Novel Vector based Forwarding Protocol and Efficient Depth based Routing Protocol Acoustic Underwater Wireless Sensor

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Research Article

Keywords: Routing Protocol, Energy Consumption, UWSNs, Novel Vector-based Forwarding, Efficient depth-based Routing

DOI: https://doi.org/10.21203/rs.3.rs-312620/v1

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Abstract

Underwater Wireless Sensor Network offers broad coverage of low data rate acoustic sensor networks, scalability and energy saving routing protocols. Moreover the major problem in underwater networks is energy consumption, which arises due to lower bandwidth and propagation delays. An underwater wireless sensor network frequently employs acoustic channel communications since radio signals not worked in deep water. The transmission of data packets and energy-efficient routing are constraints for the unique characteristics of underwater. The challenging issue is an efficient routing protocol for UWSNs. Routing protocols take advantage of localization sensor nodes. Many routing protocols have been proposed for sensing nodes through a localization process. Here we proposed a Novel vector-based forwarding and efficient depth-based routing protocol. The proposed novel vector-based forwarding provides robust, scalable, and energy-efficient routing. It easily transfers nodes from source to destination. It adopts the localized and distributed alternation that allows nodes to weigh transferring packets and decreases energy consumption and provides better optimal paths. Efficient depth-based routing is a stochastic model that will succeed in a high transmission loss of the acoustic channel. The simulation was used to compare the energy consumption, network lifetime in the form of depth-based routing, delivery ratio, and vector-based forwarding to prove the optimal route finding paths and data transmission propagation delay.

1. Introduction

Remote sensor networks have been utilized broadly in many land-based applications. Moreover, for a significant period of time, the methodologies for building submerged sensor organizations were rapidly evolving. It is giving versatile and clever steering administration in UWSNs. It is highly tested because of the novel characteristics of submerged sensor entities. Due to the high weakening of radio recurrence signals or the desirable adoption of large separations and high operating frequencies, underwater sensor networks generally use acoustic signals for communications. Despite the way that the submerged acoustic channel is one of the most testing remote spread media, an enormous number of utilizations, for example, early notice frameworks (e.g., for torrents), environment checking, oil boring, military observation, etc, leaves us no choice except for using submerged acoustic sensor organizations.

In UWSNs, the acoustic signal is commonly preferred over the radio signal. The performance of radio signals in water is low as compared with acoustic signals. In any case, the acoustic signal user in the UWSNs faced a few complications. The acoustic signs have restricted transmission capacity due to the high ingestion factor. Likewise, proliferation postponement of acoustic signs is longer than radio signs. In UWSNs, the increase in network life is important, as the replacement of batteries in such an environment is over expensive. The directing conventions have a significant function in the planning network model. In UWSNs, directing convention assumes a significant part of the proficient progression of information from source to the objective. In UWSNs, the plan of the effective directing convention is a difficult errand due to brutal climate, clamors, contamination, temperature and so forth. The plan of proficient steering convention in UWSNs considers diverse boundary. To expand network lifetime, steering convention must
consider productive usage of energy. The utilization of energy during packet exchange is greater than the acceptance of the packet. A hub can send a packet straightforwardly to the base station or embrace multi-jump transmission. Also, a hub devours more energy when sending a packet at a long separation. A steering convention is effective on the off chance that it lessens the number of transmissions and furthermore partition heap of work similarly among all the hubs. Among steering conventions for UWSNs, a significant job is played by limitation-free conventions. These expect that hubs just know their profundity (and conceivably that of their neighbors) when taking directing choices. Such conventions are generally received for networks with high hub portability, channel blurring, and so on as they are fit for finding new courses for every transmission. Therefore, the boundaries of the convention must be arranged to adjust the different presentation records. For a given cost, the optimal arrangement achieves the best balance between energy utilization, mean start to finish delay, throughput, and conveyance likelihood; and so for the test network, the environment in UWSN is seen in the accompanying Fig. 1. It shows the overall structure of the UWSN, different sending techniques for UWSNs are spoken to, for example, cabled ocean bottoms and acoustic correspondence joins.

