International Journal for Multidisciplinary Research (IJFMR)
E-ISSN: 2582-2160 ● Website: www.ijfmr.com ● Email: editor@ijfmr.com

A Survey on Wireless Sensor Networkof Underwater Environment Types & Techniques

Arjun Rajput[1], Dr. Divyarth Rai[2]

[1]PhdScholar, CSE, LNCT University, Bhopal
[2]Professor, CSE, LNCT University, Bhopal

Abstract:
Underwater Wireless Sensor Networks (UWSNs) consist of vehicles and sensors deployed in a particular acoustic region to perform collaborative monitoring and data collection duties. These networks are utilized in an interactive manner between various nodes and ground stations. The paper provides an overview of the communication challenges in UWSN. This paper provides a summary of other researchers' efforts to optimize WSN network protocols, hardware, etc. This paper provides an overview of USAN network types and routing techniques for reducing the energy required for packet transfer. This article concludes with a list of evaluation parameters for technique comparisons.

Keywords: Energy Optimization, Clustering, UWSN, Routing, Channel Optimization.

INTRODUCTION

Underwater Acoustic Sensor Networks, also known as UW-ASNs, comprise typically of a collection of underwater vehicles, each of which is equipped with an underwater sensor. These vehicles are then deployed in the study area to collect scientific data such as the water's temperature, salinity, and conductivity. Typically, an underwater sensor is constructed as an embedded system, which means that inaddition to its primary recognizing function, it also includes mechanisms for data processing, communication with other devices, and power supply.
Monitoring the marine environment is crucial to marine research and development. In order to encompass this monitoring, it is necessary to establish underwater sensor networks in subsea space.

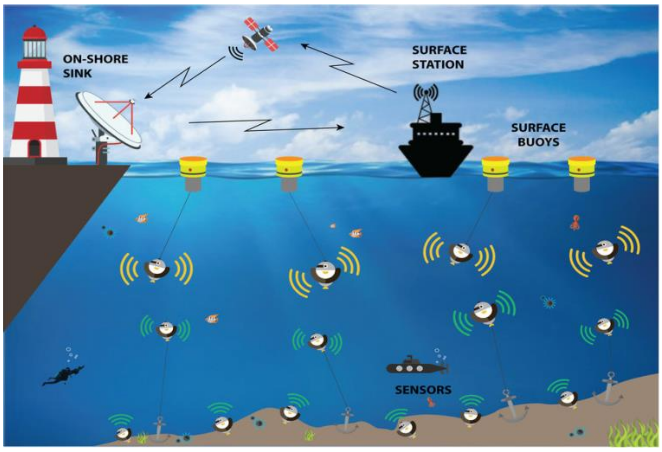

Fig. 1: Under water WSN monitoring of aquatic environments.

Figure 1 illustrates an illustration of 3D underwater sensor networks with hybrid energy storage system. Due to the significant attenuation of electromagnetic waves in water, acoustic waves must replace electromagnetic waves in underwater wireless networks [3]. This issue presents new challenges regarding acoustic wave characteristics. The remainder of this paper is structured as follows: first, we review characteristics of transmission schemes in acoustic channels, and then, in the third section, we address the difficulties of acoustic connections for application in underwater networking. The final section is designated for the conclusion.

Due to the intricacy of its hardware, an underwater sensor may be considerably more costly than a terrestrial sensor. Due to this, it is difficult to deploy underwater sensors densely, so they are frequently dispersed and located at great distances apart. In addition, the propagation speed of an acoustic link is only 1,500 meters per second, which is approximately 105 times slower than the speed of a radio link. This suggests that the propagation delay for an acoustic link is approximately two times 105 times greater. Furthermore, the quantity of available bandwidth is quite limited. In reality, the available bandwidth is severely constrained due to the adverse environment, which is impacted by transmission loss, noise, and extra propagation delay [6]. The most obvious difference between terrestrial and underwater sensors is the quantity of energy required by each. Because auditory communication requires a substantial quantity of energy, an underwater sensor has significantly greater power requirements than a terrestrial sensor. In actuality, the transmit power in acoustic lines is not only excessively high, but it also trumps the receive power. In actuality, the power being transmitted is frequently one hundred times larger than the power being received.

Rest of the paper was organized into four more sections. Second section brief the research work done by the scholars in field of underwater WSN optimization. Further paper has detailed different types of network for the sensor network. Routing techniques also plays an important role, so paper has list few of techniques that impacts on WSN network optimization. Finally paper has list dome of evaluation parameters used for the comparison of different techniques of underwater WSN.

