sent to microcontroller for further processing. While designing the hardware of any sensor node the main feature in consideration is the reduction of power consumption by the node. Most of the power consumption is by the radio subsystem of the sensing node. So the sending of required data over radio network is advantageous. An algorithm is required to program a sensing node so that it knows when to send data after event sensing in event driven based sensor model. Another important factor is the reduction of power consumption by the sensor which should be in consideration as well. During the designing of hardware of sensing node microprocessor should be allowed to control the power to different parts such as sensor, sensor signal conditioner and radio.

II. ROUTING PROTOCOLS IN WSN

Due to the difference of wireless sensor networks from other contemporary communication and wireless ad hoc networks routing is a very challenging task in WSNs. For the deployed sheer number of sensor nodes it is impractical to build a global scheme for them. IP-based protocols cannot be applied to these networks. All applications of sensor networks have the requirement of sending the sensed data from multiple points to a common destination called sink. Resource management is required in sensor nodes regarding transmission power, storage, on-board energy and processing capacity. There are various routing protocols that have been proposed for routing data in wireless sensor networks due to such problems. The proposed mechanisms of routing consider the architecture and application requirements along with the characteristics of sensor nodes. There are few distinct routing protocols that are based on quality of service awareness or network flow whereas all other routing protocols can be classified as hierarchical or location based and data centric.

A) Flooding and Gossiping

In order to relay data in sensor networks without the need for any routing algorithms and topology maintenance the two classical methods are flooding and gossiping. A sensor node broadcast a data packet to all its neighbors and this process continues until destination is found and this technique is known as flooding where as in gossiping packet is not sent to all neighboring nodes but to selected random neighbors which selects another random neighbor and in this packet arrives at the destination. Sensors Protocols for information via negotiation. The key feature of SPIN is that meta-data before transmission are exchanged between sensors through data advertisement mechanism. The new data is advertised by each sensor node to its neighbors and the interested neighbors which do not have the data send a request message in order to retrieve data. The classic problems of flooding are solved by SPIN's meta-data negotiation.

B) Directed Diffusion

In this protocol the idea is to diffuse data by using naming scheme for the data through sensor nodes. To get rid of unnecessary operations of network layer routing in order to save energy is the main idea behind using such a scheme.

C) Energy-Aware Routing

To increase the lifetime of a network here proposed to use set of sub- optimal paths occasionally. Depending on the energy consumption of the path, these paths are chosen by means of probability functions. The approach is concerned with the main metric of network survivability. This protocol has the following phases: Setup phase and Data communication and route maintenance phase.

D) Rumor Routing

Another variation of Directed Diffusion is the rumor routing and is proposed for contexts in which geographic routing criteria are not applicable. The query is flooded in the entire network in Directed Diffusion when there is no geographic criterion to diffuse tasks. Thus the use of flooding is unnecessary in cases where a little amount of data is requested.

E) Gradient-based Routing

Gradient based routing (GBR) is a slightly changed version of Directed Diffusion. In this routing scheme the idea is to maintain number of hops when the inter EST is diffused through the network. So minimum numbers of hops are discovered by each hop to sink that are called node's height. The gradient is the difference between node's height and that of its neighbor on that link. With the largest gradient a packet is forwarded on the link.

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Vol. 2, Issue 2 , February 2015

F) Location-based Protocols

Location information is required for nodes in sensor network in most of the routing protocols. Energy consumption is estimated by calculating the distance between two particular nodes for which location information is required. As there are no schemes like IP-addresses, data is routed in an energy efficient way by utilizing location information. By using the location of sensors the query is diffused only in particular region which is known to be sensed, significant number of transmissions will be eliminated. The protocols are designed primarily for MANETs considering the mobility of nodes whereas they are also applicable to sensor networks in which nodes are fixed or mobility is less. Location–based protocols are as follows: Minimum energy communication network (MECN) and small minimum communication energy network (SMECN), Geographic Adaptive Fidelity (GAF) and Geographic and Energy aware routing (GEAR).

