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Secure Transmission of Data Under Water Wireless Sensor Network with Improved Performance

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ABSTRACT

UWSNs, or underwater wireless sensor networks, have been demonstrated as a possible alternative to conventional undersea wireline devices for ocean monitoring and exploration. The communication properties of the acoustic channel, however, continue to significantly restrict the data collection capabilities of UWSNs. The creation of routing protocols taking into account the special features of the underwater acoustic communication and the highly dynamic network topology is one technique to enhance the data collecting in UWSNs. The GEDAR routing protocol for UWSNs is suggested in this research. Data packets from sensor nodes are sent to several sonobuoys (sinks) at the surface of the sea using the anycast, geographic, and opportunistic routing protocol GEDAR. Instead of the conventional methods of using control messages to discover and maintain routing paths along void regions, GEDAR switches to the recovery mode procedure when the node is in a communication void region. This procedure is based on topology control through the depth adjustment of the void nodes. According to simulation data, GEDAR greatly outperforms baseline solutions in terms of network performance, especially in challenging mobile scenarios involving extremely sparse and dense networks as well as high network traffic loads. Key words: GEDAR,geo-opportunistic routing, underwater wireless sensor networks (UWSNs).

1. INTRODUCTION

Numerous academics have become interested in underwater wireless sensor networks (UWSNs) due to their numerous applications in the environment, sciences, industry, and military. Both radio and optical signals have an effect on how well UWSNs function, but radio signals have a bigger effect because they travel over longer distances at lower frequencies (30-300), require large antennas, and require more energy to broadcast. Underwater. Routing according to region is easy and scalable[1]. To enhance data delivery and lower energy usage for packet retransmissions, geographic routing and opportunistic routing (OR) (geo-opportunistic routing) can be coupled. Once a packet has been correctly received by a next-hop node in the set, it will only be transmitted if the highest priority nodes in the forwarding set have not already done so. We provide a trustworthy spatial opportunistic routing protocol that is immune to numerous attacks and can be utilised without the cost of an expensive PKI. When the present forwarder node is the only one closer to the destination than itself and there isn't a neighbour node closer to the destination, this is known as a communication vacuum region problem. In this paper, we propose the GEDAR routing protocol, which combines topology management based on depth adjustments and geographical and opportunistic routing.Since the Hop-ID rises with the number of deeper depth sensors, each node placed close to the sink will have a low Hop-ID.

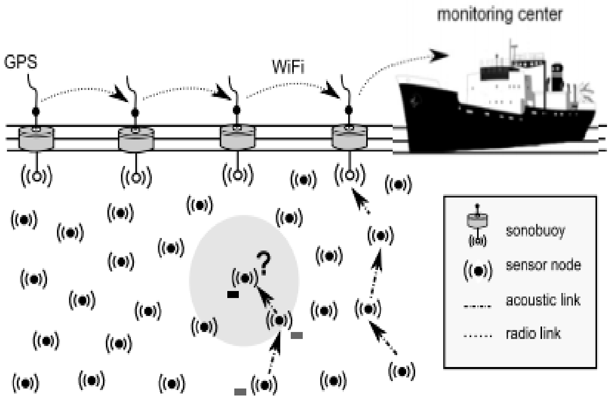


Fig1. The proposed under water architecture

Using the coordinates of a few well-known sonobuoys and the location information of nearby nodes, in the direction of the target. These are the sensor nodes, which are mobile and have a limited bandwidth. Utilising the sonobuoys that are well-known to be in the target's general area, as well as the location data of certain neighbouring nodes. These are the mobile sensor nodes of its low bandwidth capability. The delicate nature of communication in this environment makes it challenging to transmit information using conventional methods. The unique void node recovery method of the GEDAR is its most significant feature[2]. We suggest adopting a topology control method based on void node recovery depth adjustment rather than the conventional message-based void node recovery process. The results of the simulation demonstrate that void node number reduction is possible using GEDAR's depth adjustment-based void node recovery methodWhen compared to the most recent routing protocols and the simple geographic and opportunistic routing (GOR) without any recovery mode, GEDAR improves the packet delivery ratio and decreases end-to-end delay for the important situations of low and high densities and diversified network traffic loads. Additionally, in this study, we create an opportunistic routing method to alleviate the limitations of underwater acoustic communication. Sonobuoys and anchors were used as sensor nodes in a static underwater sensor network scenario.

