# A BRIEF SURVEY ON UNDERWATER WIRELESS SENSOR NETWORK ROUTING PROTOCOL FOR ACOUSTIC COMMUNICATIONS TECHNIQUES

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**Abstract:** This survey aims to provide a comprehensive overview of the present research on Underwater Wireless Sensor Networks (UWSNs), focusing on routing techniques provide reliability, security and load balance, which are especially critical in the resource constrained system such as UWSN. This paper aims to present a brief survey and comparative study on Underwater Wireless Sensor Network routing protocol for acoustic communications techniques in which the goal is to minimize the amount of energy, time is needed to re-optimize the solution when the routing changes. Number of previous studies namely MAC and Routing, Clustering techniques, CDS techniques, Random Adjustment, Location-free routing and Radius-based courier node routing projections. To conclude the discussion, the multi-path routing algorithm has provided reliable data transmission, even distribution of network traffic and data delivery performs a number of paths that make it an interesting study of packet analysis are discussed and evaluate the performance in UWSNs.

***Keywords:*** *UWSN, Routing, WSN, Acoustic communications.*

## I. INTRODUCTION

Wireless Sensor Networks (WSNs) is a promising technology of the day which is used to huge amount packets are divided tiny embedded sensor nodes used in examining and sensing of data or packets from the aqueous surroundings [4], [1]. In current years, wireless sensor network applications distance in the different fields used in pollution monitoring, weather monitoring, health, military, home, and commercial companies.

In Underwater Wireless Sensor Network (UWSN); routing is different from the global wireless sensor networks appropriate to inadequate bandwidth, node mobility, energy, and end to end delay in the data packet communication [9]. The energy efficiency is a significant precondition to their dependable operation and resource management. The routing protocol methods play an essential role in energy efficiency that supports network quality of service [10]. Because, each application has special quality factors and challenges, there is requiring diversifying routing protocol having capability to complete the application requirements [14].

The UWSN topology is a fundamental factor in determining the energy consumption, the capacity and the dependability of a network. So, the network topology should be carefully engineered and post-deployment topology normalization should be executed, when possible. Suggestion architecture for two-dimensional underwater networks is described in Fig. 1. A group of wireless sensor nodes are attached to the underneath of the ocean with deep ocean anchors. Underwater sensor nodes are interrelated to underwater sinks (uw-sinks) by wireless acoustic links. Uw-sinks, as shown in Fig. 1, are network devices in charge of communicating data from the ocean ground network to an outside station. To complete this objective, uw-sinks are prepared with two acoustic transceivers, namely a vertical and a horizontal transceiver. The vertical link is used by the uw-sinks to relay data to a surface station. The horizontal transceivers used by the uw-sink to correspond with the sensor nodes in order to: (i) send commands and configuration data to the sensors (uw-sink to sensors); (ii) collect monitored data (sensors to uw-sink).

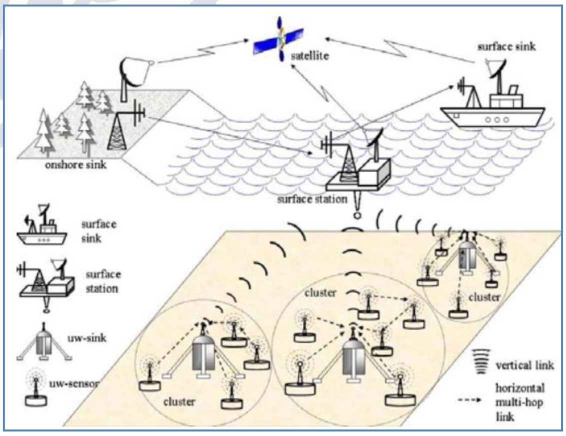


*Figure 1: Architecture for 2D UWSN*

The routing is an essential task of network layer used to establish the route from origin to target node. The network layer is the administrator that informs how the packs or messages are routed within the networks. In UWSN; routing is special from the terrestrial WSN appropriate to partial amount of bandwidth, node mobility for ocean present and end to end delay in data packet transmission [12]. Therefore, in order to hold the network jointly, there is a need to expand the routing policies. The design of routing protocol for UWSN is disturbed with saving energy and node mobility in the long term non-time significant applications. The researchers have made several efforts to expand efficient routing protocol while considering the distinctive characteristics of underwater network [3].

