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ENHANCED GEOGRAPHIC BASED ROUTING PROTOCOLS FOR UNDERWATER SENSOR NETWORKS

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Abstract: Geographic based routing protocol has been proposed for UWSNs. It is an any cast, geographic and opportunistic routing protocol. Increasing attention has recently been devoted to underwater sensor networks (UWSNs) because of their capabilities in the ocean monitoring and resource discovery. UWSNs are faced with different challenges, the most notable of which is perhaps how to efficiently deliver packets taking into account all of the constraints of the available acoustic communication channel. This paper is an enhancement of geographic based routing protocols for underwater sensor networks. It includes void problem and the energy-reliability trade-off in the selection of forwarding set. Geographic based routing protocol takes advantage of distributed beaconing, constructs the adjacency graph at each hop and selects a forwarding set that holds the best trade-off between reliability and energy efficiency. The unique features of Geographic based routing protocol in selecting the candidate nodes in the vicinity of each other leads to the resolution of the hidden node problem. Experimental analysis has shown the effectiveness of the proposed systems.

Keywords: Routing protocols, Geographic routing, Underwater sensor networks, Hop count and Energy Efficiency

I. INTRODUCTION

Wireless Sensor Network (WSN) is a collection of spatially deployed wireless sensors by which to monitor various changes of environmental conditions (e.g., forest fire, air pollutant concentration, and object moving) in a collaborative manner without relying on any underlying infrastructure support. Recently, a number of research efforts have been made to develop sensor hardware and network architectures in order to effectively deploy WSNs for a variety of applications. Due to a wide diversity of WSN application requirements, however, a general-purpose WSN design cannot fulfil the needs of all applications [1]. Many network parameters such as sensing range, transmission range, and node density have to be carefully considered at the network design stage, according to specific applications. To achieve this, it is critical to capture the impacts of network parameters on network performance with respect to application specifications.

Underwater sensor networks consist of number of underwater sensor nodes or just called sensor nodes which are equipped with acoustic transceivers that enable them to communicate with each other to perform collaborative sensing tasks over a given area from shallow water and seabed. USNs have many potential applications in ocean monitoring, such as current flow, oil pollution, seismic and tsunamis monitoring, to supply the high spatiotemporal resolution capability [2]. Nowadays, resource discovery in the underwater environment has become one of the important goals to reduce dependency on land resources.

However, it is a difficult and costly task to monitor and discover the underwater environment. Underwater sensor networks (UWSNs) have recently attracted much attention due to their significantly ability in ocean monitoring and resource discovery. Due to restrictions on the use of radio waves, acoustic transmission is most commonly used in the underwater environment. Required data are collected by the underwater sensors and directed towards the sink on the surface. Afterwards, the sink can transmit collected information to the monitoring centre via satellite for further analysis. Some unique features of UWSNs make data forwarding in this environment a challenging task [3]. This includes node movement, low available bandwidth, slow propagation speed, high deployment cost and a lossy environment. It also should be mentioned that the Global Positioning System (GPS) cannot be used in an underwater environment as a localization system because of the quick attenuation of its waves in water. Furthermore, nodes cannot be aware of their positions by pre-configuration, because they are not stationary due to the water current. Nevertheless, the depth of each node in the water can be estimated through an embedded pressure gauge.

The rest of the paper is organized as follows: Section II presents the related work; Section III presents the proposed work; Section IV presents the experimental analysis and concludes in Section V.

II. RELATED WORK

This section presents the prior works on geographic based routing systems. Underwater wireless sensor networks (UWSNs) have been showed as a promising technology to monitor and explore the oceans in lieu of traditional undersea wireline instruments [4]. Nevertheless, the data gathering of UWSNs is still severely limited because of the acoustic channel communication characteristics. One way to improve the data collection in UWSNs is through the design of routing protocols considering the unique characteristics of the underwater acoustic communication and the highly dynamic network topology. In this paper, Rdolfo et al propose the GEDAR routing protocol for UWSNs. GEDAR is an anycast, geographic and opportunistic routing protocol that routes data packets from sensor nodes to multiple sonobuoys (sinks) at the sea's surface. When the node is in a communication void region, GEDAR switches to the recovery mode procedure which is based on topology control through the depth adjustment of the void nodes, instead of the traditional approaches using control messages to discover and maintain routing paths along void regions [5]. Simulation results show that GEDAR significantly improves the network performance when compared with the baseline solutions, even in hard and difficult mobile scenarios of very sparse and very dense networks and for high network traffic loads.