2. RELATED WORK

There are several uses for underwater sensor nodes, such as obtaining oceanographic data, monitoring pollutants, offshore exploration, disaster prevention, assisting navigation, and tactical surveillance. Furthermore, scientific data collection during cooperative monitoring flights will be made possible by sensor-equipped unmanned or autonomous underwater vehicles (UUVs, AUVs). The key components of underwater acoustic communications are examined in this paper. They are still insufficient for usage in underwater communications because of their inefficiency in conserving energy. The nodes' falling throughput is substantial as the distance between them increases.We present a novel platform for underwater sensor networks in this article that will be used to continuously monitor fisheries and coral reefs. Both stationary and moving underwater sensor nodes make up the sensor network. In order to cut down on energy use, increase packet delivery ratio, and further maximise network lifetime, it is essential to design and build an efficient algorithm that addresses the aforementioned issues.In multihop wireless networks, we propose a novel link metric for geographic routing called normalised advance. NADV selects neighbours based on the optimal trade-off between proximity and link cost. When combined with geographic routing's local next hop choice, NADV enables a flexible and efficient cost-aware routing method. In accordance with the objective or message priority, applications can use the NADV framework to minimise a variety of network costs. We offer reliable methods for calculating link costs and carry out exhaustive simulations in a variety of scenarios[3]. Our results show that NADV outperforms current systems in a number of different ways. In noisy environments with frequent packet losses, using NADV, for instance, led to a delivery ratio that is 81% higher.When compared to centralised routing, geographic routing using NADV identifies paths with costs that are almost optimal.In order to improve the efficiency of packet delivery, this work investigates the geographic collaborative forwarding (GCF) scheme, an opportunistic routing variant that exploits the broadcast properties and spatial diversity of the wireless medium. To provide comprehensive analysis and guidance for the development of more efficient routing and forwarding protocols, our goal is to fully appreciate the underlying concepts, advantages, and drawbacks of node collaboration. The highest expected packet advancement (EPA) that GCF is capable of accomplishing is first determined, and its concavity is then shown.In order to balance packet advancement, dependability, and energy consumption, we propose a new metric called EPA per unit energy utilisation. A major issue is energy efficiency. We then offer a practical method for selecting a viable candidate pool that maximises this local metric by utilising the tested attributes[4]. To demonstrate the effectiveness of the new metric, we compare GCF's performance with that of the existing geographic and opportunistic routing approaches. Simulations are used to validate the validity of our analytical findings.

.If each node ni embeds its known sonobuoy locations, for instance $|S_i|$ If lower layer headers are not taken into account, along with its location, the size of its beacon message $2(m+n) \times |N_s| + 2m + 3n$ bits, where m and n represent, respectively, the size of the sequence number and ID fields and the geographic coordinates.

To identify the neighbours who can forward the packet to a specific destination, we use the packet advancement (ADV) metric[5]. The distance between the source node and the destination node D, less the distance between the nodes that are next to each other, is what is referred to as the packet advancement. Accordingly, the neighbours candidate set in GEDAR is as follows:

$$\mathcal{C}_i = \{n_k \in N_i(t) : \exists s_v \in S_i(t) \,|\, D(n_i, s_i^*) - D(n_k, s_v) > 0\},$$

Where D(a,b) is the euclidean distance between the nodes a and b and $s_i^* \in S_i(t)$,is closest sonobuoy of ni as:

$$s_i^* = argmin_{\forall s_j \in S_i(t)} \{D(n_i, s_j)\}.$$

3. THE PROPOSED PROTOCOL AND PERFORMANCE ASSESSMENT

Several sonobuoys are intended to receive a packet from a source node utilising the anycast, geographic, and opportunistic GEDAR protocol. With each hop, GEDAR uses the greedy forwarding technique to get the packet closer to the surface sonobuoys. A recovery mode technique based on the depth modification of the void node is used to transport data packets that become stuck at void nodes[6]. The proposed routing protocol employs the greedy forwarding technique to determine the qualified neighbours to continue for-warding the packet towards some sonobuoys by using the location data of the current forwarder node, its neighbours, and the known sonobuoys.