Routing in UWSNs is very significant and it is well-known from other networks appropriate to the following characteristics [4]:

- An IP-based system is hard to be applied in UWSNs, because of incomplete available resources and a particularly huge scale.
- Different traditional routing protocol, in UWSNs, mainly traffic is routed from nodes to the base station.
- In UWSNs, the nodes are resource controlled in terms of energy, storage, and computational capacity. Proficient use of resources is necessary.

There are commonly two varieties of routing methods, single path routing and multiple path routing. Single path routing is easy and scalable, but does not proficiently assure the requirements of resource constrained UWSNs. It is simple since the route among the origin node and the target node can be well-known in a particular period of time. It is scalable since, even if the network modifies from ten nodes to ten thousand nodes, the complexity and the approach to determine the path remains the similar. Multipath routing is an alternative routing method, which selects multiple paths to deliver data from origin to target. Because of the nature of multipath routing that uses unnecessary paths, multipath routing can fundamentally address the dependability, security and load balancing problems of distinct path routing protocols.

The factors affecting on the communication of underwater acoustic signals have become the designing challenges for UWSN. Following are the factors that result on transmission of underwater acoustic signals: [6]

- **Bandwidth:** The bandwidth obtainable is particularly restricted due to water absorption.
- **Propagation delay:** In underwater network, the transmission delay is five times higher than RF (terrestrial channel). The Radio Frequency (RF) speed is 3x108 ms-1 whereas speed of acoustic signal is about 1.5x103 ms-1. The little speed of sound origins multi-path propagation to extend over time delay. It results real time application of UWSN.
- **Shadow zones:** Due to the underwater great characteristics like density and temperature, elevated bit error rates and temporary losses of connectivity occur.
- **Energy:** Incomplete battery power is complex to recharge.
- **Attenuation:** Appropriate to decreased amplitude and amount of a signal.
- The devices for underwater sensor networks are additional expensive and have incomplete availability in market.
- Noise from machinery, shipping and movement of the fish or animals are concerned in UASN.

This survey paper explores an Underwater Wireless Sensor Network routing protocol for acoustic communications of new concepts that characterize common features of, and differences between, routing.

## II. UNDERWTER ROUTING PROTOCOLS

In this section this paper classifies UWSN protocols into three categories:

- Energy-based routing
- Geographic Information-Based Routing
- Courier Node based routing protocols

Each routing protocol is carefully analyzed

### *2.1 Energy Based Routing*

The Energy based routing protocols address the overall energy consumption in UWSNs. They reduce the overall energy consumption of the network for sustained operation of the sensor nodes. These protocols involve energy consumption with balancing and ensure that certain nodes within the network do not get overburdened due to frequent data forwarding. This is because the overburdened nodes deplete their battery power and die soon. The death of such nodes interrupts the reliable delivery of data to the surface of the water. Generally, nodes close to the surface of the water are overburdened as these nodes are heavily involved in data routing due to the closeness to the water surface. The some of existing energy based routing protocols follows below.

***Aziz et.al.*, (2013) [2]** discussed the survey focused on the energy efficiency problem and presented a completed study of topology control methods for expanding the lifetime of battery powered WSNs. First, they evaluation the important topology control algorithms to present insights into how energy efficiency is attained by design. Advance, these algorithms are categorized according to the energy protection approach they accept, and evaluated by the trade-offs they recommend to assist designers choosing a method that best ensembles their applications. Because the idea of “network lifetime” is extensively used for reviewing the algorithms’ performance, they emphasize different definitions of the term and confer their advantages and drawbacks. Newly, there has been increasing interest in algorithms for non-planar topologies such as deployments in underwater surroundings or multi-level buildings. For this cause, they also comprised a detailed discussion of topology control algorithms that work efficiently in 3 dimensions. Based on the results of their evaluation, they recognized an amount of open research problems for attaining energy efficiency through topology control.

