

Designing Energy efficient Underwater Wireless Sensor Network for Secure Communication

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Abstract:– The term "underwater sensor network" (USN) refers to a system of interconnected sensor nodes and vehicles that work together to complete an underwater mission. The sensors and vehicles in autonomous networks operate independently of any central control. Since water makes up 75% of Earth's surface, the network may adapt to marine environment characteristics to help it reach its objective. Submerged resources are plentiful. Those have to be looked at more. Opportunities to conduct underwater investigations utilizing sensors at all levels have arisen as a result of recent technological advancements. In order to achieve its intelligence, smart sensing, and communication capabilities, USN combines wireless technology with a very small micromechanical sensor technology.

Keywords– USN, sensor nodes, wireless technology, micromechanical sensor, intelligent computing, communication

Introduction

There are many small, self-sufficient devices—sensors, motes, or nodes—scattered throughout a certain area to form a Wireless Sensor Network (WSN). A sensor network is a system of interconnected sensors and nodes that work together to gather data from their surroundings and relay that data through wireless connections to a central location. Distributed sensor nodes detect environmental or physical parameters including temperature, noise, vibration, pressure, motion, and pollution, and relay this information jointly via the network. Electronics in the sensor collect data about the surrounding environment and convert it to a signal [1]. The fundamental structure of a WSN is shown in Figure 1. The image shows how all of the sensors set up in one area are linked together. This device, which might be a PC or a mobile phone, serves as the network's "Base Station" (BS) or "sink." A gateway might serve as a communication hub between the sensors and the BS. In a wireless sensor network (WSN), a gateway is an aggregating platform between the client application and the nodes themselves. This is a network feature that is both optional and essential. The gateway collects data from the wireless nodes, processes it (if necessary), and then sends it on to the application running on the sink. It's possible to have a wide range of sizes for sensor nodes. The sensors collect information and expose characteristics of things in their surroundings. These sensors may either talk to one another or to a separate base station (BS) [2]. WSNs have both scalability and intelligence. While individual sensor nodes' capabilities may be low, WSNs are based on the idea that the combined strength of the network is adequate to complete any given task. WSNs have recently attracted the attention of the scientific community because to the many theoretical and practical difficulties associated with studying and implementing them. Researchers in this field have recently been delving into the many novel uses for large-scale sensor networks. Several aspects set WSNs apart from other networks [3]; they include the network's topology, the variety of applications it supports, the nature of its traffic, and the severity of its resource limitations.

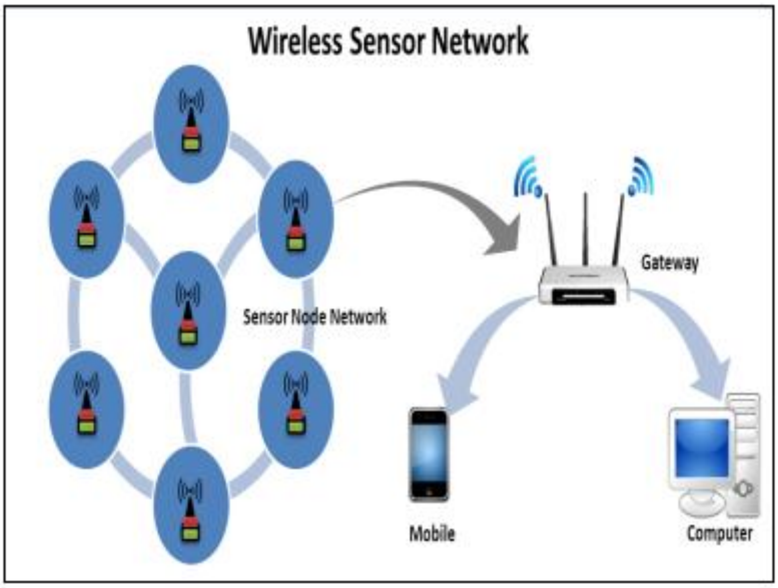

Figure 1. Basic Arrangement of a Wireless Sensor Network

Underwater Wireless Sensor Networks

Multiple sensor nodes and submerged vehicles may be deployed because to UWSN's wireless connectivity. Information from these sensor nodes is gathered by autonomous underwater vehicles. Problems with underwater communication include delays due to propagation, reduced bandwidth, and failed sensors. In this case, the use of acoustic transmission facilitates the transfer of data. The batteries in UWSNs have a limited lifespan and are difficult to recharge or replace. Here, sensors are more vulnerable to corrosion in water and need additional covering and protection. Concerns have been raised about how to reduce energy consumption in these networks.