III. AODV ROUTING PROTOCOL

There are two types of routing protocols which are reactive and proactive. In reactive routing protocols the routes are created only when source wants to send data to destination whereas proactive routing protocols are table driven. Being a reactive routing protocol AODV uses traditional routing tables, one entry per destination and sequence numbers are used to determine whether routing information is up-to-date and to prevent routing loops. The maintenance of time-based states is an important feature of AODV which means that a routing entry which is not recently used is expired. The neighbours are notified in case of route breakage. The discovery of the route from source to destination is based on query and reply cycles and intermediate nodes store the route information in the form of route table entries along the route. Control messages used for the discovery and breakage of route are as follows: Route Request Message (RREQ), Route Reply Message (RREP), Route Error Message (RERR), HELLO Messages.

A) Request (RREQ)

A route request packet is flooded through the network when a route is not available for the destination from source. The parameters are contained in the route request packet are presented. Source Address, Request ID, Source Sequence Number, Destination Address and Destination Sequence Number. A RREQ is identified by the pair source address and request ID, each time when the source node sends a new RREQ and the request ID is incremented. After receiving of request message, each node checks the request ID and source address pair. The new RREQ is discarded if there is already RREQ packet with same pair of parameters. A node that has no route entry for the destination, it rebroadcasts the RREQ with incremented hop count parameter. A route reply (RREP) message is generated and sent back to source if a node has route with sequence number greater than or equal to that of RREQ.

B) Route Reply (RREP)

On having a valid route to the destination or if the node is destination, a RREP message is sent to the source by the node. The following parameters are contained in the route reply message: Source Address, Destination Address, Destination Sequence Number, Hop Count, and Lifetime.

C) Route Error Message (RERR)

The neighbourhood nodes are monitored. When a route that is active is lost, the neighbourhood nodes are notified by route error message (RERR) on both sides of link.

D) Discovery of Route

When a source node does not have routing information about destination, the process of the discovery of the route starts for a node with which source wants to communicate. The process is initiated by broadcasting of RREQ. On receiving RREP message, the route is established. If multiple RREP messages with different routes are received then routing information is updated with RREP message of greater sequence number.

E) Setup of Reverse Path

The reverse path to the node is noted by each node during the transmission of RREQ messages. The RREP message travels along this path after the destination node is found. The addresses of the neighbours from which the RREQ packets are received are recorded by each node.

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Vol. 2, Issue 2 , February 2015

F) Setup of Forward Path

The reverse path is used to send RREP message back to the source but a forward path is setup during transmission of RREP message. This forward path can be called as reverse to the reverse path. The data transmission is started as soon as this forward path is setup.

IV. SYSTEM IMPLEMENTATION

Proposed a protocol called time synchronization for high latency (TSHL) and validated that TSHL can correct clock offset and skew in a reliable and efficient manner using simulations. In this paper, we implement this protocol on the UANT platform that is composed of a software defined radio and a mix of custom and commercially available hardware for the acoustic transmitter and receiver we demonstrate that TSHL can effectively synchronize clock offset and skew. To the best of our knowledge, this is the first real implementation of its kind. These methods are having number of advantages. Because we introduced a sequential time-synchronization and localization algorithm which relies on the existence of a navigation system that self-estimates the motion vector of nodes in short the algorithm utilizes the constant movements of nodes in the channel and relies on packet exchange to acquire multiple to a measurements at different locations.

