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Security Analysis of Eemccp Protocol for Underwater Acoustic Sensor Networks

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Abstract:** Underwater Acoustic Communication (UWAC) is a recent addition to the ad hoc networking arena, and it has a variety of applications using autonomous underwater vehicles (AUVs). However, UWAC faces several challenges such as the Doppler Effect, channel availability problems, and limited bandwidth. Efficient management of the network is crucial to overcome these challenges, and clustering is an effective approach to achieve this. In this paper, we propose a novel protocol called EEMCCP (Efficient Energy Management and Cluster-based Communication Protocol) that uses clusters to route packets efficiently with the lowest cost. The Chaotic Algae Algorithm (CAA) is used to efficiently achieve clustering without requiring node position information. One node from each cluster acts as the Cluster Head (CH) to ensure the proper combination of network components. The proposed protocol does not consider nodes based on their location or position. Instead, the Received Signal Strength Indicator (RSSI) value of the Hello packets is used to select some CHs as gateway nodes, which are responsible for supplying AUVs with data. When gateway CH nodes exhaust their energy, back-up nodes take over, making the protocol flexible. Communication links transmit the data from AUV nodes to terrestrial destinations. We compare the performance of EEMCCP with existing underwater communication protocols, and our analysis shows that EEMCCP achieves a higher throughput and a higher Packet Delivery Ratio (PDR) than the existing protocols. EEMCCP is a cost-effective solution for transmitting data underwater, and it opens up several avenues for research in the field of UWAC. EEMCCP achieves a higher throughput and a higher Packet Delivery Ratio (PDR) than existing underwater

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communication protocols such as AEERP and EEDBR, making it a cost-effective solution to transmit data underwater.

Keywords: Underwater Acoustic Communication, Autonomous Underwater Vehicles, Efficient Energy Management Cluster-based Communication Protocol, Cluster Head, Chaotic Algae Algorithm, RSSI, Routing.

1. INTRODUCTION

A network that collects data underwater can be described as an underwater network communication [1]. Communication points receive data from AUVs [2]. Communication is enabled by the sensor nodes. Nodes underwater should be able to self-configure. Military and civilian applications of underwater communication are numerous. Also, it has the benefit of helping us to study how environmental changes affect the bottom of the ocean and how they affect it [3]. Company under water. Scientific data can be gathered and monitored with underwater communication. Nodes' configuration, locations, and movements need to be shared between UWSNs. Data is analyzed by UWSNs, and then transferred to inland locations for use by UWSNs after being processed. Communication between the nodes is done through radio waves, which are used to send and receive data. Wireless acoustic interfaces are required for underwater communication. Data transmission suffers from scattering like any other network node. Taking into account the network features like delay, energy of the nodes, the network layer helps find the right path for under water communication. Ad hoc WSN routes are discussed in a wide range of fields. In order for existing underwater networks to function effectively, the difficulties in the underwater environment must be addressed. Proactive, reactive, and geographical routing protocols are currently available in the industry. UWS networks are notorious for their memory and energy consumption, which is why proactive protocols should not be used [4]. The large latency, asymmetrical links, and topology of reactive protocols make them unsuitable for use. Localization information is provided by geographic based routing protocols. As shown in Figure 1 (a & b), the AUVs are the nodes that communicate with the surface node through which data is collected and transferred, and then the surface node passes it on to the intended recipient in turn[5]. In the remainder of the manuscript, we have arranged the contents in the following order: Section 2 provides an overview of recent research dealing with underwater communication. This research work is motivated by a number of factors, as explained in section 3. The challenge of underwater communication is illustrated in Section 4. An explanation of the proposed underwater communication research is presented in Section 5. The results of the research are explained in section 6. The research work is concluded in section 7.