Implementation of Homogeneous Low Energy Adaptive Clustering Hierarchy Protocol in Two Dimensional And Three Dimensional Wireless Sensor Networks

Wireless sensor networks (WSNs) collect data about their surrounding environment, analyze it, and then send it to a central hub. Each sensor in the network consists primarily of a radio transceiver, which is responsible for sending and receiving data, a microcontroller, which is responsible for processing data, and a power supply, often a battery. One of the key challenges in sensor networks is minimizing power consumption [1]. In addition, the deployment of the nodes is determined by the applications, with wired connectivity being made accessible only when absolutely necessary. Most WSN applications make some reference to a 2D design, which provides only so much in the way of insights and outcomes. Such situations call for a more precise and suitable 3D design approach. In practical contexts, environmental sensing is only possible in three dimensions. The design of 2D WSNs for terrestrial networks typically assumes that all nodes lie on a flat plane. If a network is deployed in a more general environment, such as the ocean or a forest, where nodes are spread out throughout a three-dimensional region, this assumption may not always hold true. More realistic, useful, and consistent with the actual world would be a 3D study of the region of interest.

Data transfer between locations in the ocean is now accomplished using electromagnetic, optical, and auditory means. Since optic waves are absorbed by saltwater, they can only be used over a very limited distance, unlike electromagnetic communication methods, which are unaffected by the conducting nature of seawater. Less attenuation in saltwater makes acoustic communication one of the few methods that can be used for effective underwater communication. In addition, the depth and temperature stability of the seas reduce the attenuation of acoustic transmission. Multipath effect due to reflection and refraction, temperature gradients, and surface noise all interfere with audio communication in shallow water [5].Recent research in mining and environmental monitoring has focused on acoustic sensor networks (UASN) like Jin Xiaoting. UASN sensor nodes may function with non-standard, inconvenient battery types. In a multi-hop network, it's crucial to account for the hop set size, yet the system performs effectively when subjected to the required delays. In this essay, we will first investigate how to effectively count hops with varying distances in UASN multi-hop, then analyze the link between energy usage, final delays, and hop count. Value determined by the terms of a business deal. Gas consumption and injection are two forms of energy. Then, we provide the cost function that will be used to rank the kids. A possible trap for numerous UASNs may be avoided, according to simulation findings, by working with alternative distances and assuming a lower energy consumption and eventual delay. This study presents a model that may be used to calculate the optimal number of hops for a UASN serving a big water treatment facility. The essay delves into the connection between energy use, delay, and hops. With a group of UASNs working together. Additionally, there is a wide range of trade-offs between energy use, end-to-end latency, and yearly UASN cooperative counts due to the presence of delay. Then, it provides a cost calculator that factors in things like energy use, distance traveled, and monetary transactions. It may be used to figure out how many relays are required to keep energy consumption and total consumption at a constant.

Literature Review

The Acoustic Sensor Network (UASN) is becoming more popular as a means to bring wireless sensor networks to the ocean floor. For UASN It is challenging to develop an EGRC that is efficient and reliable while transmitting data in the aquatic environment due to factors like the variety of environmental conditions (such as the well-known oil monitoring) and the relevance of energy consumption in setting up many UASNs. The features it has are as follows: Think about the media that can be used while underwater, such 3D editing, fast transmission, motion, and distance. All current ground-based routing techniques (both proactive and reactive) are insufficient for underwater sensor networks due to major difficulties including energy saving and mobility. These low-power, topology-variation-handling, asymmetry-aware, and delay-tolerant protocols are just what the marine environment needed.

Together, DU and co. LevelBased Adaptive Geo-Routing (LBAGR) is a proposed system that classifies data transmissions into four distinct groups. Upstream entails sending data from a source to a sink, downstream entails sending data from a sensor node to a target node, and so on. Density, available battery power, and distance between neighbors are utilized to choose the ideal next hop for data transmission. The purpose of Level-Based Adaptive GeoRouting is to minimize transmission lag, cut down on energy use, and maximize packet delivery and reception rates. This protocol enhances delivery ratio and makes better use of battery power while decreasing communication latency at both ends. The primary focus of routing methods for underwater sensor networks is the efficient use of battery power (M Sunithaet.al, 2019). The term "localization" is used to describe the process of determining where each sensor node is inside a network. Because successful communication between underwater sensor nodes depends on this data, it is essential. The primary difficulty here is the significant difference between the marine and terrestrial environments, which naturally leads to uncertainty in sound speed changes and greater noise in the channel. Here, we look at techniques for reducing localization mistakes using Kalman filters and extended Kalman filters. The shallow water experiment is replicated virtually, and the localization findings are compared, to verify this.

