A SURVEY ON GEOGRAPHIC AND OPPORTUNISTC ROUTING FOR UNDERWATER SENSOR NETWORKS

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Abstract— *Underwater Wireless Sensor Network systems (UWSNs) have appeared as an encouraging innovation to screen and investigate the seas as an alternative to customary undersea wireline instruments. UWSNs can be efficaciously utilized for oceanographic data collection, pollution monitoring, offshore exploration, disaster prevention, assisted navigation and tactical surveillance applications. In any case, the information collection and conglomeration of UWSNs is still extremely constrained on the grounds that of the acoustic channel communication attributes. One approach to boost the information accumulation in UWSNs is through the construction of routing protocols by taking into account the typical attributes of the underwater acoustic communication and the extremely dynamic network topology. In this paper, we analyze different existing routing protocols in order to develop an enhanced routing protocol for UWSNs.*

Keywords—Geographic Routing; Local Minimum; Topology Control; Underwater Sensor Networks

1. INTRODUCTION

Wireless Sensor Network(WSN) are the disseminated independent sensors to screen physical or natural conditions, for example, temperature, sound, and so forth., it empowers remote communication, detecting, computerizing and passing their information to the various wanted area through the network.WSN has turned into a capable system for many applications.

The use of wireless sensor systems to the underwater arena has immense potential for checking the strength of stream and marine situations and useful for tactical surveillances. The seas alone cover 70% of our planet and alongside oceans and lakes are basic to our prosperity. Observing these conditions is difficult and exorbitant for humans. The sensor networks deployed underwater might be used to observe the underwater physical variables and could be used for tactical surveillance purposes. In this unique situation, Underwater Wireless Sensor Networks (UWSNs) [1] have picked up the consideration of the logical and modern groups due their capability to screen and investigate oceanic environments.

Underwater condition is vastly different from terrestrial as underwater remote sensor organization comprises of number of sensors that play out an attractive errand over a given territory. Terrestrial Wireless Sensor Network (TWSN) work in a domain overwhelmed by Radio Frequency (RF) communication. However, it isn't an ideal communication channel for underwater applications since RF wave propagation is constrained in underwater. So, underwater system communication utilizes acoustic innovation. Acoustic communication is a procedure of sending and receiving the message beneath water. Acoustic communication has been considered as the main achievable technique for underwater communication in USWNs.

Real difficulties in the outline of submerged acoustic systems are discussed here. The available bandwidth is extremely constrained. The underwater channel is severely vitiated, particularly due to multi-path and fading. Propagation delay in underwater is five orders of magnitude higher than in RF terrestrial channels, and it is intensely variable. High bit error rates and temporary losses of connectivity (shadow zones) can be experienced, due to the extraordinary characteristics of the underwater channel. Battery control is constrained and generally batteries can't be energized, also the solar power cannot be used. Underwater Sensors are inclined to failures as a result of fouling and corruption. The network topology can be considered in general as a significant factor in finding the energy consumption, the capacity and the reliability of a network. Hence, the network topology ought to be deliberately built and post-network topology enhancement ought to be performed, when conceivable. Underwater monitoring missions can be highly costly due to the high cost of underwater gadgets. . Hence, it is duly important that the deployed network be profoundly reliable, so as to avoid failure of monitoring missions due to failure of single or multiple gadgets.

2. RELATED WORK

Routing is a major issue for any network. Routing protocols discover and maintain the routes during the forwarding of data packets. This section dissertates major routing protocols available for underwater networks.

P. Xie et al. [2] proposed Vector Based Forwarding (VBF) which is intended to provide powerful, versatile and energy efficient routing. VBF is basically a geographic and location based routing protocol. No state data is required on the sensor nodes and solely a little part of the nodes is engaged with routing. Besides, information packets are sent in superfluous and interleaved ways, which add vigour to

VBF. A localized and distributed self-adaption algorithm is being used in the VBF in order to achieve a better performance. The self-adaptation rule permits the nodes to calculate the gain to forward packets and scale back energy consumption by discarding the low profit packets. In sensor systems, energy consumption is a critical factor since sensor nodes for the most part keep running on battery, and it is unthinkable or hard to energize them in most application situations. In underwater sensor systems, in addition to saving the energy, the routing protocols ought to have the capacity to deal with node portability in an effective way.