(a)

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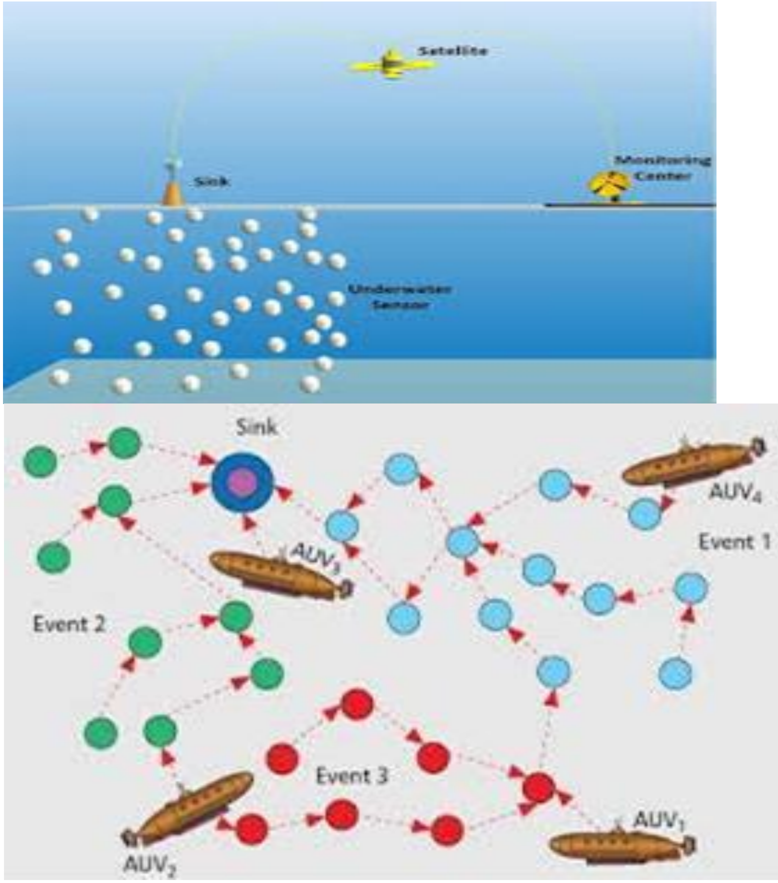

(b)

Figure 1 (a &b) Under Water Communication Models

Comparative Studies

There are many applications for underwater sensor networks in oceanography. Changes in the environment affect the ocean floor. Marine life is directly affected by this. As a result of their data collection and communications capabilities, underwater communication helps to prevent catastrophes. However, underwater communication is also subject to the same problems that plague networks such as bandwidth, signal scattering, error rates, delays, and other problems. Studies of acoustic channels have been conducted in recent years [6] [7] [8]. There is also a great deal of research being done on protocols for underwater communications [9] [10]. Several sensors and autonomous underwater vehicles are used to carry out the communication process in UWCNs (Underwater Wireless Communication Networks (UWCNs)). In particular, underwater monitoring is one of their applications (Figure 1). Data is shared between the nodes and coordinated among them. The general threat posed by this is security-related [12]. Oceanic floors and their environment are at risk of adverse environmental conditions, which can lead to the loss of life. As a result of the mobility of the nodes, communication between the vehicle and the AUV sensor system is quite challenging. It has been found that the movement of water currents is further hindering the mobility of the nodes[13][14]. Routing issues also arise in underwater communication. Routing protocols should ensure that the data is routed in the most cost-effective and optimal way possible. As part of [15], effective routing methods are studied based on the Traveling Salesman Problem. Through the use of the AUV, multiple nodes can simultaneously communicate with each other to optimize the performance of the network. Depending on contouring distances, the AUV decides on an optimal route. This information is utilized by the AUV during data collection. As a result, the AUV will be able to minimize its travel costs and data delivery ratio. The discrepancy in the information received by the sensor nodes leads to an elongated delay in the network with this scheme. There are a few key points in this paper that are aimed at developing a path to the end point that is cost-effective. Unlike most data delivery schemes, this scheme does not take into account the optimal ratio and delay of data delivery. In multihop routing, in addition to focusing on data collection, there is a focus on coordinating among the nodes [16] [17] [18].