In a 2018 study, Jianxin Liu and colleagues Due to its large bandwidth, minimal time delay spread, stability, high rate, and so on, underwater wireless optical communication has been a major worry of academics in recent years. In this study, we present a DEEB algorithm for distributing energy efficiently and equitably over a wireless optical sensor network deployed in the deep sea. The DEEB works with both stationary and moving networks. By comparing the DEEB to preexisting algorithms, simulation trials show that the former may drastically cut energy consumption during routing while also balancing the energy burden of nodes to increase their productivity. Energy-efficient data forwarding towards the surface sink was developed by Huang et al. utilizing fuzzy logic and decision tree methods. The purpose of the routing protocol is to make the most effective use of the available power source so as to minimize the amount of energy used by the acoustic communication process. The protocol lessens the burden of acoustic channel traffic while simultaneously decreasing power consumption. Minimal end-to-end latency and high efficiency are now the most important criteria for routing protocols in underwater sensor networks. Diagonal and Vertical Routing system for Underwater Sensor Network (DVRP) is an end-to-end delay-efficient routing system presented by Ali et al. The process for forwarding packets relies on the angle of the flooding zone, and flooding nodes may be managed by adjusting the angle for the food area. Reduced end-to-end latency and reduced power consumption of sensor nodes are primary goals of the Diagonal and Vertical Routing Protocol. When it comes to routing data packets to their final destinations, Diagonal and Vertical Routing Protocol just needs to employ the information it has locally. There is no impact on the network as a whole when nodes are added or removed.

Two procedures are chosen by Basagni et al. Two such protocols are examined and contrasted here: Code Division Multiple Access (CDMA) and Distance Aware Collision Avoidance Protocol (DACAP). Using a variety of packet sizes, bit error rates, and traffic loads, the author calculates how much of a difference larger packets make in multichip underwater sensor networks.

By slicing up large data packets into manageable chunks, the disadvantage of collision is mitigated, as introduced by Basagni et al. DACAP is used to test the effects of techniques with and without taking data fragmentation into account. Retransmissions, energy usage, and packet delay are all reduced, as well as total traffic and substantial overhead, thanks to fragmentation. Basagni et al. fail to account for fragmentation, which increases the traffic strain on a communication channel that is already overburdened as a consequence of fluctuating bandwidth and interference. Due to the importance of communication in the area of underwater sensor networks, increasing the throughput of a single hop packet size is considered a vital metric. When communicating with underwater sensor networks, half-duplex methods are used, which may be avoided with proper packet size selection. The sensor nodes in the proposed feeding control system collaborate to make decisions. One of the system's contributions is that it makes it possible to save money while minimizing waste and harm to the environment [7-9].

For QERP, Faheem et al. proposes a. The goal is to make underwater acoustic sensor networks more stable for transmitting data. The sensor nodes are organized into tiny clusters and linked hierarchically so that power and data may be shared fairly. This method minimizes the potential for data loss while maintaining a high-quality connection when submerged. The lack of mobility and the failure to address node density are the main problems with this approach. Multichip network throughput, energy efficiency, and latency are all measured and analyzed by Basagni et al. The best packet size is chosen after taking into account the impact of factors including bit error rate, interference, collision, and retransmission. Basing et al. choose two media access control protocols, CDMA and DACAP, compare their findings, and then alter the network deployment scenario to study how changing the packet size impacts the network's throughput, energy efficiency, and latency.

With optimum packet size selection, Basagn et al. improve upon all metrics, including throughput, energy usage, resource use, and packet delay. The best packet size in terms of energy efficiency has been studied by Junget al. using the NS-2 simulator. The authors establish a 100-node cluster with coordinates 2 km, 2 km, and 200 m. The correlation between packet size and energy efficiency has been experimentally shown. The most efficient packet size minimizes wasted power. The high bit error rate of a faulty channel leads to excessive energy loss, however this loss may be mitigated by using the optimum packet size for the faulty channel. Due to the very variable nature of the environment, reliability (in the sense of data transmission) is a significant challenge for underwater sensor networks.

Using a two-hop acknowledgment mechanism with the same packet size, Ayaz et al. present an algorithm that may find the optimal packet size for dependable data transport. Using energy efficiency as the parameter for optimization, this algorithm explores the optimum data packet size for underwater sensor networks. The algorithm's primary function is to ensure that data travels from its origin to its final destination, which might be another node or the network's surface sink. This article provides a high-level summary of recent developments in the area of acoustic-channel-based wireless sensor networks used in aquatic environments. However, there are still problems and obstacles to overcome. That not only hinders the efficacy of the aforementioned methods, but also necessitates a remedy from the academic community.