Vector-Based Forwarding (VBF) convention meets these necessities effectively. In VBF, every packet conveys the places of the sender, receiver and the forwarder (i.e., the node which forwards this packet). The forwarding path is indicated by the forwarding vector from the sender to the receiver. After accepting a packet, a node knows its relative position to the forwarder by calculating its distance to the forwarder and the Angle Of Arrival (AOA) measure of the received signal. Every one of the nodes accepting the packets calculate their positions repeatedly. On the off chance that a node discovers that it is near enough to the routing vector (e.g., not exactly a predefined threshold limit), it puts its own registered position in the packet and keeps forwarding the packet. Else, it merely disposes the packet. Along these lines, all the packet forwarders in the sensor network shape a routing pipe. The sensor nodes in this pipe are qualified for packet sending, and those which are not near the directing vector (i.e., the axis of the pipe) don't forward.

H. Yan et al. [3] proposed Depth Based Routing (DBR) protocol doesn't need full-dimensional location data of sensor nodes. Instead, it desires solely native depth data, which may be simply obtained with a reasonable depth device that may be equipped in each underwater device node. Thus, supported with the depth data of every device, DBR forwards information packets greedily towards the water surface. A key preferred standpoint of this convention is that it can deal with network progression productively without the help of a localization service benefit. Besides, this routing protocol can take favorable position of a numerous sink underwater sensor networks without presenting additional cost. DBR well uses the general underwater sensor networks: information sinks are typically arranged at the water surface. In this way in view of the profundity and depth data of every sensor, DBR advances information packets avariciously towards the water surface i.e., the plane of information sinks. In DBR, an information packet has a field that records the depth data of its current forwarder and is refreshed at each bounce. At the point when a node gets a packet, it advances the packet if its depth is littler than that inserted in the packet. Else, it disposes of the packet. Clearly, if there are various information sinks sent at the water surface, as in the numerous sink underwater sensor architecture, DBR can normally exploit them. Packets that reach any of the sinks are considered as effectively conveyed to the last destination since these water-surface sinks can communicate with each other productively through radio channels, which have substantially higher data transmissions and much lower propagation delays. It is assumed that a bundle comes to the destination as long as it is effectively conveyed to one of the sinks. Furthermore, it is presumed that each sensor node knows its depth data, to be specific the vertical separation from itself to the water surface. Practically speaking, this depth data can be acquired effortlessly with a depth sensor. In correlation, getting full-dimensional area data is substantially more troublesome.

DBR is an avaricious calculation that tries to deliver a parcel from a source hub to sinks. Amid the course, the profundity of sending nodes diminishes while the packet approaches the destination. The profundity of the sending node is diminished in each progression since the packet is going to be delivered to the water surface (if no "void" zone is available). In DBR, a sensor node distributively settles on its choice on packet forwarding, in light of its own profundity and the profundity of the past sender which is the key concept of DBR.

U. Lee et al. [4] proposed Pressure routing protocol. HydroCast, a hydraulic pressure based anycast routing protocol that endeavours the deliberate pressure levels to course information to the surface sonobuoys. It takes after a system to choose the subset of forwarders that augments the avaricious advance yet restricts co-channel obstruction and an effective underwater deadlock recovery strategy. In this examination, the georouting issue is particularized in that it is anycast to any sonobuoy at first glance. Hence, it does the trick to forward a packet upwards to shallower depth, provided that the locally available pressure gauge can precisely calculate depth, the profundity data can be utilized for geographic anycast routing. Note that this hydraulic pressure based anycast routing protocol is stateless and does not require costly disseminated localization. In the proposed situation, the labeling of the detected information with its location can be performed when the information rises to the surface. For instance, a monitoring centre can proficiently perform offline localization utilizing just the nearby neighbor data gathered from every node. The key difficulties of pressure based routing are the untrustworthy acoustic channel and the nearness of voids; along these lines, it requires effective avaricious sending and deadlock recuperation strategies. The remote channel quality is considered and concurrent packet gatherings among a hub's neighbors are manipulated keeping in mind the end destination to empower opportunistic routing by means of a subset of the neighbors that have got the packet effectively. Keeping in mind the end destination to smother the concealed terminals, the current sending set utilizes a heuristic to pick node in a geographic locale confronting the bearing toward the destination. It is exhibited that these methodologies don't boost the normal advance toward the destination and, as a rule, finding such a set is computationally troublesome. In this way, a straightforward avaricious or greedy heuristic is recommended that looks for a group of nodes with the most extreme advance and restricted concealed terminals, utilizing the neighborhood topology data as it were. The reenactment comes about to approve that the proposed approach can find a set whose normal advance is near that of the ideal arrangement. At that point, an effective recovery technique is proposed that best guarantees the delivery of packets.