The epic part of this paper is the cutting-edge examination and diagram of the current steering conventions for UWSN. One of the most broadly utilized confinement-free directing conventions is Depth Based Routing (DBR). DBR utilizes the profundity data of hubs to assemble a course from the source sensor hub to the on-surface sink. The hubs gauge their profundity by ready weight sensors and add this data to any bundle they convey, with the end goal that all beneficiaries can compute the profundity distinction between themselves and the transmitter. DBR embraces a recipient-based sending plan in which the potential forwarders are picked based on the profundity contrast between the sender and the collector. So as to decrease repetitive transmissions, DBR presents the idea of a parcel holding time, i.e., a period that a likely forwarder holds up prior to sending the bundle. Various conventions are proposed in writing, which contribute towards proficient directing in UWSNs. DBR [7] is a steering convention that utilizes sending profundity of a sensor hub to decide the course of an information parcel from its source hub to the sink. Hubs are typically sent arbitrarily in submerged climates and the sink is set at the outside of water. More profound Sensor hubs send information parcels to the hubs to lower profundity. Getting hub at that point sends this bundle to the next hub with lower profundity. Along these lines, information parcels are passed to the sink. In DBR, nodes that are a long way from the sink only send their own personal information parcels to low-profundity hubs subsequently devouring lesser energy.

Various conventions are proposed in the literature, which contributes towards productive steering in UWSNs. DBR is a directing convention that utilizes the arrangement profundity of a sensor hub to decide the course of an information bundle from its source hub to the sink. Nodes are typically conveyed arbitrarily in submerged climates and the sink is put at the outside of water. In this way, data parcels are passed to the sink. In DBR, nodes that are a long way from the sink only send their own personal information bundles to low-profundity hubs henceforth devouring lesser energy and going on for a longer time. On the other hand, sensor hubs close to the sink get information parcels from every other hub and send them to the sink. It communicates its own personal information bundles to the sink. So they devour more energy than every other hub and pass on. Directing is an essential issue for any organization and
steering conventions are estimated to keeping up the courses and charge of finding. The vast majority of the review works with respect to UWSNs has issues identified with the organization layer, for example, steering strategies are to some degree new region and actual layer. An efficient steering calculation convention is used to research this problem. Despite the fact that submerged systems administration and steering are still at the newborn child phase of the study. The submerged sensor networks have proposed various directing conventions. The rundown of the steering conventions in UWSNs is clarifying the focal points, weaknesses, functionalities, and execution issues for every method. The organizational design of UWSNs steering conventions is classes into area-based, level, and progressive directing conventions. Vector-Based Forwarding (VBF) convention has been proposed so as to unravel the issues of high mistake likelihood in the extraordinary organization. VBF is an area-based steering convention. One of the critical functionalities in building submerged sensor networks is to course information from sources (sensor hubs that gather and create information) to sinks (some surface hubs which are associated with on-shore war rooms). The first directing convention intended for versatile submerged sensor networks is Vector-Based Forwarding (VBF). VBF is a direction-based sending convention. It speaks to a direction with a "steering vector" from the source to the sink. Instinctively a virtual line with the source-to-sink vector as the pivot is utilized as the theoretical course for information conveyance. The Novel Vector-based Forwarding is tending to direct issue and adaptable, solid, and energy proficient in submerged sensor organizations. It is essentially an area-based steering approach and does not have the necessary state data on the sensor hubs, and only a small division of the hubs is engaged in steering.

Future more, in VBF, parcels are sent superfluous and interleaved ways from a source to an objective, consequently, VBF is incredible against bundle misfortune and hub disappointment. Also, here build up a restricted and appropriated self-variation calculation to upgrade the exhibition of VBF. The self-variation calculation permits hubs to adjust the advantage of sending parcels and in this manner diminish energy utilization by eliminating low advantage bundles. VBF can effectively accomplish the objectives of power, energy productivity, and high achievement of information conveyance.