Recent advances in environmental energy harvesting technologies have provided great potentials for traditional battery-powered sensor networks to achieve perpetual operations. Due to dynamics from the temporal profiles of ambient energy sources, most of the studies so far have focused on designing and optimizing energy management schemes on single sensor node, but overlooked the impact of spatial variations of energy distribution when sensors work together at different locations [6]. To design a robust sensor network, it has been used mobility to circumvent communication bottlenecks caused by spatial energy variations. Wang et al employ a mobile collector, called SenCar to collect data from designated sensors and balance energy consumptions in the network. To show spatial-temporal energy variations, first they conduct a case study in a solar-powered network and analyze possible impact on network performance. Next, the system presents a two-step approach for mobile data collection. First, adaptively select a subset of sensor locations where the SenCar [7] stops to collect data packets in a multi-hop fashion. Wang et al develop an adaptive algorithm to search for nodes based on their energy and guarantee data collection tour length is bounded. Second, focus is on designing distributed algorithms to achieve maximum network utility by adjusting data rates, link scheduling and flow routing that adapts to the spatial-temporal environmental energy fluctuations. Finally, numerical results indicate the distributed algorithms can converge to optimality very fast and validate its convergence in case of node failure [8].

In wireless sensor networks, sensor nodes are usually self-organized, delivering data to a central sink in a multi-hop manner. Reconstructing the per-packet routing path [9] enables fine-grained diagnostic analysis and performance optimizations of the network. The performances of existing path reconstruction approaches, however, degrade rapidly in large scale networks with lossy links. Gao et al presents Pathfinder, a robust path reconstruction method against packet losses as well as routing dynamics. At the node side, Pathfinder exploits temporal correlation between a set of packet paths and efficiently compresses the path information using path difference. At the sink side, Pathfinder infers packet paths from the compressed information and employs intelligent path speculation to reconstruct the packet paths with high reconstruction ratio. Gao propose a novel analytical model to analyze the performance of Pathfinder and further evaluate Pathfinder [10] compared with two most related approaches using traces from a large scale deployment and extensive simulations. Marchang et al reduce the duration of active time of the IDSs without compromising on their effectiveness. To validate the proposed approach, model the interactions between IDSs as a multi-player cooperative game in which the players have partially cooperative and partially conflicting goals

III. PROPOSED WORK

This section depicts the working model of our proposed algorithm. The proposed model composes of four phases, namely,

A) Topology creation:

The simulation process composes of finite number of sensor nodes with the number of sonobuoys are 6. It is randomly deployed with region of 2265 X 1000. The data packets are arranged in poisson process with low traffic load. Considers the effect of meandering sub-surface currents (or jet streams) and vertices. We set the main jet speed range from max 5 m/s to min 2.70 m/s. The nodes have a transmission range (rc) of 250 m and a data rate of 50 kbps. The size of the packet is deter-mined by the size of the data payload and by the space required to include the information of the next-hop for-warder set. They considered that data packets have a payload of 150 bytes.

B) Enhanced Beaconing process:

Periodic beaconing plays an important role in GEDAR. It is through periodic beaconing that each node obtains the location information of its neighbors and reachable sonobuoys, where each node can be informed beforehand concerning the location of all sonobuoys (as long-term underwater monitoring architecture is formed by static nodes attached to buoys and/or anchors), efficient beaconing algorithm that keeps the size of the periodic beacon messages short as possible. For instance, if each node ni embeds its known sonobuoy locations $|S_i|$ together with its location, the size of its beacon message in the worst case, without considering lower layer headers, $2(m+n) \times |N_s| + 2m + 3n$ bits, where m and n are the size of the sequence number and ID fields, and each geographic coordinates, respectively. Given that the transmission of large packets in the underwater acoustic channel is impractical, an enhanced beacon algorithm that takes this problem into consideration. Similarly, each sensor node embeds a sequence number, its unique ID and X, Y, and Z position information.

Moreover, the beacon message of each sensor node is augmented with the information of its known sonobuoys from its set $S_i(t)$ .Each node includes the sequence number, ID, and the X, Y location of the its known sonobuoys. The goal is for the neighboring nodes to have the location information of the all reachable sonobuoys. GPS cannot be used by underwater sensor nodes to determine their locations given that the high frequency signal is rapidly absorbed and cannot reach nodes even localized at several meters below the surface. Thus, each sensor node knows its location through localization services. Moreover, after a node broadcasts a beacon, it sets up a new timeout for the next beaconing.

C) Candidate Set selection using neighbors

Whenever a sensor node has a packet to send, it should determine which neighbors are qualified to be the next-hop forwarder. GEDAR uses the greedy forwarding strategy to determine the set of neighbors able to continue the forwarding towards respective sonobuoys. The basic idea of the greedy forwarding strategy is, in each hop, to advance the packet towards some surface sonobuoy. The neighbor candidate set is determined as follows. Let ni be a node that has a packet to deliver, let its set of neighbors be and the set of known sonobuoys $S_i(t)$ at time t.