Related Work

In [7], the most recent analysis of the available evidence is presented through a review of five-year-old studies on various aspects that enable network activities and implementations in AIASNO environments. This work was motivated by the need for robust and adaptable solutions that can meet the requirements for the rapid development of wireless sensor networks submerged in water. This paper defines the vital requirements for accomplishing essential services and common AIASNO platforms. It also contributes a classification of the critical elements in AIASNOs by classifying architectural elements, connectivity, routing protocols and standards, security, and AIASNO applications.

In [8] authors presents a "reliable multipath energy-efficient routing protocol (RMEER)". This research aims to increase the network's lifetime and determine the optimal route for delivering information to the intended destination. The entire network is separated into five distinct, equal layers. The final destination node is situated atop the water's surface, and powerful static carriers are deployed in the surprisingly. The final network layer consists of standard sensor nodes. Following the multipath data routing mechanism, the information is delivered. Multiple sinks utilizing the multipath disjoint algorithm are utilized to enhance the packet delivery ratio. In this algorithm, if a node expires, an alternate usage of advanced will bypass the route of the deceased node [9]. The process of data forwarding is defined by a routing table. The courier node transmits a greeting packet; after receiving this packet, each source code changes its routing table. This table includes the residual energy, the link quality, and the ID of the node. By analyzing all of these parameters, the optimal forwarder node for data transmission to the sink is chosen.

Cooperation and multihop energy-efficient routing techniques for UA-WSNs are introduced in [10]. The data is produced by the nodes, and a multihop algorithm routes this information to the receivers. One-hop communication is introduced with a cooperation scheme to increase network reliability. The data transmission phase is completed in two phases. In the first phase, the forwarder node receives the data, and in the second phase, the forwarder node and one relay node are configured to transmit the data. When both forwarders get the information, the MRC technique is used to combine the two packets into a single, reliable packet. RSS is an algorithm that measures the relative distance between nodes. The effects of the proposed scheme provide the greatest energy and network stability responses.

The fuzzy vector technique, which addresses delay reduction and battery life issues, is determined in [11]. This is a sophisticated variant that employs fuzzy logic technique (FLT). The source generates data and then transmits it to the sink via a multihop mechanism, taking into account the utmost residual energy for data transmission. The optimal forwarder selection is determined by the residual energy and node position. All of the source's neighbors receive the data packet when it is broadcast. One optimal neighbor is selected to send information to the following neighbor. The selected node's residual energy should be maximized so that it does not expire quickly, and its distance from the sink node should be minimized. The experimental results provide the fastest data transmission speeds, and the network has the greatest number of active nodes.

According to the current state of affairs, advancements in wireless communications and Micro-Electro-Mechanical devices have been observed and are anticipated in the near future. As wireless sensors are dependable despite being remotely powered by batteries, compact, convenient, and inexpensive, it is simple to retrieve data from them. Therefore, they must be deployed in large numbers for periodic performance reports, making them suitable for demanding applications remote monitoring and abandoned areas. Underwater acoustic communications differ from terrestrial radio communications in that the acoustic channel is asymmetric and features large and variable end-to-end propagation delays, distance-dependent limited bandwidth, high bit error rates, and multi-path fading. In addition, the mobility and limited battery capacity of nodes present challenges for the design of networking protocols. Routing in underwater acoustic networks is a difficult task for which numerous protocols have been proposed. Consequently, it is necessary to develop energy-aware solutions to extend the lifespan of sensor networks.

Year	Techniques	Remarks
2021 [12]	MOGA (multiple objective genetic algorithms)	Find path by multi hop manner. This work was implement on ground. Hence under water study is required.
2021 [13]	Energy-effcient Clustering and cooperative Routing K-means and Q-learning (ECRKQ)	K-Mean clustering is good for static network. Dynamic / mobile node need random adoptable algorithms.
2020 [14]	HHF or Hyper-Heuristic Framework	Use of neural and genetic for energy optimization at individual node increase processor load. Hence centralized system

		should be incorporate.
2020 [15]	Clustering Based Adaptive Routing Algorithm (CBAR)	Next Hop based routing takes more time to complete the transmission.

UASN Network Types

Centralized Communication Networks

The method by which various subsea sensor systems are interconnected using acoustic modems is a crucial aspect of the aforementioned case that merits additional consideration. These nodes constitute the underwater sensor network (UAN), a crucial conduit for the exchange of invaluable underwater intelligence. In the example, the UAN employs a centralized network topology in which the centrally located master node coordinates all network node communication [16], shown in fig. 2. A sensor node must first request permission to transmit from the master node using the request-to-send (RTS), clear-to-send (CTS), or direct polling for data protocols. Typically, the master node is positioned such that it provides everyone in the network with adequate acoustic communications coverage. Typically, the master node is positioned to adequately encompass the network's deployed nodes for acoustic communications. When the network's required coverage area is greater than the master node's absolute maximal acoustic communications range, a number of fixed relay nodes must be established.