A cluster head is tasked with directing the CEAACK MANET scheme. However, as node density increases, overheads may increase as well. Because the nodes are so mobile, it is possible to reform clusters as a result of their high mobility. Cluster heads are elected again if they move away from their post. Network performance may be reduced by reclustered and reelected processes. In this case, network transmissions would be disrupted. A fuzzy dynamic cluster formation scheme is introduced in CEAACK technique to address the issue of cluster formation. The cluster formation is enhanced through the use of heuristic parameters derived from the network [19] [20]. Clusters can be formed even in the event of broken links between nodes based on the details of each node. As a final phase of the technique, the data is encrypt with a secure route that guarantees the best possible transmission security [21]. There are many different routing algorithms for MANETs which were analyzed using the FDCRP protocol. An ant colony algorithm was used to develop a routing scheme that is intelligently based on an ant colony as the basis for routing in a MANET network.

In order to provide efficient routing and dynamic cluster formation within an ad hoc network, the study focuses on some of the important parameters. A three tire filtering methodology has also been incorporated into the routing process itself in order to filter out nodes that are efficient for routing purposes. There are two methods for forming dynamic clusters based on the information pertaining to the nodes [22] [23]. Using dynamic broadcasting of this information [24], members of a dynamic cluster are filtered using three different levels for the purpose of calculating their trust index by observing their behaviour [25] and [26]. AODV, OLSR, and DSDV over FDCRP were simulated in order to assess the performance objectives of FDCRP in relation to existing protocols such as AODV, OLSR, and DSDV. A simulation analysis of AODV, OLSR, and DSDV over FDCRP was conducted to assess the performance objectives of this protocol. In order to make the best use of the scarce resources available to wireless ad hoc networks, routing schemes have been developed for these networks. Using this technique, the network's lifespan is extended within the constraints available within battery power [28-30]. Sensors on the ocean floor are relayed through AUVs [31]. Pre-defined gateway nodes and AUVs are deployed as part of the AURP to serve as a network of entry points. Communication points on the surface receive information from

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AUVs that are sent from CHs (gateways). There are a number of hops between the UWSN nodes and the gateway node in order for them to communicate. In the course of the communication phase, the same path is used throughout. The size of the data may be excessive in nature, and therefore it may result in the gateway node losing some energy (reduced battery life) [32]. This in turn may affect the life of the network, resulting in a shorter life of the sink node and a lower volume of data to be sent through the network.

Purpose

There are many avenues to explore in the field of underwater communication. Ocean water and aquatic flora and fauna pose major obstacles to routing data underwater, as the nodes encounter them. For optimal routing, it is essential to manage the network communication range effectively. The CHs are assigned to each cluster of the network after it is clustered. CH must meet certain eligibility requirements before they can be selected. Data is routed by these cluster heads. Additionally, they tend to leave the cluster when they retire. For the AUV nodes to be able to successfully acquire data from the cluster heads, they must be identified in order to use optimal cluster heads. As the sinks are deployed on the surface of the water, they act as destination nodes, which can be reached by a network of vessels. A sink node receives data and considers it delivered data because this sink node has the ability to communicate with nodes that have higher bandwidth ranges of communication which allow it to be considered delivered data. In order to ensure that there is a minimal delay in the network, these sink nodes employ radio communication. A frequent monitoring of the portability of the newer techniques in terms of their use in the exchange of data under water is necessary when implementing them. Communication underwater poses some unique network issues, which must be addressed by these techniques in order to overcome these issues. It's important to make arrangements to make sure the data reaches its destination safely no matter where it's forwarded. Cost-effectiveness is essential for every protocol implementation. AUV nodes are used to transfer the data. These nodes are required to coordinate with the CH for the data transfer to be successful. For effective data delivery, it is important to conserve the energy of the AUV nodes. There needs to be protocols that are robust, scalable, and energy efficient for underwater communication, as well as being flexible enough to accommodate unforeseen issues that may arise in the future.

Conflicts

In order to facilitate underwater communication, protocols must address a variety of issues and challenges. To ensure data transmission to the destination, EEMCCP has two types of nodes. Cluster heads communicate with ordinary nodes. The courier nodes will then send the data to the nodes on the surface of the water via the courier nodes, which will send the data to the nodes on the surface of the water. There are a number of objectives we aim to achieve in our proposed work, which includes, among other things,

- Efficient use of resources
- This network can be clustered efficiently by using the clustering algorithm
- It is important to choose the right CH for your situation