The key thought is that a node can decide if it is on the local minimum on the grounds that lone the profundity or depth data is utilized for routing, i.e., a local minimum happens while neighbouring hubs with a lower depth than the present depth don't exist. In the proposed plot, every neighbourhood least node keeps up a recuperation course to a node whose profundity is lower than itself. After at least one or more portions of the packet segment experience the local minima, a packet can be directed out of the void and can change back to the recovery mode. Since any node situated underneath the void zone can conceivably experience the ill effects of the void and artful sending along the recuperation way is attainable, the proposed approach is more productive than an irregular walk-based approach. For economical route discovery, a route discovery methodology that implements hop-limited second flooding over the surface of void locales is projected and this is a big enhancement atop the easy 3D flooding.

Y. Noh et al. [5] proposed Void Aware Pressure Routing (VAPR) routing protocol. The principle focus point of this paper is to outline an effective anycast routing protocol from a portable sensor to any of the sonobuoys on the ocean level. In any case, this is difficult in light of the fact that geographic voracious routing makes an information packet to be dispatched to a hub which isn't the destination, yet nearer to the destination than the majority of its neighbours. This node is known as a local maxima hub. In such circumstances, it ends up noticeably important to recoup from this deadlock way by routing around the border of the district (a void). Keeping in mind the end destination to cure this issue, we propose the Void Aware Pressure Routing (VAPR) routing.

VAPR exploits what is as of now innately a characteristic piece of geographic routing to give intimations on the routing heading for information packets with negligible overhead to explore around the voids. VAPR manipulate opportunistic beacon reference to bypass void territories and productively advance towards the goal while picking sending nodes. The way to accomplishing this inside VAPR lies in using the beaconing instrument innate in geographic routing.

It also proposed utilizing the routing metadata to give clues to nodes to powerfully find a directing way to the goal on-the-fly. This convention takes after this heading by implanting little measures of following routing information in each beaconing packet to advise neighbouring nodes about the broadcasting status as a local maxima or deadlock node. This routing meta-data shapes the reason for giving signals to hubs on its encompassing neighbours. Given this data, nodes can locally settle on directing choices to best abstain from routing to hubs which may prompt a void in the system. Since data is installed in the beaconing system, it can be (responsively) forwarded downwards drearily all through the system to separate the void areas and the bunches of deadlock nodes which they must abstain from routing to. Like most topographical routing conventions, an intermittent beaconing component is utilized to educate neighbouring nodes of a node's quality and the previous' one-hop availability. It is amid this trade during which nodes illuminate their neighbours of its depth. In view of this data, every node can decide if it is a local maxima by looking at the profundities of neighbouring nodes and contrasting and its own profundity. Apart from simply communicating the depth data, the trace of whether the neighbouring node is also additionally a nearby local maxima can be dispersed in the beacon packet to provide some insight which is used to decide whether to prune a specific hub from a potential sending route estimation as it prompts a deadlock (either from above or beneath) which it should then recoup from. Every node is relied upon to keep a negligible measure of local state data relating to its one-hop neighbours.

F. Kuhn et al. [6] proposed Worst Case Optimal and Average Case Efficient Geometric AdHoc Routing known as GOAFR, a new geometric ad-hoc routing algorithm that combines greedy and face routing. GOAFR is the first ad-hoc algorithm that is both asymptotically optimal and average-case efficient. It is also proved that that other popularly known algorithms are not optimal in the worst-case, and also the only algorithm hitherto known to be optimal in the worst-case is not viable, that is not efficient in the average case.