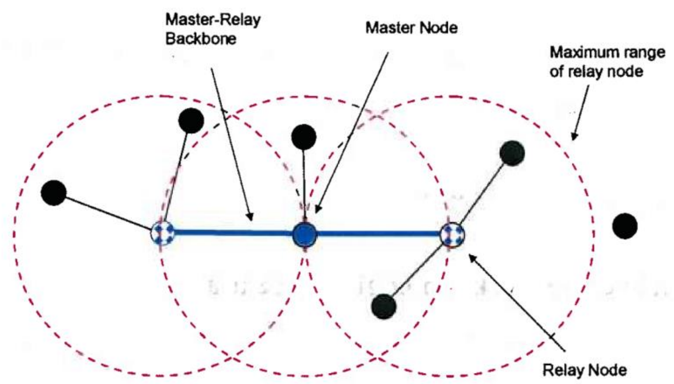

Fig. 2 Centralized WSN network model.

Distributed Communication Networks

In contrast to centralizednetwork topologies, decentralized or dispersed ad-hoc networks are self-organizing, rapidly deployable multi-hop wireless networks that alter their structure in response to node mobility, node additions, and node removals. Distributed ad-hoc networks, in contrast to centralizednetwork topologies, do not rely on specialised nodes in the network for traffic routing and do not require any fixed infrastructure for node-to-node communication [17]. Each node functions as a router, sustaining communication paths to other nodes in the network that may not be within direct transmission range and forwarding data packets from other nodes. Figure 3 contrasts a distributed topology with a centralizednetwork architecture. In a centralizednetwork topology, only the central server and the slave nodes can communicate simultaneously, though the master node may permit the slave node to communicate simultaneously with another slave node. In the dispersed network topology, multiple pairs of nodes may be communicating at any given moment. There are typically more communication paths available in a dispersed network than in a centralized network.

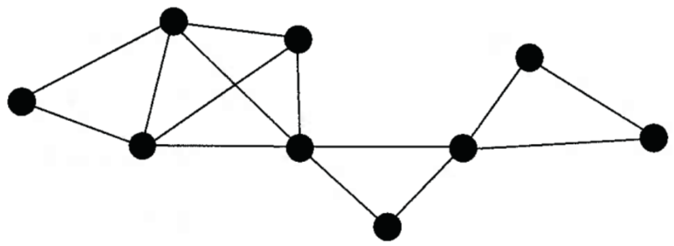

Fig. 3 Distributed WSN network model.

WSN Routing Techniques

Data-Centric Protocols

When routing is data-centric, the drain sends queries to specific areas and awaits sensor responses. Since queries are used to request data, attribute-based nomenclature is necessary to describe the data's characteristics. SPIN, the first knowledge protocol, considers data transmission between nodes in order to reduce superfluous data and conserve energy [18]. Directed Diffusion was developed subsequently. Subsequently, a large number of additional methods have either been devised utilizing Directed Diffusion or a similar concept [19].

Sensor Protocols for Information via Negotiation (SPIN) : Sensor Protocols for Information through Negotiation SPIN is based on the concept of using high-level identifiers or meta-data when designating the data. Prior to transmission, the primary characteristic of SPIN is the data advertisement system, which allows sensors to share meta-data. Each node notifies its neighbors when it receives new data, so interested neighbors can send a query message to request the data if they do not already have it. SPIN's meta-data negotiation significantly increases energy efficiency by addressing the traditional congestion issues of redundant information transfer, overlapping sensing regions, and resource blindness. It is assumed that the format of meta-data is application-specific, and there is no standard for it. The SPIN protocol specifies three messages for data communication between nodes. The ADV message allows a sensor to propagate specific metadata, the REQ message makes a specific data request, and the DATA message contains the actual data. More information about it can be found at [18]. As SPIN requires only the single-hop neighbors of each node to be known, continuations are limited. Applications that require reliable data packet delivery at regular intervals, such as intrusion detection, do not use SPIN.