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- The CH was successfully coordinated with the BS, resulting in a successful communication
- The gateway cluster head nodes will need to be identified in order for the cluster to function
- The CH gateway nodes should be backed up in case one fails
- Data collection and transmission to the nearest AUV is one of the key functions of the system
- It is estimated that the nodes consume approximately 4 percent of the total energy
- AUV nodes under the water can transfer data to the AUV nodes on the surface of the water by means of a wireless network
- Data delivery should not be interfered with by the location of the node
- Enhancing network performance and PDR
- Preventing delays as much as possible

Work Proposed: Protocol For Energy Efficient Minimum Cost Clustering (Eemccp)Protocol Architecture (EEMCCP): With EEMCCP, the goal is to develop a cluster routing protocol capable of supporting a wide range of applications

- Affrdability
- Intuitive
- Disseminated
- A safe environment

The proposed EEMCCP scheme is illustrated in Figure 2. An underwater node setup is shown physically in this image. UWSNs (light blue spheres) are shown in the diagram as scattered between the communication range for the underwater wireless sensor network. The Chaotic Algae Algorithm (CAA) organizes the nodes into clusters. Through the use of the CAA, it is also possible to select the Cluster Head (CH) (red spheres). In order to select a CH, the energy level of the CH and the location of the CH within the cluster are taken into consideration. There is also a backup CH (BCH) node chosen for each cluster, which will serve as a backup CH in case the original CH leaves the cluster (dark blue spheres) for any reason. The selected CHs of every cluster in the network are then in contact with the nearest base station to determine which direction the data should be routed once the network is clustered. CHs that are identified as gateway CHs are a few of the CHs in this group. A gateway node receives data created by other nodes. As a result, gateway CH nodes transmit the routed data to the AUV (the nodes travelling within the communication range of the network) and the other nodes within the network. As a result of the AUV nodes transmitting the data, it is possible for the next level of communication to be located on the surface of the water (ship) or on land (base station). EEMCCP ensures that data is delivered to the destination node in a safe and secure manner, regardless of where it is located.

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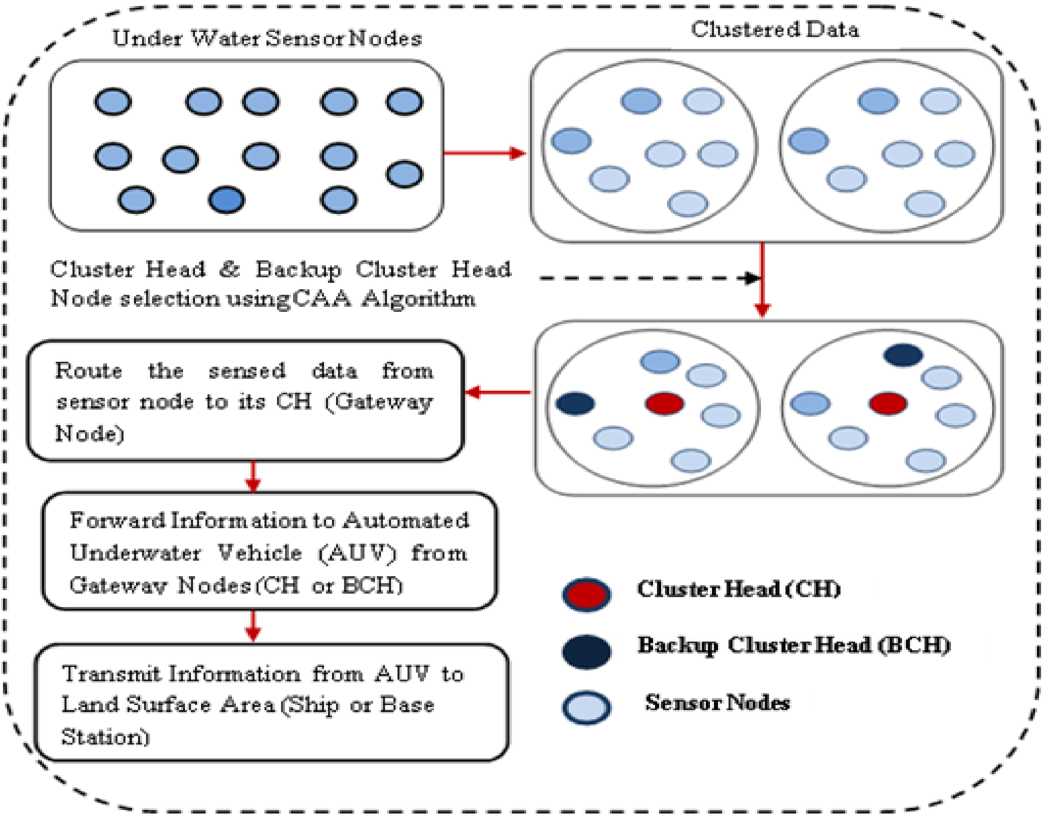