Greedy Routing In Underwater Wireless Sensor Networks

In WSNs [1,] a routing protocol is utilized to map out the connection from a source node to a sink node. A routing protocol must be designed and developed as the first step in the functioning of any network. The number of routing methods suggested for WSNs is rather significant. However, if the network is expanded to be deployed underwater, it becomes necessary to take into account the peculiarities of the acoustic channel, as discussed in the previous chapter [2]. Geographical routing is a frequent kind of routing that uses the origin and destination locations to determine the best path to take. Assuming that each node is aware of its final destination, it facilitates the selection of next-hop nodes [3]. One kind of geographical routing is called "greedy routing" [4]. As its name indicates, greedy routing prioritizes delivering messages to their final destination while minimizing the number of intermediate nodes visited. By sending data to their neighbors, nodes in a network with greedy routing may determine the shortest path to their target node [3]. Taking into account the implications of various acoustic channel characteristics, this work implements the greedy routing algorithm in a 3D homogeneous UWSN. It has been considered that sensor nodes are deployed at different depths in a 3D network. A generic model for a 3D UWSN has each sensor node assigned with coordinates (x,,).

Sensor Hop-Based Energy Efficient Network Approach For Routing In Underwater Acoustic Communication

The primary challenge of every network is developing a reliable routing mechanism. Research on the best ways to connect and route sensors deployed underwater is just getting started. The abundance of untapped potential on Earth is due in large part to the abundance of water on the planet. Due to battery constraints, there is a need to discover techniques to facilitate the creation of UWSN protocols that are judicious with energy use. In an ideal world, the sensor network should be allowed to carry out its duties for as long as feasible [1]. In order to guarantee scalability and achieve high energy efficiency to extend network lifespan in WSN settings, researchers have extensively used the practice of grouping sensor nodes into clusters. Data fusion and aggregation are made possible by the sensor nodes' hierarchical cluster-based architecture, resulting to substantial power savings. In the prior chapter, we used a greedy routing strategy in our work. Additionally, cluster based routing has been developed to further improve the network's energy efficiency. The energy efficiency of the suggested method has been measured and compared to that of one of the current benchmark cluster-based methods. It's almost impossible to recharge batteries in deep water. It is important to limit the use of power by the underwater sensor network. In most cases, single-hop routing is used in a clustered network. By just having to make one hop from the source nodes to the BS, clustering may significantly cut down on communication energy requirements. However, one hop transmission requires more energy and is less efficient over longer distances. Multi-hop communication reduces power consumption in a network with many nodes [3]. The focus of this paper is on developing a novel method for 3D UWSNs; this method is named Sensor Hop-based Energy Efficient Networking Approach (SHEENA). A parallel has been drawn with multi-hop LEACH, a popular networking protocol. The CHs in this first most scenario are chosen at random. In order to get data to the sink, these CHs follow the best route and send it to the CH(s) that are geographically closest to it.

UWSNs are made up of several pre-charged, battery-operated sensors spread around the area of interest. Our aim is to have a system architecture that is energy-efficient, scalable, and resistant to failure. An approach to lowering energy use is the Sensor Hop-based Energy Efficient Network Approach (SHEENA). Underwater nodes of a certain number are supplied to the network in the suggested paradigm. These vertices are separated out into their own functions. The model's nodes may play the functions of sensors, coordinators (CHs), or super heads (SHs). The sensing nodes collect information and relay it to the corresponding control hubs. The fused data is sent from the CHs to the SHs, which are presumed to be energy-rich devices that can efficiently aggregate and analyze the data. The SH is a significant node in UWSN, allowing for extensive communication range. The SHs are the points of contact with the outside world. Because if the SHs are compromised, the whole network is compromised, it is expected that they are secure and reliable. Energy efficiency is used to prioritize CH. The sensor node with the highest total energy is chosen as the CH. Even with the restricted pool of SHs, the rule is true. This method has been used with 3D UWSNs in which sensor nodes are placed at varying depths.

Conclusion

The work intends to compare Two Dimensional and Three Dimensional architectures and network models for Wireless Sensor Networks, study and analyze various characteristics of the acoustic channel, develop energy efficient routing technique for Underwater Wireless Sensor Networks, analyze optimal scenarios for routing in acoustic networks, and calculate energy cost of secure communication for the same. Seeing the situation or potential applications in three dimensions brings them closer to their counterparts in the real world. Similarly, the standard protocol Low Energy Adaptive Clustering Hierarchy has been adapted for use in 3D WSNs, when it was originally developed for 2D WSNs. The updated protocol is applicable to any 3D use case, including underwater wireless sensor networks. In addition, a description of an underwater wireless sensor network has been made. It has been shown that increasing the signal's frequency results in greater signal attenuation at greater depths. The same may be said about background noise. The speed of an acoustic signal, however, slows

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down with depth. An effective model of an underwater wireless sensor network may be developed with the aid of this characterisation.

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