This paper trusts that node portability is a standout amongst the most critical parameters in ad hoc networks, mobility isn't considered in this paper. It is expected that routing happens significantly speedier than node movement. Additionally it is expected that location data is open to the routing layer. These presumptions are expressively made to investigate and evaluate the integral nature of geometric routing algorithms without conceivably reducing symptoms of other communication layers. It might be said that geometric routing can be viewed as a lean adaptation of source routing: The source appending the position of the destination to the message, none of the middle of the road nodes is required to keep up routing records or trade the specialized routing data. It also presents Adaptive Face Routing (AFR). The premise of this calculation is shaped by Face Routing. At the core of Face Routing lies the investigation of the stratifications of faces in a planar chart, utilizing the local right hand rule. On its way around a face, the calculation monitors the points where it crosses the line st that connects the source s and the goal t. Having totally encompassed a face, the calculation comes back to the one of these convergences lying nearest to the destination, where it continues by investigating the following face nearer to t. On the off chance that the source and the destination are associated, Face Routing dependably finds a way to the destination. A characteristic way to deal with utilizing the maximum potential of greedy routing comprises in joining greedy routing and AFR, that is to proceed in an avaricious way and utilize AFR to escape from potential local minimum. It is, however demonstrated that, by utilizing avaricious routing, this calculation loses AFR's asymptotic optimality. By and by a variation of AFR (OAFR) whose blend with voracious routing (GOAFR) does at long last yield a calculation that is both normal case effective and asymptotically ideal.

R. W. L. Coutinho et al. [7] proposed Depth Controlled Routing (DCR) which alters the depth of the nodes in order to devise the network topology for enhancing the network connectivity and forward information where the greedy geographic routing fails. This proposed protocol is the first geographic routing protocol for underwater sensor networks that considers the sensor node vertical locomotion power to move the sensors for topology control intent.With the topology control, the part of disconnected nodes and nodes located into communication void regions, are drastically reduced and subsequently leads to the delivered data rate enhancement.

DCR is a geographic routing protocol that uses the avaricious or greedy forwarding technique to send information towards sonobuoys. In greedy sending methodology, when a node has information to send, it should choose the neighbour nearest to the destination to go about as a next-hop, and after that forward the packet to them. This procedure proceeds until the point when the packet is received by the destination. In this, since a packet is effectively delivered in the event that it is got by some sonobuoy, the sender node will choose the neighbour that has the shorter distance to some sonobuoy. Besides, the proposed routing plays out the topology control, deciding the arrangement of nodes that cannot achieve any destination through multihop communication (disengaged hubs) and figuring them with new depths. For effortlessness, the connectivity is brought into consideration only in the light of relative node position. The proposed protocol is made up of two noteworthy stages, in particular network initialization and network operation. In the network initialization stage, the topology control through the movement of node is performed, with a specific end goal to show signs of improvement in the design of the node areas to enhance the connectivity and the voracious geographic routing protocol. A particular algorithm is utilized to decide the new depth of the void nodes keeping in mind the destination to move them so as to make them leave the communication void districts. Within the network operation stage, the underwater sensor nodes sense the atmosphere and sporadically send the gathered knowledge towards sonobuoys. As there are some sonobuoys, we tend to contemplate the space of neighbours to its nearest sonobuoy, that are got from beacon packets, during the time spent in next-hop determination. Consequently, the neighbour that will be chosen to go about as next-hop in the forwarding procedure is the node which is the nearest to some sonobuoy among every one of the neighbours. In the event that the chosen node to go about as next-hop cannot proceed with greedy forwarding, it communicates a message to advise its neighbours of its void node circumstance. The neighbours at that point refresh its routing table, evacuating the void node entry.

R. W. Coutinho et al. [8] proposed Movement Assisted-topology Control and Geographic Routing Protocol which is an anycast greedy geographic forwarding protocol and two topology control methodologies. The proposed geographic routing protocol takes into consideration the anycast network architecture in the data forwarding process. The proposed centralized topology control (CTC) and distributed topology control (DTC) methods organize the network with the help of depth adjustment of some nodes.

Here instead of utilizing message transmissions-based strategies, topology control methodologies can be powerful to adapt to the communication void region issue. In this specific situation, the goal of the topology control is to devise network topologies where communication void districts can be limited or even disposed of. Especially, the topology control through movement helped or depth alteration of a few nodes can arrange the topology positively to utilize the voracious geographic routing protocols. In this approach, there is an underlying energy cost reliant on the depth modification innovation to move the nodes to new areas. This cost is weakened in the long haul of system operation, i.e., the energy per delivered packet is amortized.