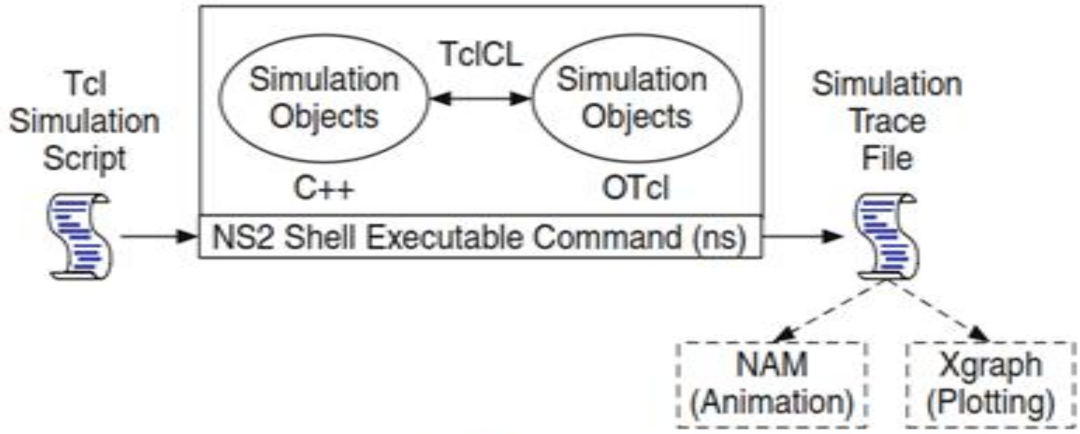

Figure: NS 2 Architecture

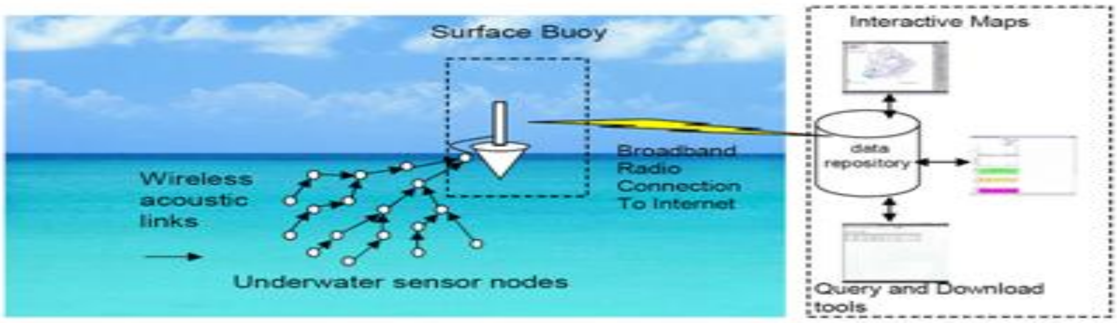

Figure: Simulation Architecture

A) Network formation

Inter organizational networks emerge as a result of the interdependencies between organizations that ensure organizations to interact with each other and lead in time to network structures. Where hierarchical arrangements can be purposely planned, networks are reactionary since they emerge out of contextual events that initiate the formation of a collaborative network. Although network emergence is well studied, the process in which networks come into being and evolve through time is not as well known. Mainly due to the difficulties in terms of data collection and analysis.

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Vol. 2, Issue 2 , February 2015

This is especially the case for public sector networks since network evolution studies are predominantly focused on the private sector. Some authors suggest that networks evolve through a cyclical approach. Ansell and Gash (2007) propose five iterative phases that are important in all cooperative phases: face-to-phase dialogue, trust building, commitment to the process, shared understanding, and intermediate outcome. Another model is developed by Ring and Van de Venn (1994) who state that cooperative inter-organizational relations go through three repetitive phases: 1) negotiation phase in which organizations negotiate about joint action, 2) a commitment phase in which organizations reach an agreement and commit to future action in the relationship, and 3) an execution phase where joint action is actually performed. These three stages overlap and are repetitive throughout the inter-organizational relationship (Ring & Van de Venn, 1994). Both cyclical models attempt to explain the processes within an operating network, but they do not consider the evolutionary process organizational networks go through from their emergence till their termination.