2. Related Works

S. Basit and M. Kumar [13] are supporting guiding conferences for underwater wi-fi locator organizations. The creators complex the 10 notable styles of directing conventions for u.s.a. i.e., Vector-based all, extra favorable district quality, profundity fundamentally essentially based Routing, centered Beam Routing, Hop-by utilizing Hop Dynamic Addressing, sans ps, transient Propagation set back Multi-course and strain Routing Protocol. They collectively investigate these conventions explicitly with the strengths and downsides of each one. Another quite complete analysis is the expense of the different components of our steering conventions. The WSN guiding conventions in the various square measurements are fully illustrated much like the u.s. Many observers have been interested in the presentation investigation of UWSNs, their development, and control for more than a decade.

Recreational rather than formal models are the number one tool to look at implementation, according to G. Fish and V. C. Gungor [9]. Although replication models are often terribly accurate, execution
calculations are, by and wide, time-consuming, and their reception for enhancement capacities is incredibly expensive. An assortment of the expository models, look at the spacial related fleeting vulnerability of the submerged acoustic channel and broaden an applied arithmetic form that is acclimated propose a particular disseminated back topic with an upgraded transmission approach. In those papers, neither the calculation of the suggested end-to-stop setback and quality admission nor the effect of the steering conventions on the organization's execution is considered. Then DBR is ready for us from America, an innovative technique, in the comprehension of Syed Bilal Hussain [6]. DBR utilizes the features which characterize during which, insights sink square measure basically composed at the outside of the water. Thus, in point of the significant records of various sensors, DBR measurements programs voraciously inside the bearing of the water floor. In DBR, the companion information bundle is sent reprobate and modified for the character jump, containing information about the circle of its sizable dimensions. One of the most important reasons for the success of their approach is that they can properly structure additional substances without the use of a restriction benefit. DBR offers a dissipated directing convention in point of neighboring insights of the indicator center focuses. For the different sink engineer environments, assume that the sinks are without a point and that they are continuously sent on the water surface. Given the coordinated technique and, as a result, the middle reason affiliation, it is feasible to locate a superior amusement set up ranges for the various sinks to finish the higher execution.

S. M. Mazinani et al. [5] proposed a directing convention called Vector-essentially fundamentally based Forwarding (VBF). The right to anticipate each locator hub to have its own region is referred to as the VBF convention. Any identifier center will then deliver reality packages containing the world realities' of flexibility, objective, and a selection area. With a given sweep, the forward hubs cause causation to the line. Advanced hubs are chosen in this case. The Pipe is a part of the elegant hub to the sink hub. The extent of the whole network is withered as a result of vector-based forward reductions measure of sending hubs. Despite the undeniable fact that getting the sweep of the line is miles short. Any of these VBF conventions have the potential to improve vehicle quantitative connectivity and force usage.

3. Theoretical Background

3.1 Underwater Sensor Networks

Submerged organization's actual layer uses acoustic innovation for correspondence. Restricted data transmission, limit, and variable deferrals are attributes of acoustic innovation. Accordingly, new information correspondence procedures and effective conventions are needed, for submerged acoustic organizations. Planning the organization's geography requires a huge commitment from the planner, on the grounds that submerged organization execution is for the most part contingent on geography plan. Organization dependability should increment with effective organization geography and organization unwavering quality ought to likewise diminish with less productive geography. Energy utilization of productive organization geography is profoundly less when contrasted with off base and less effective geography plan of a submerged organization.
3.2 Depth-Based Routing Protocol

DBR is a standard geographic directing convention dependent on the profundity data of every sensor that can be estimated by the profundity sensor. So as to additional control the number of hubs partaking in bundle sending, the creator included profundity limit $d_{th}$. When a hub receives a package, it sends it if its profundity is less than the profundity of the previous hub less $d_{th}$. Otherwise, the package is discarded. The creator proposed a holding time so as to lessen the quantity of excess sending parcels in DBR. DBR can function admirably in the different sink submerged sensor designs. Its correspondence design is given in Fig. 2.