Figure 2 EEMCCP Protocol Architecture

2. DISCUSSION AND RESULTS

EEDBR (Energy Efficient Depth Based Routing) and AEERP (AUV aided Energy Efficient Routing Protocol) are compared to the proposed EEMCCP technique. It is possible to communicate underwater using either of these protocols. By comparing our proposed protocol to the existing ones, we will be able to analyze its performance. Aqua Sim for NS2 is used to conduct the comparison. Several network metrics are used in the comparison, including:

- Consumption of energy
- Data collection by the AUV
- PDR
- Delay from the beginning to the end

AEERP Protocol. The basic assumptions underlying the AEERP protocol are as follows:

- The density of the network is low
- Having unlimited capacity in a battery
- Nodes are always located in the same place

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EEDBR Protocol

- There are several salient characteristics of this protocol, including:
- A sensor node's priority determines whether it can transmit
- Data collection and transmission are two phases of the process
- Calculation of the node's priority value

Consumption of electricity

According to Figure 7, the three protocols under study consume different amounts of energy. In comparison with the AEERP and the EEDBR protocols, the EEMCCP protocol consumes less energy. When the nodes are made to perform a great deal of work without any regard to time, a lot of energy is usually consumed on the network. Energy consumption is lower for AEERP than EEDBR. There are no energy-consuming nodes, low network density, or unlimited battery power in the AEERP protocol, but its overall framework and working are based on fixed assumptions. It may be due to this that it has a higher energy consumption value than EEDBR. Due to the design of the AEERP scheme, clustering is not supported. Priority is calculated before a transmission begins in the EEDBR protocol on a different plane. If a high priority node wishes to transmit data, any sending node must suppress its energy.

Moreover, it works in two phases, wherein the first phase consists of gathering the node's data, after which the second phase consists of transmitting the node's information to the network. The node spends a considerable amount of time sending information before it transmits. There is a significant reduction in the nodes' battery power as a result of this. A node's priority is also calculated by the EEDBR protocol during the first phase. Nodes' battery power is reduced by all of these factors. It appoints a CH and a backup cluster head as part of the proposed EEMCCP scheme. Rather than allotting power to every node, power is diverted to a single CH, which conserves energy. Sensor data is collected by the gateway node. Another timer enables the sensor nodes to transfer data to the gateway node. The gateway node can conserve less energy since it does not spend so much time collecting data (since it spends less time collecting it) and can transmit the data to the AUVs more efficiently. A gateway node can also be determined efficiently based on the RSSI value. As a result of failing to join a cluster, the nodes which are unable to do so are suspended in an attempt to save energy. Due to the fact that this is the case, the proposed EEMCCP technique has a lower energy consumption than its counterparts. It helps the gateway node to conserve their energy (since it spends lesser time in collecting the data) efficiently pass on the data to the AUV nodes. Also, the RSSI value is used to determine the gateway node efficiently. The nodes that fail to join a cluster are suspended to save their energy. This is the reason why the energy consumption is lower in the proposed EEMCCP technique.