B) Anchor node selection

Choosing anchor points is a crucial step of the data gathering process since it determines the efficiency of energy transferring and the latency of data gathering. A trivial scheme is to simply visit all the sensor nodes, gather data through single-hop transmission and use the SenCar to forward data back to the static sink through long range communications. However, this scheme would trigger several new problems in our data collection and wireless recharge scheme. First, using single-hop data collection can only collect data from a very small number of nodes per interval. Only the nodes reside at the anchor points are able to transmit data while data generated at other nodes is not collected. Therefore, the fairness of data collection among all the nodes is greatly undermined in single hop data collection. In contrast, if multi-hop transmission is used, we can collect data from the larger neighbourhood of anchor points thereby improving the fairness of data collection. Second, the average packet latency will be increased with single hop communication. Since if nodes are not visited by the SenCar, their data packets would be buffered until these nodes are selected as anchor points. It would result in longer average data collection latency and is not scalable for large networks. In contrast, in our proposed solution, the SenCar only visits a subset of selected sensor nodes (anchor points) and collects data through multi-hop transmissions, which can enhance data collection fairness, reduce data collection latency, and avoid stopping at unnecessary sensor locations for battery recharge.

C) Sequential approach

Sequential approach in which first nodes are time-synchronized and then location is estimated. We start with quantizing the spatial domain by representing the continuous motion of nodes as a series of discrete locations. That is, we define the sets of quantized locations 퓛$= \{\boldsymbol{k}1, \boldsymbol{k}I\}$, $\boldsymbol{k}\rho= [kx\ \rho, ky\ \rho]$, and 퓝$= \{\boldsymbol{u}1, . . . ,\}$, $\boldsymbol{u}v= [ux\ v, uy\ v]T$, for the UN and l, respectively, and are interested in the estimation of location $\boldsymbol{j}N$ at the end of the localization window. This representation allows us to associate multiple exchanged packets with discrete node locations to obtain two-way to a measurement.

D) Path selection

We introduce mechanisms for path selection when the energy of the sensors in original primary path has dropped below a certain level. This allows us to distribute energy consumption more evenly among the sensor nodes in the network. Number of hope counts is also identified by using this method. The Energy Efficiency of the individual node is increased by this path selection method

E) Analysis

We will analysis our research to following Parameters Packet Delivery ratio, Residual Energy, Delivery Latency.

a) Packet delivery ratio

Packet delivery ratio is defined as the ratio of data packets received by the destinations to those generated by the sources mathematically, it can be defined as: PDR=S1/S2 where, S1 is the sum of data packets generated by the each source. Graphs show the fraction of data packets that are successfully delivered during simulations time versus while the PDR is increasing in the case of DSR and AODV, AODV is better among the three protocols.

b) Residual energy

You could rationalize, certainly, that it just was or wasn't inviting. You could argue that the decor was all wrong or you might not have liked the individuals currently living there and subconsciously superimposed your suspicions onto the home. There also is the potential that the home is in fact occupied by an entity, spirit or specter. The ghost of some wayward soul, trapped for an eternity to forever wander the abyss of your basement, watching your every move and causing the hairs on your body to constantly stand at attention. But, there is another option that may be considered. Residual energy negatively or positively charged left behind from former tenants of the home. Human auras are a powerful and potentially tangible substance. The human aura can literally extend up to three feet outside of a living body. It contains a multitude of colors, varying from red, blue, black, gray, pink and purple. The fluctuations of colors, of course, depend on many variables. If someone is angry, the aura will emit red. When someone is sad or in a very unstable mood, it tends to be gray. It glows pinks, lavenders and blues when balanced and happy.

c) Delivery latency

In general, the period of time that one component in a system is spinning its wheels waiting for another component. Latency, therefore, is wasted time. For example, in accessing data on a disk latency is defined as the time it takes to position the proper sector under the read/write head. In networking, the amount of time it takes a packet to travel from source to destination. Together, latency and bandwidth define the speed and capacity of a network. In VoIP terminology, latency refers to a delay in packet delivery. VoIP latency is a service issue that is usually based on physical distance, hops, or voice to data conversion.