The reasons that our safe convention depends on the DBR convention are as per the following: Full dimensional field data isn’t needed by the DBR Protocol. The DBR Protocol ready to keep up unique organizations through ideal energy productivity and it uses advantages of a few sink network designs without presenting extra expense.

DBR can utilize the advantages of the different sink submerged sensor network design. A case of such organizations is outlined in Fig. 3. The various sinks USNs are set with both radiofrequency and acoustic modems, both of these situated at the water surface. In DBR, a sensor hub distributive settles on its decisions on bundle change, in light of its own personal profundity and the profundity of the previous sender. It is the critical thought of DBR. In DBR, while accepting a parcel, a hub first recuperates the profundity $dp$ of the bundle’s prior bounce, which is joined in the bundle. The getting hub at that point contrasts its own personal profundity $dc$ and $dp$. On the off chance that the hub is closest to the water surface, i.e., $dc < dp$, at that point it will think of itself as a certified possibility to advance the bundle. Else, it drops the parcel since the bundle originates from a (superior) hub that is closest to the surface. It is useless for the accepting hub to advance the bundle.

DBR steering convention doesn’t track total measurement and area data of hubs. The source hub sends its profundity data alongside the information bundle to the middle hub. The middle hub contrasts its profundity and the profundity of the source hub, in either case, a hub with less profundity and close to the sink is chosen as sending hub. DBR is cost-effective contrasted with other area-based directing conventions. The crash must be kept away from in situations when more than one hub turns out to be similarly qualified for sending the bundle.

3.3 Vector-Based forwarding protocol

Vector-Based sending convention is additionally called an area-based directing convention. The Location-based steering convention is intended for submerged sensor organization. It alludes to a portion of the issues that are helpful to upgrade the lower delay and fruitful pace of the directing convention in submerged sensor organizations. VBFP engineering depends on submerged sensor organization and it assumes a significant part in the USN. VBF is known as a vector-based directing sending convention. In some cases, VBF is called a steering pipe. The directing line is utilized to play out a particular errand for building the association between source, objective, and bundle conveyance. The information bundle is an
assortment of the goal, sender area, sender, and reach field. Energy proficiency, higher information conveyance, Robustness, and energy adequacy these four highlights are going under area-based convention however they haven't existed in USN as a result of this VBF is presented. This convention is useful for the bundle to communicate directing-related data, and no state data is needed for hubs that are similarly adaptable in terms of organization size. That hub is close to the steering vector and is remembered for information transfer. So it is viable. Likewise, the self-adaption calculation allows a hub to assess its outcome in its area and henceforth change its sending plan to spare more energy. The recreation results have set up the VBF demonstrating execution.

3.4 Methodology of Novel Vector-based Forwarding Protocol and Efficient Depth based Routing Protocol

Acoustic Underwater Wireless Sensor

a. Underwater Wireless Sensor Network (UWSN)

From different divisions, there has been a major consideration in viewing the submerged climate for logic, business, and military activities. Constant observing is significant for the vast majority of the application and that calls for the need of building Underwater Wireless Sensor Networks (Fig. 3). UWSNs contain surface stations, sensor hubs, and self-ruling submerged vehicles organized to accomplish the shared observing errands.

b. Routing Protocols in UWSNs

Energy-saving is a major concern for UWSNs. One of the most complex undertakings in portable hubs is the transfer of knowledge from source hubs to sink hubs. At times, the versatility of the node is often taken care of in UWSNs. Directing Protocols in UWSNs is partitioned into three different ways i.e proactive, reactive and topographical. The table-driven is another name for proactive. In the case of requests, the proactive routing contains massive overhead, either at times or when environmental changes occur. Responsive conventions are more reasonable for complex organizations, which could trigger massive delays and enable the source to respond to floods of control bundles for guidance.