***Zenia et.al.*, (2016) [15]** reviewed, the core design features for an ideal UWSN are recognized which are energy-efficiency and dependability. These design features are calculated in terms of communication efficiency and energy consumption – in order to provide an insight to the network designers on ideal design metrics. It is an establish that the protocols are extremely selective, and the robustness of some protocol depends exclusively on the application and design requirements, which is addressed. They also presented a complete overview through assessment and simulation to examine and review the MAC and routing protocols under concern.

### *2.2. Geographic Information-Based Routing*

The Geographic Information-Based Routing protocols consider the knowledge of the localization information of sensor nodes and combine it with network coding to overcome high energy consumption and duplicate packet transmissions. The existing Geographic Information-Based Routing protocol follows below.

***Jiang, P., Wang, X., Jiang, L* (2015) [5]** designed an efficient deployment technique to assurance optimal monitoring quality is one of the key subjects in underwater sensor networks. At present, sensible approaches of deployment involve adjusting the depths of nodes in water. One of the classic algorithms used in such procedure is the Self-Deployment Depth Adjustment Algorithm (SDDA). This algorithm mostly focuses on exploiting network coverage by continuously adjusting node depths to decrease coverage overlaps among two neighboring nodes, and thus, attained excellent performance. Still, the connectivity performance of SDDA is undetermined. The authors proposed a depth adjustment algorithm based on Connected Tree (CT). In CTDA, the sink node is used as the initial root node to begin building a linked tree. Lastly, the network can be prepared as a forest to preserve network connectivity. Coverage overlaps among the parent node and the child node are then reduced within every sub-tree to optimize coverage. The hierarchical policy is used to regulate the distance among the parent node and the child node to decrease node movement. Moreover, the silent mode is accepted to decrease communication cost. Simulations showed that evaluated with SDDA, CTDA can attained high connectivity with different communication ranges and different numbers of nodes.

***Tuna, G., Gungor, V.C* (2017) [11]** discussed a Wireless Sensor Networks (WSNs) have involved the consideration of both the research community and the industry, and this has finally guide to the extensive use of WSNs in different applications. The considerable advancements in WSNs and the merits brought by WSNs have also allowed the express development of underwater wireless sensor networks. In UWSN's, in addition to consumption, determining the positions of underwater sensor nodes after they have been positioned is significant because it plays a vital role in numerous applications. A variety of localization methods have been proposed for UWSN's, and each one is suitable for detailed situations and has exclusive challenges. They presented an overview of possible UWSN applications; a review of the deployment methods and localization algorithms for UWSN's has been obtainable based on their key merits and demerits.

### *2.3. Courier Node Based Routing*

The Courier Node Based Routing Protocol (CNBRP) combination with a cost function, track-ID, residual energy, and depth to forward data packets. The CNBRP is specifically designed for long-term monitoring with higher energy efficiency and packet delivery ratio. The purpose of CNBRP is to facilitate a network for longer periods in risky areas. The existing Courier Node Based Routing Protocol follows below.

***Muhammad Khalid, et.al.*, (2018) [8]** discussed an Underwater wireless sensor networks (UWSNs) use acoustic waves to communicate in an underwater surroundings. Acoustic channels have different limits such as small bandwidth, a higher end-to-end delay, and path loss at positive nodes. Believing the restrictions of UWSNs, energy efficient communication and dependability of UWSNs have become a predictable research area. The current investigate interests are to control sensors for a longer time. The currently investigated research area towards competent communication has different challenges, like broadcasting, numerous copies creation path loss and small network life time. Therefore, it is different from existing work which solved certain challenges by determining the depth, remaining energy, and transfer hop-IDs to nodes. This study has proposed a novel scheme called radius-based courier node (RMCN) routing. RMCN uses radius-based architecture in grouping with a cost function, residual energy, track-ID and depth to promote data packets. The RMCN is exclusively designed for long-term observing with advanced energy efficiency and packet delivery ratio. The reason of RMCN is to assist a network for longer periods in dangerous regions. The proposed routing method has been evaluated with depth-based routing and energy-efficient multipath grid-based geographic routing with respect to alive nodes left, end to end delay, delivery ratio and energy consumption.