GEDAR considers the anycast nature of underwater routing when multiple surface sonobuoys are deployed as sink nodes, despite the fact that the next-hop forwarder selection technique known as "greedy forwarding" is widely used.

Algorithm for Proposed Approach

```
Packet of data to be send to destination is ready
1. Send request to neighbor nodes for HopID
2. Received Hopid stored in an array
     Array is sorted  to get the minimum Hopid
3. If min Hopid<current Hopid Then
4.     If current node and source node are different then
5.         Send ACK to previous hop node
6.         Forward the data packet to the node with min HopID
7.     Else
8.         Forward the data packet to the node with min HopID
9.     End if
10. Else
11. Wating time enabled for given time
12. Goto step 1
13. End if
```

3.1 Simulation of WSNs

In wireless sensor environments, only the agent-based modelling and simulation paradigm currently permits the simulation of complex behavior. A more contemporary paradigm uses agents to simulate wireless sensor and ad hoc networks[7]. OPNET, NetSim, NS2, and OMNeT are a few examples of network simulators that can be used to simulate a wireless sensor networ

3.2 Simulation setup

To assess GEDAR's implementation of opportunistic routing. Using underwater architecture, a 600 m by 600 m aquatic region is reconstructed. In this setting, 46 sensors have been placed and are configured for geo-opportunistic packet routing to the centre, where there is a single sink node (a submersible) for data collection[8]. Each sensor starts the simulations for each scenario with 10 kJ of initial energy, and it is assumed that every node is arranged with the same height and orientation.

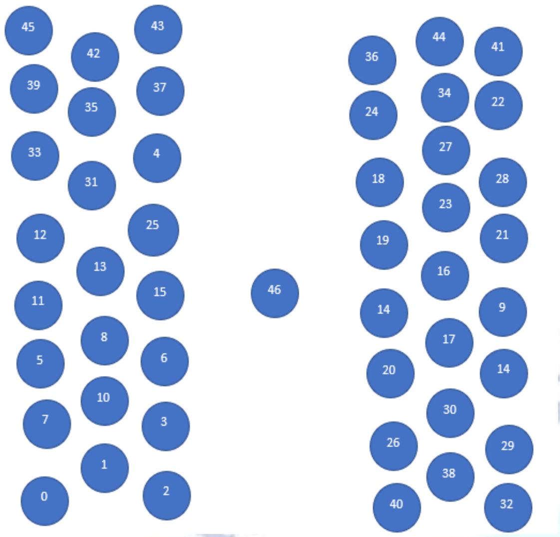


Fig 3. Overall design of the network

3.3 Performance metrics

We focus on two factors to evaluate how well our proposed GEDAR performs:

3.4 Packet delivery

This parameter allows us to monitor the impact of changes in the transmitted data by counting the number of segments received[9]. As more packets are provided, the performance of our data gets better.

3.5 Retransmission ratio

Since it indicates how frequently a segment is received, this measurement is essential for undersea communication. Energy loss is one of the major problems in the marine environment, and it is addressed in this information[10]. The ideal number is as low as is practical.

Table 1.

THROUGH PUT

It is described using data transmission and receptionrates.

Round trip latency	TCP throughput
0ms	93.5 Mbps
30ms	16.2 Mbps
60ms	8.07 Mbps
90ms	5.32 Mbps

4. RESULTS AND DISCUSSION

GEDAR also provides a novel topology control mechanism based on depth adjustment that is used to move void nodes to new depths in order to get around the communication void regions. Our simulation findings showed that geographic routing methods based on the position location of the nodes are more successful than pressure routing protocols.Along with reducing the number of transmissions required to deliver the packet, opportunistic routing has also been shown to be crucial for the network's performance. By using node depth adjustment to address communication void zones, network performance was significantly improved.

Table 2.

Description of essential simulation parameters.