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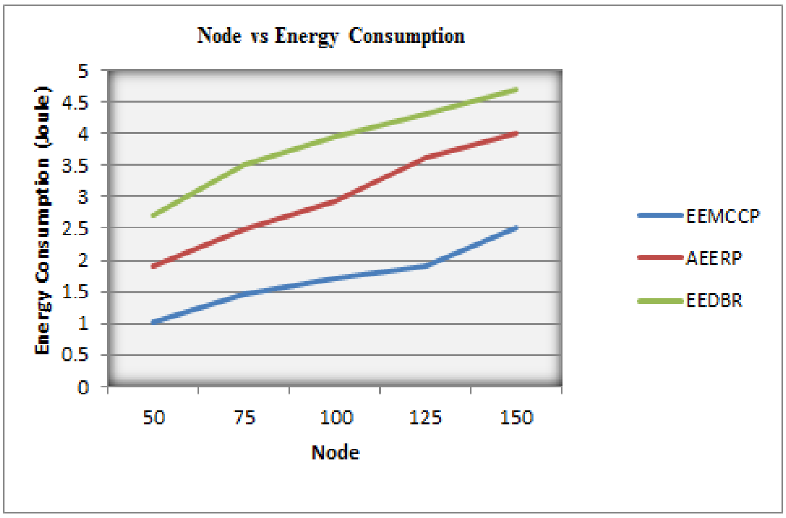

Comparison of energy consumption in Figure 7 AUV's total collection of data

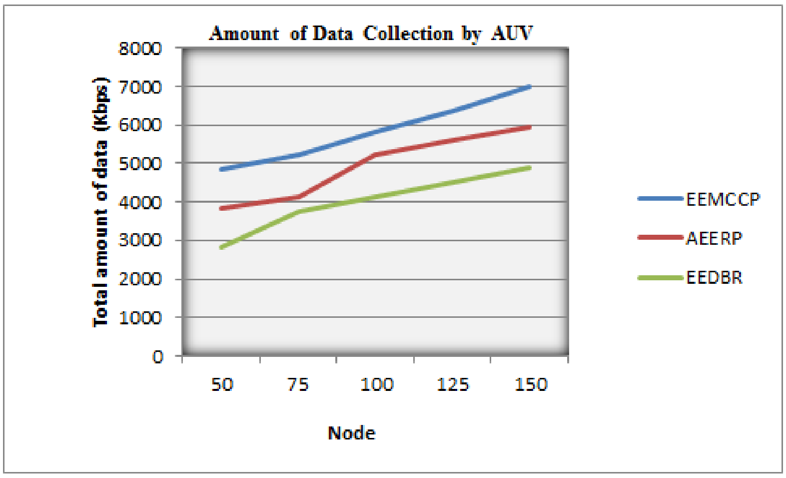

Figure 8 shows how much data is collected by the AUV in terms of quantity

In Figure 8, we can see that the EEMCCP scheme collected a greater amount of data about AUVs than the two other protocols because it used the as-needed principle. In fact, there is almost a straight line on the graph, highlighting that the way the data is collected is much more smooth than how it is being collected through the other two methods. There is no apparent difference in performance between AEERP and EEDBR on the graph, indicating that they performed worse than the proposed method. Cluster operations are handled by the CH in the EEMCCP scheme due to its clustering technique. Data transfer efficiency is ensured by the CH by ensuring that data (collected by the sensor nodes and cluster members) is transferred between them. There is always a backup CH available even if a primary CH fails. Data can be transferred from gateway nodes to their nearest AUVs as soon as they are nearby. In order to efficiently manage the process of collecting data, strict time limits are strictly adhered to, and as a result the whole process is regulated. There is no clustering involved in the AEERP scheme. All of the nodes are autonomous, therefore, there is no one who can monitor them, and so this is a disadvantage. It is not known whether there are active

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sensor nodes until the AUV arrives in order to gather the data, in case there are inactive sensors. All nodes in EEDBR are calculated based on priority. When a high priority sensor node needs to transmit, a sensor node of low priority will normally be prevented from transmitting. The AUV data collection process will be disrupted as a result. This has a negative impact on data transfer. There is no doubt that the data collection phase was disrupted as shown by the graph.