***Llor, J., Malumbres, M.P.* (2012) [7]** analyzed the development of underwater acoustic prediction illustrations from a simple approach to further detailed and truthful models. Then, dissimilar high layer network protocols are tested with dissimilar acoustic propagation models in order to establish the influence of environmental parameters on the obtained outcomes. After numerous experimentations, they can conclude that higher-level protocols are responsive to both: (a) physical layer parameters connected to the network scenario and (b) the acoustic transmission model. Conditions like improvement location, ocean outside activity, bathymetry or floor sediment composition, might change the signal propagation performance. So, when designing network architectures for UWSNs, the location of the physical layer should be seriously taken into explanation to classify declare that the attained simulation consequences will be close to the ones obtained in real network scenarios.

***Xu, G., Shen, W., Wang, X* (2014) [13]** presented a comprehensive evaluation of the state-of-the-art technologies in the field of marine surroundings monitoring using wireless sensor networks. Initially illustrates the application regions, a general architecture of WSN-based oceanographic monitoring systems, a common architecture of sensing parameters and sensors, an oceanographic sensor node and wireless communication technologies. Then, it presented a comprehensive review of various related projects, systems, techniques, approaches and algorithms. It also argued challenges and opportunities in their research, improvement, and consumption of wireless sensor networks for marine environment monitoring.

## III. COMPARISON ANALYSIS

This survey paper aims to collect and consider papers that deal with Underwater Wireless Sensor Network routing protocol for acoustic communications techniques. The aim is not to assume a constraint reviews, but quite to provide a broad state-of-the-art view on these related fields. Several previous methods have been projected to assist UWSN, routing techniques, which has mentioned in a body of literature that is spread over a wide variety of applications.

**Table 1: SUMMARY TABLE FOR COMPARISON OF UNDERWATER WIRELESS SENSOR NETWORK ROUTING PROTOCOL FOR ACOUSTIC COMMUNICATIONS TECHNIQUES**

| TITLE | ALGORITHM | KEY-IDEA | TECHNIQUES | PERFORMANCE |
|---|---|---|---|---|
| Underwater Wireless Sensor Networks: How Do Acoustic Propagation Models Impact the Performance of Higher-Level Protocols? (2012) [7] | Static Routing algorithm | Acoustic propagation models, MAC and routing protocols. | Higher-Layer Protocols: MAC & Routing | 10000 Collisions occurred during Multi-hop performance |
| A survey on distributed topology control techniques for extending the lifetime of battery powered wireless sensor networks (2013) [2] | Discovery of neighbors that is energy-efficient to communicate. | Wireless Sensor Networks (WSNs), Topology Control (TC), Connected Dominating Set (CDS). | Clustering techniques, CDS techniques. | Topology control algorithms that run slowly may not have sufficient time to update the changes in the network. |
| Node Deployment Algorithm Based on Connected Tree for Underwater Sensor Networks (2015) [5] | Depth Adjustment Algorithm based on Connected Tree (CTDA). | Underwater Sensor Network Deployment, Node Depth Adjustment, 3D coverage, Connected Tree. | Random Adjustment. | Energy consumption of CTDA is less than that of connected dominating set, particularly in a sparse environment |
| Energy-efficiency and reliability in MAC and routing protocols for | Energy efficient routing algorithm. | Medium access control (MAC), Routing protocol, Underwater Sensor Network (UWSN), | Cluster based routing techniques and Reliable and | 80% Throughput of Reliable and Energy Efficient Vector Based |

| | | | | |
|---|---|---|---|---|
| underwater wireless sensor network: a survey (2016) [15] | | Reliability, Energy-eefficiency | Energy Efficient Vector Based Forwarding (REE-VBF) | Forwarding (REE-VBF) |
| Radius-based multipath courier node routing protocol for acoustic communications (2018) [8] | Radius-Based Courier Node (RMCN) routing | Energy efficient communication and reliability of UWSNs. | Location-free routing and Radius-based courier node routing. | RMCN attains End-to-End delay of 8 seconds. |

## IV. CONCLUSION

This paper presents a brief survey about an Underwater Wireless Sensor Network routing protocol is for acoustic communications techniques are discussed. This survey can be classified into Higher-Layer Protocols: MAC and Routing, Clustering techniques, CDS techniques, Random Adjustment, Location-free routing and Radius-based courier node routing projection analysis. To conclude the discussion, the multi-path routing algorithm has provided reliable data transmission, even distribution of network traffic, and data delivery.