Directed Diffusion (DD): DD is an important turning point in the study of data-centric routing for sensor networks. The concept endeavors to distribute data across sensor nodes by adopting a naming mechanism for the data. DD recommends the use of attribute-value pairs for the data and queries the sensors using these pairs as required. In order to construct a query, an interest is specified using a set of attribute-value pairs, such as object names, interval, duration, geographic area, etc. A washbasin informs its neighbours of its interest. Each node that receives interest is capable of caching information for subsequent use. Additionally, the nodes can aggregate data within the network. Using the cached interests, the received data is then compared to the values in the cached interests. There are also gradient fields present in the interest registration. A gradient is a connection made in response to a neighbor who initially expressed interest. Consequently, routes between sinks and sources are formed using gradients and interest. It is possible to set up multiple routes so reinforcements choose one. As DD is on-demand and does not require the maintenance of a global network structure, it is extremely energy efficient. However, because DD is based on a mechanism for query-driven data dissemination, it cannot be used for all sensor network applications. You can read more about DD in [18].

Rumor Routing (RR):establishes a balance between flooded queries and flooded event notifications. In contrast to event flooding, which generates a gradient field across the entire network, the primary objective of this protocol is to construct paths leading to each event. Therefore, rather than overwhelming the network with inquiries, if one is generated, it can be sent on a random journey until it discovers the event path. Once the path to the event has been identified, it can be directed directly to the event. If the path can also be located, the application may attempt flooding or resubmitting the query. The RR can be useful for disseminating requests to events in vast networks [12].

Location-Based Protocols

In this section, location-based protocols for WSNs, is presented. They are based on two principal assumptions [17]:

- It is assumed that every node knows its own network neighbors positions.
- The source of a message is assumed to be informed about the position of the destination.

Distance Routing Effect Algorithm for Mobility (DREAM): As part of this proactive protocol [17], every Mobile Host (MN) in the network monitors the location of all other nodes. In order to maintain the table, each MN broadcasts location packets at a specific frequency to nearby MNs in the sensor network and at a separate, lower frequency to distant MNs in the sensor network. It is not necessary for an MN to have the current location of distant MNs, as they appear to move more rapidly than nearby MNs. In an effort to reduce the overhead of location packets, DREAM endeavours to differentiate between nearby and distant MNs.

Geographic and Energy Aware Routing (GEAR): Unlike prior geographic routing protocols [20], GEAR does not transfer the packet to its destination using greedy algorithms. Consequently, their methods for bridging communication divides vary. The GEAR routes a payload using energy-conscious and geographically aware neighbor selection heuristics.

Minimum Energy Relay Routing (MERR) - Location: It is based on the premise that a great deal depends on the distance between two data-transfer nodes [21]. This distance is directly proportional to the total amount of energy expended on the journey from the source to the ground station. Consequently, in MERR, each sensor searches locally for the node downstream that is closest to the characteristic distance within its maximal transmission range. When a sensor decides to use the next hop, it reduces its transmission power to the point where the radio signal is scarcely detected by the corresponding node. Thus, energy consumption can be reduced. If the distance between each pair of sensors is greater than the average distance, each sensor will choose its own direct route.

Evaluation Parameter

Number of Rounds: Round is a period where each node can send a packet to base station. So counter of total round for a WSN network till last node energy loss is Number of rounds. Algorithm which has higher number of rounds is better.

First Node Discharge: This parameter count number of nodes complete by the network before discharge of first node. Algorithm that discharge first node in high count is better than others.

Total Number of Rounds: Count of total rounds taken by the network before lost of last node to discharge. Algorithm that dischargeleast node in high count is better than others.

Execution Time: Time required to find cluster center from the dynamic node position with available energy is execution time. Here time is in second and algorithm which take less time is better.

Packet Transfer: Total number of packet transfer by all set of node since begning till last node in the network.So wireless arrangement having maximum number of packet transfer is good solution.

Conclusion

Underwater Wireless Sensor Networks (UWSNs) consist of vehicles and sensors deployed in a particular acoustic region to perform collaborative monitoring and data collection duties. These networks are utilized in an interactive manner between various nodes and ground stations. UWSNs are presently confronted with issues and obstacles relating to limited bandwidth, high propagation delay, 3D topology, media access control, routing, resource utilization, and electricity constraints. Due to the variable characteristics of the underwater environment, some of these issues and challenges remain unresolved despite the fact that the research community has developed a variety of approaches to address them over the past few decades. This paper discusses numerous optimization techniques for underwater networks. According to previous research, the majority of work involves energy optimization. Thus, in the future, academics will be able to propose an energy-optimized algorithm based on acoustic conditions.