4. Problem With Routing In Underwater Sensor Network

There are numerous issues with steering in submerged sensor organization. Those issues are:

A. The organizational climate is the fundamental testing capacity and it goes under steering convention for submerged sensor organization.

B. It has a low Bandwidth limit because the steering convention for submerged sensor network originates from high piece blunder rates.

C. The following problem is that of low energy consumption. It needs the use of battery power.
D. Because of the longer engendering delays, a radio single can't compete with a submerged sensor organization's directing convention.

E. The principal factor of the steering convention of the submerged sensor network is high engendering delay.

4.1 VBF Underwater Sensor Networks

DBR steering convention doesn't keep up a record of complete measurement and area in the arrangement of hubs. The source hub sends its profundity data alongside the information parcel to the middle hub. The depth of the middle of the road hub is compared to the depth of the source hub; in any case, the hub with the fewest profundities and closest to the sink is chosen as the sending hub [14]. DBR is cost proficient contrasted with other area-based steering conventions. The crash must be evaded in situations when more than one hub turns out to be consistently qualified for sending the bundle.

4.2 Depth based routing protocol (DBR)

Figure 5 presents the sending hub choice situation of DBR. Hubs n1, n2, and n3 are neighbors of one bounce of the sender hub S. Hub n3 are more profound inside and out, so it will not be considered, hub n1 and n2 both are qualified for sending the information, n1 which is near the sink is chosen as the sending hub.

5. Experimental Simulation

In this work, we recreated the presentation of the Novel-VBF and E-DBR. The MATLAB 7.0 is utilized for these recreation measures. Examinations use the same number of nodes in a reproduction. 400 sensor hubs are utilized for checking a 500 m * 500 m * 500 m region. The beginning energy of every sensor hub is 5 joules. Force usage of the hub in sending and getting information is 2 W and 0.1 W correspondingly. Any sensor hub's transmitting range is set to 100 meters. Each layer has an 80-meter depth, and each layer uses 80 hubs to handle irregular requests. The whole hubs pass 2–3 m/sec of water flows in the flatways.
Table 1
Parameters of Experimental simulations

| Simulations Parameters | Simulations Values |
|------------------------|--------------------|
| Simulations Area       | 500 m * 500 m * 500 m |
| Total nodes            | 400                |
| Starting energy of nodes | 5 joule           |
| Size of data Packet    | 200                |
| Range of Communication | 100 m              |
| Total Sink Nodes       | 2                  |
| $\alpha, \beta, \gamma, \theta, \mu, \epsilon$ | 1,1,0.7,0.3,0.6,0.4 |

Forwarder Node Selection Algorithm

1: **Initialization Forwarder Node Selection**

2: **for** each Hi of the head node

3: **for** each Hj of a head node is neighbors Hi’s

\[ \text{LN-1} = \text{Hj’s LN} \]

4: compute $H_{cost}(j)$

5: **end for**

6: choose two nodes as forwarders with two highest $H_{cost}$

7: send packet N_DATA to the forwarder

8: **end for**

9: **for** each Ni node gets a data packet

10: **if** next-hop id1 in received packet = Ni’s id

11: **if** the data packet $\notin$ records

12: saves data packet

13: sends a data packet

14: **else** delete the data packet

15: **end if**
16: **else if** next-hop id2 in received packet's id
17: **if** the data packet $\notin$ records
18: saves data packet
19: certain time packets wait
20: **if** not gets the same packet
21: sends a data packet
22: **else** delete the data packet
23: **end if**
24: **else** delete the data packet
25: **end if**
26: **else** delete the data packet
27: **end if**
28: **end for**

In this work, the presentation of every convention is estimated regarding ideal discovered ways, bundle conveyance proportion, network lifetime, energy utilization, and engendering delay. The proportion of the number of bundles effectively got at the sink hubs to the number of parcels sent from the source hubs is known as Packet Delivery Ratio. The examination reenactments are actualized to assess the exhibition of conveyance proportion in NVBF and EDBR. Figure 6 shows the recreation of the conveyance proportion of EDBR, every sensor hub has a specific holding time dependent on the profundity contrast between a sending and a getting hub. In NVBF, the conveyance proportion is moderately in a way that is better than EDBR. Despite the fact that NVBF uses a special holding period for each forwarder, the holding time is limited and does not affect the general postponement.