This paper proposes an anycast insatiable or greedy geographic routing protocols and two topology control algorithms. The proposed routing protocol considers the anycast idea of the underwater sensor organization SEA swarm design for next-hop forward determination. The distance from the neighbours to its nearest sonobuoy and the one with the littler distance esteem are utilized in order to the following hop forwarder. The topology control calculations are intended to better compose the system topology through depth modification of a few nodes, pointing fundamentally to decrease the effect of the communication void issue in the performance of the network. Only the situations where nodes can proceed onward the vertical axes are considered here. A Centralized Topology Control (CTC) algorithm is introduced at this point that figures out which nodes don't have a way to a sonobuoy (separated nodes) and which ones are in a communication void district and, at that point, register new profundity to them. In addition, a Distributed Topology Control (DTC) algorithm is utilized where every hub locally decides whether it is in a communication void area and processes its new profundity to beat this issue. The hubs moved to new areas can successfully take part in the information sending procedure to the sonobuoys. Consequently, a huge change in the system performance is seen when contrasted with the conventional underwater sensor systems routing protocols. With both the geographic routing protocol and topology control proposed instruments, the amount of the information delivery packet was higher than 95% for CTC and 80% for DTC, that represents a gain of twenty fifth when put next with analyzed routing protocols, even in onerous and tough situations of terribly scanty or terribly dense networks.

Z. S. M. Zuba et al. [9] proposed Resilient Pressure Routing (RPR) routing protocol that broadens DBR by managing vindictive assailants, for example, caricaturing assaults. In RPR protocol, the packet header and payload are scrambled. In this encryption process, every node owns a pair of keys namely public and secret keys, and a certificate for the key pair generated by a trusted party. Public key is the key which is known and shared by both the parties in common. Secret key is the private key that is personally owned by each party and it is not shared with anyone. The certificate is used as an authentication factor given by the trusted party to guarantee that key pair is solely protected. Additionally, a Network Wide Secret key (NSK) is used here to encrypt the information that is shared among the nodes. During the packet forwarding procedure, the sender encrypts the packet payload with a Gateway Public Key (GPK). The packet header is encrypted with NSK at each forwarder and it is signed with the node public key. When the packet reaches the receiver node, the node decrypts the packet head and checks if the packet is signed by a legitimate proper node. Only packets with a proper signature are acknowledged and accepted.

M.O'Rourke et al. [10] proposed Multi-Modal Communications in underwater sensor networks using Depth Adjustment. Multi-modular communication is a routing protocol in which a sensor hub is furnished with acoustic communication modem, surface level Radio Frequency (RF) modem and a depth adjustment system that computes the trade-off network energy cost and data latency based on the amount of data needed to be sent and the cost of surfacing. Once the node determines to surface, nodes that will form the radio link path to the destination, are informed via acoustic communication to surface. This approach enables the sensor nodes to use two distinctive specialized strategies: acoustic for in-water control and radio for information exchange at the surface. Nodes calculate the compromising cost incurred due to the exchange in light of the sum of the information they have to send and the cost involved for surfacing. At the point when a node verifies that it has adequate information for surface communication, it utilizes the acoustic modems to advise nodes along the way to surface to make a radio connection. The surface routing course will vary from the acoustic routing course because of contrasting communication ranges, so the nodes along the routing course should first figure out which nodes should surface. These nodes surface together in imparting the information, and afterwards drop back to optimal detecting locations. In this paper, we concentrate on deciding the best subset of nodes along the acoustic routing course that should surface to take part in the radio communication. The trade-off between local greedy algorithms and their consolidated best partners, for limiting the energy use and limiting the hop count is analyzed and it is found that there are certain networks that makes the greedy algorithm to perform badly, there are also some typical networks that makes the greedy algorithms to function admirably, also it requires only negligible overhead, and it makes use of the local data. The drawback of this approach is that all nodes should have both acoustic and RF transmission modems.

M. Erol et al. [11] proposed AUV-Aided Localization for Underwater Sensor Networks which propose a localization strategy for acoustic underwater sensor networks that does not require an anterior infrastructure or any synchronization between the sensor nodes. An Autonomous Underwater Vehicle (AUV) helps in localizing the sensor nodes when moving across the underwater sensor region. This paper proposes a basic underwater GPS framework utilizing one AUV. AUVs can be utilized to develop a UWSN too, however because of high cost and physical failure to diffuse into little territories, they are not generally convenient , take for example , the environmental checking in and around the rocks and reefs. In this work, an architectural design is used that is halfway amongst performance and cost that considers utilizing huge number of sensor nodes and one AUV. AUV is utilized for localization purpose and mutually, once it is submerged, it can be utilized to convey the messages of detached nodes or time-critical data. The underwater sensors are openly suspended in sea (e.g. dropped into the sea from a ship or plane) and they have no surface or sea base association. This sort of ad-hoc organization powers minimum foundation where the nodes are scattered unreservedly on the 3-D space. AUV gets GPS signals while it is floating. At that point it plunges to a settled depth and takes after a predefined direction, moving among sensor nodes. While the AUV is watching the entire field of sensors, it communicates messages. Those messages that are received are alluded as beacons. Beacons incorporate the coordinate's data. Additionally they are also utilized for distance calculation. On accepting a few beacon signals, sensor nodes calculate their coordinates.