Parameter	Value
Channel	Wireless Channel
Propagation	Two Ray Ground
PHY	Wireless Phy
Antenna	Omni Antenna
Distance	75m, 84m
Frequency	25KHz
MAC protocol	Broadcast Mac
Mac bit rate	50kbps
Mac Packet header size	0
Delay	15ms
Routing Protocol	AODV
Transmission Range	600 X 600 m^2
Simulation Time	50seconds
Capacity of Channel	2Mbps
Energy at Initial Phase	10000J
Transmission Power	2.0W
Node Range	100m
GOR sender	void node
GOR receiver	GOR sink

4.1 Results and analysis

In this part, evaluate the effectiveness of the simulation. We are using the x-graph to evaluate performance. We choose two metrics for evaluation, end-to-end delay and packet delivery ratio.which measures the ratio of total packets received by the destination node to total packets sent by the source. and figure out how much energy the sensor node uses. We must analyse the simulation performance in the x-graph along with these evaluation measure

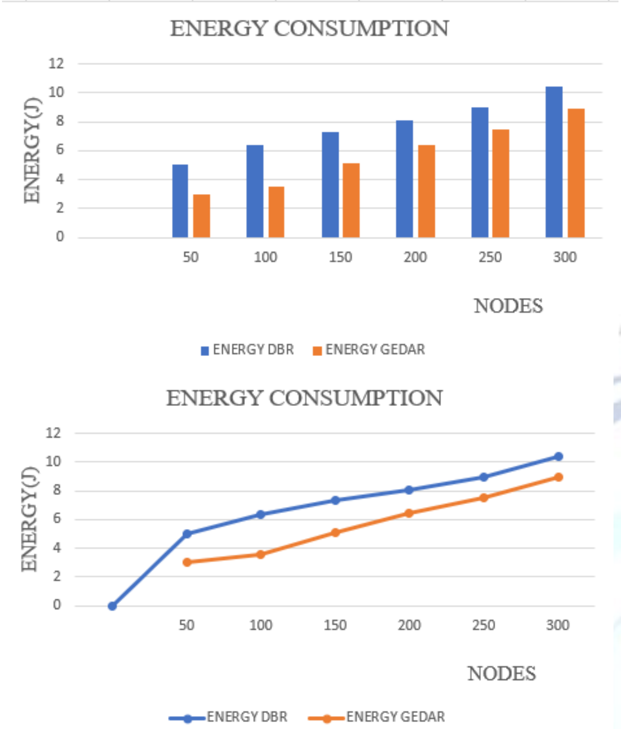
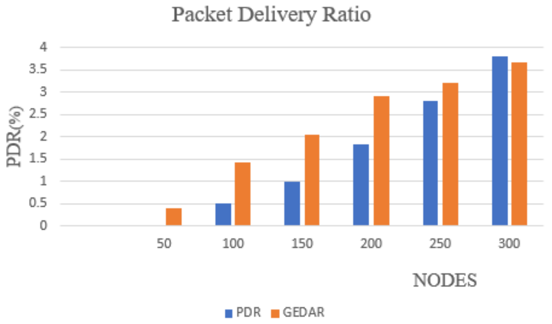


Fig 4.1 Comparison of underwater network energy consumption with number of sensor nodes.

Node vs. Energy Consumption (J)			
Nodes	DBR	GEDAR	% Improvement of GEDAR as Compared with DBR
50	5	3	40
100	6.3	3.5	23.8
150	7.3	5.1	32.8
200	8.0	6.4	40
250	8.9	7.4	45.9
300	10.4	8.9	54.9

Table 4.1 The obtained results of GEDAR with regard to energy consumption



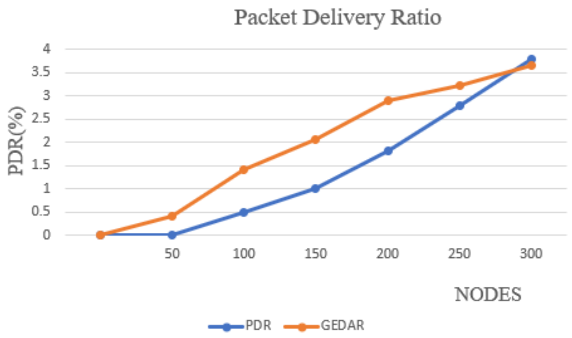


Fig4.2 Comparison of underwater packet delivery ratio with increasing number of nodes.