Energy Consumption is the primary indicator of an organization's efficiency, and it reflects the status of the organization's lifespan. The organization's lifespan is extended as it uses fewer resources. Figure 7 shows the recreation aftereffects of energy utilization. NVBF and EDBR are used to adjust the load of the whole organization, resulting in a longer lifetime and more efficient use of resources. This organization devours more energy; consequently, the leftover energy is less contrasted with the current framework.

Network Lifetime is the amount of time it takes for the entire organization to transfer all of its resources before all of the hubs die. Individually, the recreation results in the execution of NVBF, VBF, EDBR, and DBR lifetimes. Every convention containing a diverse number of hubs is mimicked with various layers.
Figure 8 shows the organization's lifetime diminishes with the expansion in the number of layers. Since each information bundle has a smaller number of hub contributions, there is a lower chance of impacts extending the organization's lifespan. The EDBR and VNBF, out of the two existing frameworks, have the longest lifespan.

Propagation delay refers to the time it takes for sink hubs to receive information packets from source hubs. Figure 9 depicts the results, which show how time is affected by the distance between a sending and receiving hub. After that, an information bundle is obtained and stored for a long time. Proliferation immediately identifies the parcel by deferring the most evident requirement. Therefore delay is reduced. Therefore information decrease is diminished the engendering time.

6. Conclusion

This paper suggested a novel vector-based transmitting and efficient profundity-based steering convention that saves a lot of energy and transmission power. The proposed work is investigated and demonstrated the presence of the submerged remote sensor networks through directing convention. In the proposed approach, the organization isolates the hubs, and each hub sink is delegated to a group. The hubs inside each group are permitted to impart the convention to each layer. The hubs are advanced and sinks are calculated using the forward determination calculation. The information parcel is progressed from the source hub to the super hubs at the highest levels. The framework lessens energy utilization, builds the bundle conveyance proportion networks, decreases the proliferation defer, and broadens network lifetimes. The execution of the result in terms of organization lifetime, energy consumption, propagation postponement, and conveyance proportion has been observed and shown by reenactment.

Declarations

Compliance with Ethical Standards

Conflict of interest

The authors declare that they have no conflict of interest.

Human and Animal Rights

This article does not contain any studies with human or animal subjects performed by any of the authors.

Informed Consent

Informed consent was obtained from all individual participants included in the study.

Funding: Not applicable
Conflicts of interest Statement: Not applicable

Ethics approval:

Consent to participate: Not applicable

Consent for publication: Not applicable

Availability of data and material:

Data sharing is not applicable to this article as no new data were created or analyzed in this study.

Code availability: Not applicable

Authors’ contributions

RT and VB agreed on the content of the study. RK and RT collected all the data for analysis. IM and VB agreed on the methodology. IM, RT and RK completed the analysis based on agreed steps. Results and conclusions are discussed and written together. Both author read and approved the final manuscript.

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Figures
Figure 1

UWSNs Architecture
Figure 2

The Network Architecture of DBR
Figure 3

Multiple-Sinks Underwater Sensor Network Architecture

Figure 4

Various Decades in Underwater Wireless Sensor Network.

Figure 5
Routing Mechanism of DBR

Figure 6

Simulation Results of Delivery Ratio
Figure 7

Simulation Results of Energy Consumption
Figure 8

Simulation Results of Network Lifetime
Figure 9

Simulation results of the propagation delay