Ratio of packets delivered

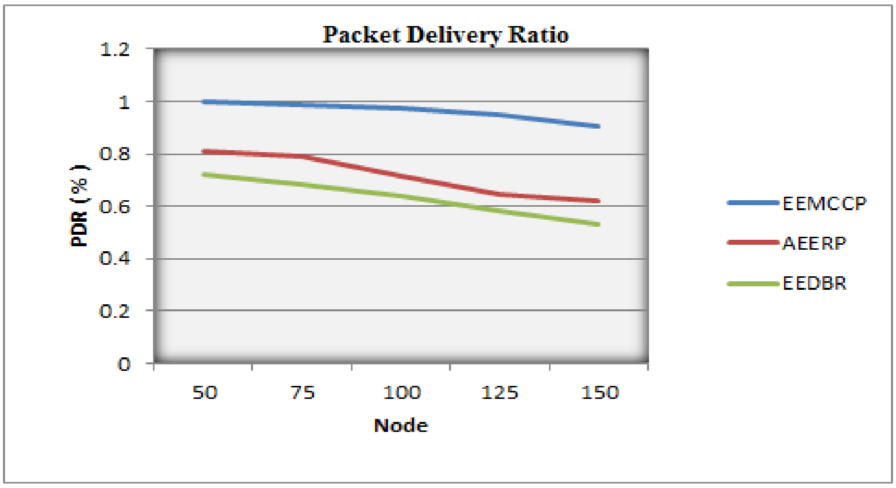

Figure 9 compares the time it takes for packets to arrive at their destination

EEMCCP's maximum PDR output is shown in Figure 9, whereas AEERP's and EEDBR's are not. In fact, EEMCCP PDR is minimally affected by the node density, and therefore it is also decreased as the node density increases, but the effect is only minimal. Data transmission is handled by CHs, which are clustered in the network. A backup CH node is also used when the CH of a cluster fails, so that transmission can proceed without interruption. Very little congestion occurs between CHs and gateways. An increase in network density results in a minimal PDR for AEERP. The network may not be clustered, which may explain this. It may cause a lot of congestion on the transmission between the sensor nodes and the gateway node since all the sensor nodes collect and transmit data to the gateway. PDR will be reduced by increasing node density. AEERPS works based on the assumption that there will be a low network density scenario in the future. Thus, there is a great deal of damage done to the PDR of the AEERP as a consequence. In addition to this, there are also disadvantages associated with the EEDBR scheme, which does not cluster the networks. The amount of data collected by the AUV is increased when the density of the nodes increases, and thus the PDR will naturally increase

The EEMCCP scheme collects more data from AUVs than either of the other two protocols. Data collection is more smoothly conducted using this method than the two other methods, as shown by the near-straight line in the graph. There is no doubt that the AEERP and EEDBR schemes perform better than the proposed method when comparing them against the graphs for AEERP and EEDBR schemes. Since the EEMCCP scheme makes use of clustering as the primary method for cluster operations, the CH is the relevant entity that oversees the cluster operations. CH supervises the transfer of the data (collected by the sensors) between the nodes and provides it to the CH Sensor nodes transmit almost simultaneously, so latency decreases. It may cause starvation issues if nodes with high priority transmit before nodes with low priority. Obviously, the PDR of a network will be impacted by this in a direct manner in the future.

3. CONCLUSION

The paper proposes an Energy Efficient Minimum Cost Cluster Routing Protocol. Cluster-based routing for UWSN is based on this protocol. A CH is selected for each cluster of the network in the EEMCCP after the network is clustered by the EEMCCP. It is also envisioned that each cluster will have a backup CH. The cluster members will use their respective CH to execute all their transactions within the cluster. Additionally, the RSSI values of each node for each CH are taken into account while selecting the efficient CH's to act as gateways. Data collected by the AUVs is transferred efficiently from the gateway to the AUVs using this method. It is then up to the AUVs to transmit the data via their nearest communication point for routing towards their destination, where it is processed and sent back to the AUVs. By using time-controlled stipulations, all of the sensor nodes are operated efficiently by using the protocol which makes sure that everything runs smoothly. As a result, it helps to conserve the energy that the nodes consume and it also speeds up the transfer of data between the nodes. A good PDR and good throughput can be achieved with the proposed protocol. It has been compared to the performance of AEERP and EEDBR protocols for EEMCCP in order to compare the performance of the EEMCCP scheme. EEMCCP appears to be performing better than existing protocols in terms of performance statistics over the years when compared to its predecessors We have planned to continue our research regarding the security of packets of data and also to verify that the transmitting nodes are trustworthy so that we may carry out further research in this area. As a result, we will be able to further refine the EEMCCP method and achieve our objectives in a more effective and efficient manner.

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