V. CONCLUSION

Proposed a protocol called time synchronization for high latency (TSHL) and validated that TSHL can correct clock offset and skew in a reliable and efficient manner using simulations. In this paper, we implement this protocol on the UANT platform that is composed of a software defined radio and a mix of custom and commercially available hardware for the acoustic transmitter and receiver. We demonstrate that TSHL can effectively synchronize clock offset and skew. To the best of our knowledge, this is the first real implementation of its kind and achieves reasonable localization accuracy even for small number of anchor nodes. Simulation results demonstrate that our algorithm compensates for time synchronization and signal propagation speed uncertainties, and achieves good localization accuracy using only two anchor nodes.

REFERENCES

[1] M.Chitre, S.Shahabodeen, and M.Stojanovic, "Underwater acoustic communications and networking: Recent advances and future challenges," in *Marine Technology Society Journal*, vol. 42, no. 1, Garmish- Partenkirchen, Germany, Apr. 2008, pp. 103–116.
[2] J. Weber and C. Lanzl, "Desigining a positioning system for finding things and people indoors," in *IEEE Spectrum*, vol. 35, no. 9, Sep. 1998, pp. 71–78.
[3] C. Lee, P. Lee, S. Hong, and S. Kim, "Underwater navigation system based on inertial sensor and doppler velocity log using indirect feedback kalman filter," in *Journal of Offshore and Polar Engineering*, vol. 15, no. 2, jun 2005, pp. 88–95.
[4] R. Hartman, W. Hawkinson, and K. Sweeney, "Tactical underwater navigation system (TUNS)," in *IEEE/ION Position, Location and NavigationSymposium*, Fairfax, Virginia, USA, May 2008, pp. 898–911.
[5] V. Chandrasekhar, W. K. Seah, Y. S. Choo, and H. V. Ee, "Localization in underwater sensor networks - survey and challenges," in *Proc. OfACM International Conference on Mobile Computing and Networking(MobiCom)*, New York, NY, USA, Sep. 2006, pp. 33–40.
[6] J. Partan, J. Kurose, and B. Levine, "A Survey of Practical Issues in Underwater Networks," in *International Conference on Mobile Computingand Networking (MobiCom)*, Los Angeles, CA, USA, Sep. 2006.
[7] W. Burdic, *Underwater Acoustic System Analysis*. Los Altos, CA, USA: Peninsula Publishing, 2002.
[8] M. Erol, H. Mouftah, and S. Oktug, "Localization techniques for underwater acoustic sensor networks," in *IEEE Commun. Mag.*, vol. 48, no. 12, 2010, pp. 152–158.
[9] H. Tan, R. Diamant, W. Seah, and M. Waldmeyer, "A survey of techniques and challenges in underwater localization," Accepted for Publication in the ACM Journal of Ocean Engineering [Online: http://ecs.victoria.ac.nz/twiki/pub/Main/TechnicalReportSeries/ECSTR11- 03.pdf].
[10] J. Garcia, "Adapted distributed localization of sensors in underwater acoustic networks," in *MTS/IEEE international Oceans conference*, Singapore, May 2006.
[11] X. Guo, M. Frater, and M. Ryan, "A Propagation-Delay-TolerantCollision Avoidance Protocol for Underwater Acoustic Sensor Networks," Proc. Asia Pacific OCEANS, 2006.
[12] J. Yackoski and C.-C.Shen, "UW-FLASHR: Achieving High Channel Utilization in a Time-Based Acoustic MAC Protocol," Proc.ThirdACMInt'lWorkshop Underwater Networks (WUWNet), 2008.
[13] C. Hsu, K. Lai, C. Chou, and K.C. Lin, "ST-MAC: Spatial-Temporal MAC Scheduling for Underwater Sensor Networks," Proc. IEEE INFOCOM, 2008.

[14] K. Kredo, P. Djukic, and P. Mohapatra, “STUMP: Exploiting Position Diversity in the Staggered TDMA Underwater MAC Protocol,” Proc. IEEE INFOCOM, 2009.
[15] V. Bharghavan, A. Demers, S.Shenker, and L. Zhang, “MACAW: A Media Access Protocol for Wireless LAN’s,” Proc. SIGCOMM, 1994.