D. Pompili et al. [12] proposed Routing algorithms for delay-insensitive and delay-sensitive applications in underwater sensor networks. It introduces a model that permits exploring some key qualities of the underwater condition and features the underwater acoustic channel usage proficiency as an element of the distance between the relating nodes and of the packet size. The model additionally permits setting the ideal packet size for underwater correspondences when a specific Forward Error Correction (FEC) strategy is used, given the 3D volume of water that the application needs to screen, the thickness of the sensor network, and the application prerequisites. A new geographic routing protocol is proposed for the 3D underwater condition, intended to distributively meet the prerequisites of delay insensitive and delay-sensitive sensor network applications that permits accomplishing two obviously clashing targets, i.e., expanding the proficiency of the channel by transmitting a train of short packets consecutively and constraining the packet error rate by keeping the transmitted packets short. The algorithms allow the delay sensitive and delay insensitive applications to enable every node to mutually choose its best next hop, the transmitted power, and the FEC rate for every packet, with the goal of limiting the energy utilization.

J. M. Jornet et al. [13] proposed Focused beam routing protocol for underwater acoustic networks which is desirable for networks that consists of both static and mobile nodes. These nodes need not essentially synchronized to a global clock. A source node needs to know its own location and the location of its final destination. It does not need to know about the location of other nodes. The FBR protocol is basically a cross-layer strategy. In this method the routing protocol, the medium access control and the physical layer are tightly held together with the help of power control capability. It is essentially an encyclical algorithm, in which a route is dynamically made when the data packet travel along the network to the final destination. The selection of the next hop is made at each step of the path after suitable candidates have proposed themselves.

S. Lee et al. [14] proposed a new link measure called Normalized ADVance (NADV) that can used in geographic routing of multihop wireless network architecture. The proposed technique selects neighbours with the best trade-off measure between proximity and the link cost. This NADV measure enables the usage of adaptive routing feature which is a feature that is not plied by most of the current on demand routing protocols. NADV can be used along with the local next hop selection to provide an accommodative and efficient cost aware routing methodology. Applications can utilize the NADV model to reduce different types of link cost based on their objectives and their message priority. The utilization of NADV in geographic routing allows using the adaptive route migration, where the quality of discovered routes is in proximity to the optimal solution given by the centralized algorithm.

K. Zeng et al. [15] proposed Geographic Collaborative Forwarding (GCF) in wireless ad hoc and sensor networks that can be seen as a variant of opportunistic routing. This makes use of the broadcasting nature and spatial heterogeneity to enhance the packet delivery efficiency. In this paper, Expected Packet Advancement (EPA) metric's upper bound that can be accomplished by the GCF is calculated. By calculating this, it is proved that higher EPA can be attained by giving higher priority to the forwarding candidates that lies in proximity to the destination. Also, a new measure called EPA per unit energy consumption is introduced that balances the packet advancement, reliability and energy usage. By taking into account the above stated factors, an efficient candidate selection algorithm is proposed that selects the candidate set which maximizes the EPA per unit energy consumption.

3. CONCLUSION

This paper presents a point by point investigation of the prevalent geographic and opportunistic routing protocols, for example, VBF, DCR, DBR and RPR. To aggregate up, every one of the protocol are valuable to be considered for routing. Every method is peculiar in its own particular manner, which may be appropriate for various applications and has its own particular advantages and disadvantages. As per the literature overview, it can be discovered that the combination of various geographic routing protocols gives the most proficient result on the basis of packet delivery ratio, end-to-end delay, throughput ratio and energy consumption. Also these metrics can be upgraded further, if geographic and opportunistic routing protocols are combined and applied to route the packets. The future work will investigate this idea and a blend of those protocols will be connected to setup a more secure and efficient routing protocol for underwater sensor networks.

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