D) Forwarder set selection using next hop process:

GEDAR uses opportunistic routing to deal with under-water acoustic channel characteristics. In traditional multihop routing paradigm, only one neighbor is selected to act as a next-hop forwarder. If the link to this neighbor is not performing well, a packet may be lost even though other neighbor may have overheard it. In opportunistic routing, taking advantage of the shared transmission medium, each packet is broadcast to a forwarding set composed of several neighbors. The packet will be retransmitted only if none of the neighbors in the set receive it. Opportunistic routing has advantages and disadvantages that impact on the network performance. For each transmission, a next-hop forwarder set F is determined. The next-hop forwarder set is composed of the most suitable nodes from the next-hop candidate set Ci so that all selected nodes must hear the transmission of each other aiming to avoid the hidden terminal problem. The problem of finding a subset of nodes, in which each one can hear the transmission of all nodes, is a variant of the maximum clique problem that is computationally hard. We use normalized advance (NADV) to measure the “goodness” of each next-hop candidate node in Ci. NADV corresponds the optimal trade-off between the proximity and link cost to determine the priorities of the candidate nodes. This is necessary because the greater the packet advancement is, the greater the neighbor priority becomes. However, due to the underwater channel fading, the further the distance is from the neighbor, the higher the signal attenuation becomes as well as the likelihood of packet loss.

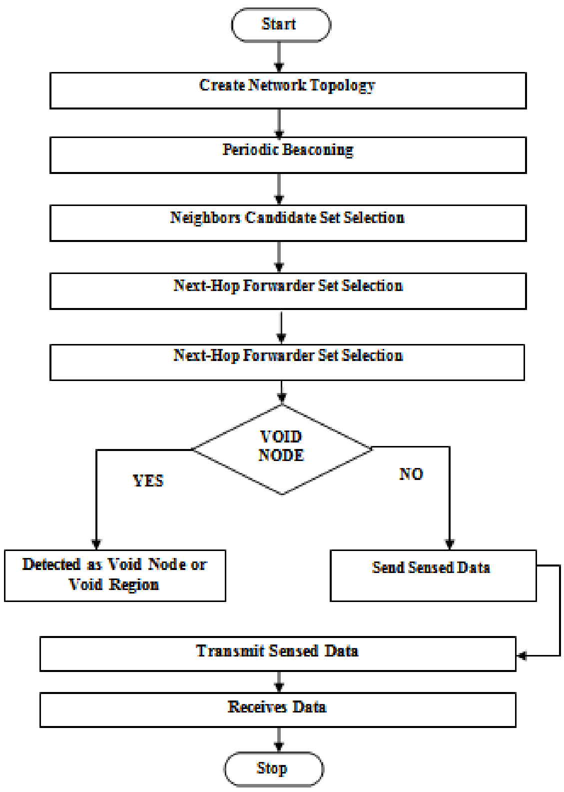

Fig.3.1 Proposed workflow

IV. EXPERIMENTAL RESULTS AND ANALYSIS

This section presents the experimental analysis of the proposed model in DOTNET framework.

Fig.4.1 Entering the receiver IP address and the data to be send

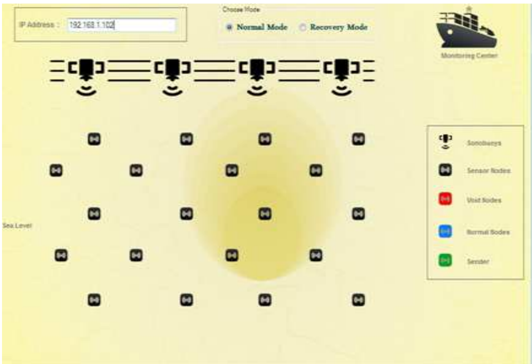

Fig. 4.2 Data monitoring process

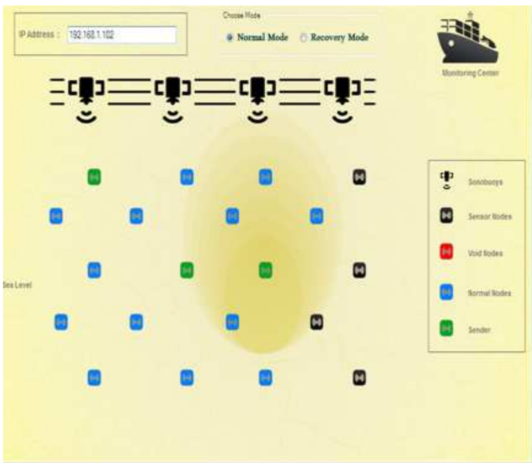

Fig.4.3 Finding the path for forwarding the data in normal node

Fig.4.4 Successfully receiving the files

V. CONCLUSION

The approach to the problem of data transmission is presented. Specifically, the packet which cannot meet its deadline constraints is dropped. By doing this, the delay is reduced and the packets reach the sink before the deadline. The energy usage is also minimized in the proposed scheme by means of selecting the best forwarders in the network for the transmission which comprises both the energy usage and also the deadline constraint. The comparison of the opportunistic routing is done with enhanced geographic based routing for evaluating the performance of the network and its shown that the approach outperforms making it a desirable choice. Experimental analysis has shown the efficiency of the systems.

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