The further work enhanced and expanded for the Underwater Wireless Sensor Network routing protocol is for acoustic communications technique in enhanced routing searching algorithm that leverages a parallel execution algorithm.

## REFERENCES

[1] Akyildiz I. F., Pompili D., and Melodia T., "Underwater acoustic sensor networks: research challenges," Ad hoc networks, vol. 3, no. 3, pp. 257–279, 2005.

[2] Aziz, A.A., Sekercioglu, Y.A., Fitzpatrick, P., et al.: "A survey on distributed topology control techniques for extending the lifetime of battery powered wireless sensor networks", IEEE Commun. Surv. Tutorials, 2013, 15, (1), pp. 121–144.

[3] Carroll P., Zhou S., Mahmood K., Zhou H., Xu X., and Cui J.-H., "Ondemand asynchronous localization for underwater sensor networks," in Oceans, 2012. IEEE, 2012, pp. 1–4.

[4] Han G., Jiang J., Zhang C., Duong T. Q., Guizani M., and Karagiannidis G. K., "A survey on mobile anchor node assisted localization in wireless sensor networks." IEEE Communications Surveys and Tutorials, vol. 18, no. 3, pp. 2220–2243, 2016.

[5] Jiang, P., Wang, X., Jiang, L.: "Node deployment algorithm based on connected tree for underwater sensor networks", Sensors, 2015, 15, (7), pp. 16 763–16 785.

[6] Kilfoyle D. B. and Baggeroer A. B., "The state of the art in underwater acoustic telemetry," IEEE Journal of oceanic engineering, vol. 25, no. 1, pp. 4–27, 2000.

[7] Llor, J., Malumbres, M.P.: "Underwater wireless sensor networks: how do acoustic propagation models impact the performance of higher-level protocols?", Sensors, 2012, 12, (2), pp. 1312–1335.

[8] Muhammad Khalid, Yue Cao , Naveed Ahmad, Waqar Khalid, Piyush Dhawankar, "Radius-based multipath courier node routing protocol for acoustic communications", IET Wireless Sensor Systems, 2018, Vol. 8 Iss. 4, pp. 183-189.

[9] Prathap U., Shenoy P. D., Venugopal K., and Patnaik L., "Wireless sensor networks applications and routing protocols: survey and research challenges," in Cloud and Services Computing (ISCOS), 2012 International Symposium on. IEEE, 2012, pp. 49–56.

[10] Song K., Ji B., and Li C., "Resource allocation for relay-aided underwater acoustic sensor networks with energy harvesting," Physical Communication, vol. 33, pp. 241–248, 2019.

[11] Tuna, G., Gungor, V.C.: "A survey on deployment techniques, localization algorithms, and research challenges for underwater acoustic sensor networks", Int. J. Commun. Syst., 2017, pp. 1–21.

[12] Wahid A. and Dongkyun K., "Analyzing routing protocols for underwater wireless sensor networks," International Journal of Communication Networks and Information Security (IJCNIS), vol. 2, no. 3, 2010.

[13] Xu, G., Shen, W., Wang, X.: "Applications of wireless sensor networks in marine environment monitoring: a survey", Sensors, 2014, 14, (9), pp. 16 932–16 954.

[14] Yalcuk A. and Postalcioglu S., "Evaluation of pool water quality of trout farms by fuzzy logic: monitoring of pool water quality for trout farms," International Journal of Environmental Science and Technology, vol. 12, no. 5, pp. 1503–1514, 2015.

[15] Zenia, N.Z., Aseeri, M., Ahmed, M.R., et al.: "Energy-efficiency and reliability in mac and routing protocols for underwater wireless sensor network: a survey", J. Netw. Comput. Appl., 2016, 71, pp. 72–85.