References

1. L.Brekhovskikh and Y.Lysanov, “Fundamentals of Ocean Acoustics”, New York: Springer, 1982.
2. S.Flatte, “Sound Transmission Through a Fluctuating Ocean”, Cambridge, UK: Cambridge University Press, 1979.
3. M.Stojanovic and J.Preisig. “Underwater acoustic communication channels: Prop- agation models and statistical characterization” IEEE Communications Magazine, vol.47: 84-89, Jan. 2009.
4. R.Coates, “Underwater Acoustic Systems”, New York: Wiley, 1989.
5. X.Che, I.Wells, G.Dickers, P.Kear and X.Gong, “Re-evaluation of RF electro- magnetic communication in underwater sensor networks”, IEEE Communications Magazine, 48: 143 -151, Dec. 2010.
6. Salmah Fattah, Abdullah Gani, Ismail Ahmedy, Mohd Yamani IdnaIdris and Ibrahim AbakerTargioHashem. "A Survey on Underwater Wireless Sensor Networks: Requirements, Taxonomy, Recent Advances, and Open Research Challenges". MDPI, Sensor, 2020.
7. M. Ahmed, M. MazleenaSalleh, I. Channa, and M. F. Rohani, “RMEER: reliable multi-path energy efficient routing protocol for underwater wireless sensor network,” International Journal of Electrical Computer Engineering, vol. 8, no. 6, p. 4366, 2018.
8. U. Ullah, A. R. Shahid, M. Irfan, J. Qadir, M. Nawaz, and R. Qureshi, “A stable and reliable short-path routing scheme for efficient acoustic wireless sensor networks (AWSNs),” IEEE Access, vol. 8, pp. 1458–1474, 2020.
9. H. Tran-Dang and D.-S. Kim, “Channel-aware energy-efficient two-hop cooperative routing protocol for underwater acoustic sensor networks,” IEEE Access, vol. 7, pp. 63181–63194, 2019.
10. R. Bu, S. Wang, and H. Wang, “Fuzzy logic vector based forwarding routing protocol for underwater acoustic sensor networks,” Transactions on Emerging Telecommunications Technologies, vol. 29, no. 3, article e3252, 2018.
11. M. A. Mazaideh and J. Levendovszky, "A multi-hop routing algorithm for WSNs based on compressive sensing and multiple objective genetic algorithm," in Journal of Communications and Networks, vol. 23, no. 2, pp. 138-147, April 2021.

12. J. Zhu, Y. Chen, X. Sun, J. Wu, Z. Liu and X. Xu, "ECRKQ: Machine Learning-Based Energy-Efficient Clustering and Cooperative Routing for Mobile Underwater Acoustic Sensor Networks," in IEEE Access, vol. 9, pp. 70843-70855, 2021.
13. J. Zhong, Z. Huang, L. Feng, W. Du, and Y. Li, “A Hyper-Heuristic Framework for Lifetime Maximization in Wireless Sensor Networks with A Mobile Sink,” IEEE/CAA Journal of AutomaticaSinica, vol. 7, no. 1, pp. 223–236, January 2020.
14. J. Wang, Y. Gao, C. Zhou, R. S. Sherratt, and L. Wang, “Optimal Coverage Multi-Path Scheduling Scheme with Multiple Mobile Sinks for WSNs,” Computers, Materials & Continua, vol. 62, no. 2, pp. 695–711, 2020.
15. AZ. Zou, X. Lin, and J. Sun, ``A cluster-based adaptive routing algorithm for underwater acoustic sensor networks," in Proc. Int. Conf. Intell. Comput.,Autom. Syst. (ICICAS), Dec. 2019, pp. 302310.
16. N.Farr, A.Bowen, J.Ware, C.Pontbriand and M.Tivey, “An integrated, underwater optical /acoustic communications system”, Proc. Oceans’10, May 2010.
17. Nvzhi Tang, QianZeng, DongyanLuo, QinyunXu, Haiyang Hu. "Research on Development and Application of Underwater Acoustic Communication System". Journal of physics, IOP publishing, 2020.
18. Kemal Akkaya and Mohamed Younis. “A Survey on Routing Protocols for Wireless Sensor Networks”. Department of Computer Science and Electrical Engineering University of Maryland, Baltimore County Baltimore, MD 21250
19. R. Shah and J. Rabaey, "Energy Aware Routing for Low Energy Ad Hoc Sensor Networks", in the Proceedings of the IEEE Wireless Communications and Networking Conference (WCNC), Orlando, FL, March 2002.
20. Y. Yu, R. Govindan, D. Estrin, “Geographical and Energy Aware Routing: A Recursive Data Dissemination Protocol for Wireless Sensor Networks,” UCLA Computer Science Department Technical Report, 2001, pp. 1-11.
21. M. Zimmerling, W. Dargie, J.M. Reason, “EnergyEfficient Routing in Linear Wireless Sensor Networks,” In Proc. 4th IEEE Internatonal Conference on Mobile Adhoc and Sensor Systems (MASS 2007), Italy, Pisa, 2007, pp. 1-3.