Node vs. Packet Delivery Ratio (%)			
Nodes	PDR	GEDAR	% Improvement of GEDAR as Compared with PDR
50	0	0.4	4
100	0.4	1.4	14.4
150	1.0	2.0	30
200	1.8	2.9	30.8
250	2.7	3.2	34.7
300	3.7	3.6	39.7

Table 4.2 The obtained results of GEDAR with regard to packet delivery ratio.

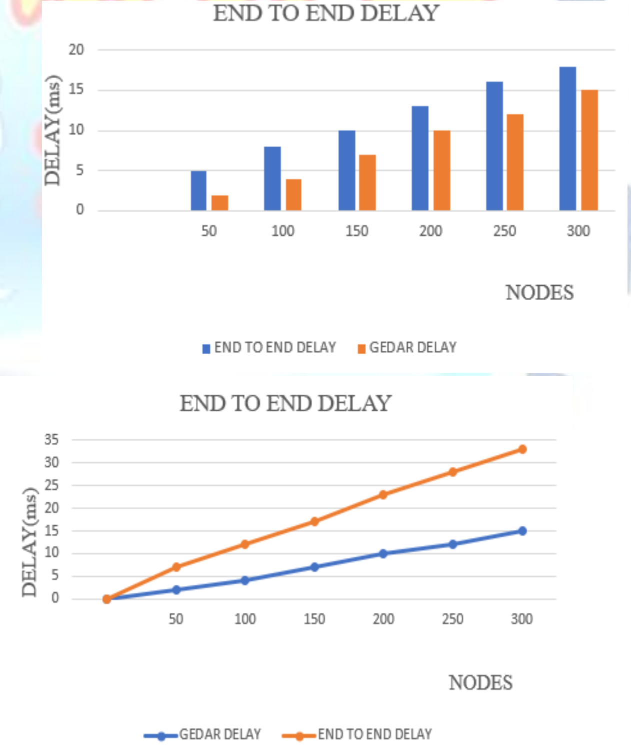
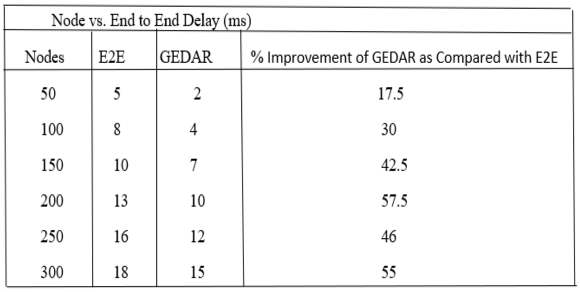


Fig4.3 Comparison of underwater end-to-end delay performance with increasing number of nodes



Node vs. End to End Delay (ms)			
Nodes	E2E	GEDAR	% Improvement of GEDAR as Compared with E2E
50	5	2	17.5
100	8	4	30
150	10	7	42.5
200	13	10	57.5
250	16	12	46
300	18	15	55

Table 4.3 The obtained results of GEDAR with regard to end to end delay

5. CONCLUSIONS AND FUTURE WORK

This study improved data routing in underwater sensor networks by developing and testing the GEDAR routing protocol. In order to efficiently and greedily distribute data packets in the direction of the sea surface sonobuoys, the GEDAR geographic routing protocol makes advantage of node placements and the broadcast communication channel. Both simplicity and scalability are features. GEDAR also provides a novel depth-based topology management method that is used to move void nodes to new depths in order to get around communication void zones. The simulation's results showed that pressure routing protocols are less efficient than geographic routing methods based on the position location of the nodes.The effectiveness of the network has also been shown to depend on opportunistic routing because it reduces the number of transmissions required to deliver a packet. Applying node depth adjustment to accommodate communication vacuum zones dramatically improved network performance. In comparison to GUF and GOR, GEDAR effectively lowers the proportion of nodes in communication vacuum zones under medium density conditions to fifty-five percent and forty-four percent, respectively. GEDAR improves network performance in comparison to conventional underwater routing methods in a variety of network density and traffic load scenarios.To create opportunistic routing protocols for UWSNs, we want to apply these topological control of depth adjustment principles while taking various QoS requirements for data delivery, the cost of reaching a neighbour node, and the network lifetime into account.

Conflict of interest statement

Authors declare that they do not have any conflict of interest.

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