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AN APPROACH FOR REDUCE TRANSMISSION ENERGY IN UNDERWATER WIRELESS SENSOR NETWORK USING MULTIPATH GRID BASED ENERGY EFFICIENT ROUTING PROTOCOL

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ABSTRACT
Energy consumption maintaining is very challenging task in Underwater Wireless Sensor Network (UWSN). In addition, energy is needed to transfer the data from source node to surface sink node. In order to get-rid off such energy consumption long lasting batteries to be installed. The proposed protocol MGEERP is working better in energy consumption by transfer the data from end to end without delay by high packet delivery ratio. The MGEERP Protocol process is divided into three stages, first one is Network division for cluster formation, the second stage is node deployment and the third is transfer the data. The experimental results show that the proposed protocol produces better results than other protocol in terms of packet delivery ratio, end to end delay and energy consumption.
Keywords: Anchor node, Energy consumption, Cluster Formation, Node deployment, Grid based routing.

INTRODUCTION

Underwater Wireless sensor network is broad area of research in both industrial and academia sector. UWSN also help in discover the unexplored marine resources and marine data collection with the help of various approaches in computational intelligence [7]. The node deployment in a powerful marine environment, anchor node is normally used. The sensor nodes maintain a specific mechanism to transfer the sensed data to sink node while a major limitation of power [8].

Grid-based routing is commonly used in MANETs. MANETs is overcome broadcast storm problem. That consumes high power and reduces the performance of the protocols [9] [11]. The existing system in localization is global coordinate system. Now a day we are used in anchor node. This data cloud be gathered or coded via some extra equipment like GPS (Global Positioning System) [10]. The rapid deployment, self-organization and fault tolerance features of sensor networks create them hopeful sensing techniques for used in military applications.

A deep-water acoustic system for extract countermeasures functions: This procedure permits the sending of an underwater acoustic system for communication and permits the AUVs to layout range using its sonar sensor and a while later characterizes potential targets.

The system concedes for the association between numerous AUVs and they can

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exchange the information to each other for a viable agreeable counter the degree operation. The acoustic modems used for communication are WHOI Smaller scale models working at around 25 kHz and a bit rate of 80bps with the transducers mounted on the body of the AUVs for most extreme scope.

The rest of this paper organized as: In section II explain the various underwater wireless sensor network protocol and compared with our work. In section III describe the proposed methodology. Section IV shows the experimental result and explain the proposed work. Section V gives the concludes the work.

RELATED RESEARCH WORKS

Faiza Al Salti et al., [1] proposed the EMGGR: an energy-efficient multipath grid-based geographic routing protocol for underwater wireless sensor networks. This routing protocol is divided in three steps. There are 1. Gateway election algorithm, 2. Update nearby node details updated in gateway and 3. Packet forwarding. EMGGR protocol is transmitted the data packets through disjoint paths by way of gateways. In this protocol transfer the data in grid manner. Computational cost is high.

Ziaur Rahman et al., [2] introduced the Reliable and energy efficient routing protocol (REEP) is forward the packets with low energy. The packets are transmitting from water surface to the seabed through energy calculation mechanism. This mechanism is only calculated vertical distance packet forwarding. If the calculate the vertical distance is fails, the nodes forwarder should rest. This mechanism is reducing the energy in whole network.

Wahab Khan et al., [3] explain the multi-layer cluster-based Energy Efficient (MLCEE) protocol work three stages first is partition of the whole network in layer by layer, second stage is cluster formation and third stage are forwarding the data via sink. The last stage is work data forward the weight calculation method. This protocol is calculating energy consumption, network life time and end to end delay. But network throughput is very low.

Chunfeng Liu et al., [4] is designed a distributed node deployment algorithm for underwater wireless sensor networks (DABVF) based on virtual forces. This algorithm is used to node deployment in the seabed and increasing the network coverage. DABVF algorithm improves the energy consumption and node distribution. Computational cost is high. **Zhiming Li et al., [5]** is describing Sensor Node Deployment in Wireless Sensor Networks Based on Improved Particle Swarm Optimization algorithm is improving the network coverage and reduces the energy.

Mukhtiar Ahmed et al., [6] is describing in CBE2R: Clustered-Based Energy Efficient Routing Protocol for Underwater Wireless Sensor Network is controlling the node mobility and protract the battery power and divided the water depth. CBE2R Protocol is transfer the data in weight value. High weight value data is sending the sink node. Source nodes are sense and gather the data. CH node collect the information in all source node and CH node sent the data

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in surface sink node. These procedures are work in layer by layers. CBE2R is reducing the energy level and end to end delay.

PROPOSED METHODOLOGY

The Multipath Gird based Energy Efficient Routing Protocol (MGEERP) assumed the network space is partitioned into 3D cube with grid manner. The structure of MGEERP is network space is divided in cluster formation. Sensor nodes are arranged in various depth and all source nodes are attached in anchor node. Source nodes transfer the data in anchor node. Anchor node communicates grid to grid through acoustic links. Anchor node passed the data packet in surface sink. Surface sink is communicating the onshore monitoring centre through RF link. The proposed protocol process is divided into cluster formation, node deployment and data transmission. This proposed work is shown in Figure 1.

Network Division for Cluster Formation

The total network space (TNS) is assumed $(\mathrm{CF1X\,CF2X}\,\mathcal{Z})$. The network space is divided in cubes. One cube has 6 sides and 8 vertices. One cube consists of one cluster. The value of cube (CB) is $(CB\ X\ CB\ X\ CB)$, where CB denotes the cluster -breath or Cube breath. Network division, consider the value of network $(\mathrm{CF1X\,CF2X}\,\mathcal{Z})$ (3D coordinate system). Where underwater depth is representing $\mathcal{Z}$ -plane. For diving the network space into equation 1.

$$\mathrm{K} = \frac{\mathrm{CF1X\,CF2X}\,\mathcal{Z}}{(\mathrm{CB\,X\,CB\,X\,CB})} \tag{1}$$

Where, K variable denotes the total number of clusters (or cubes). The K variable as a high number that is power of three: K = 2^3, 3^3, 4^3, 5^3, 6^3 and so on. The network space divided in perfect cubes and equal sizes.

$$CB = \sqrt[3]{\frac{(\mathrm{CF1X\,CF2X}\,\mathcal{Z})}{K}} \tag{2}$$

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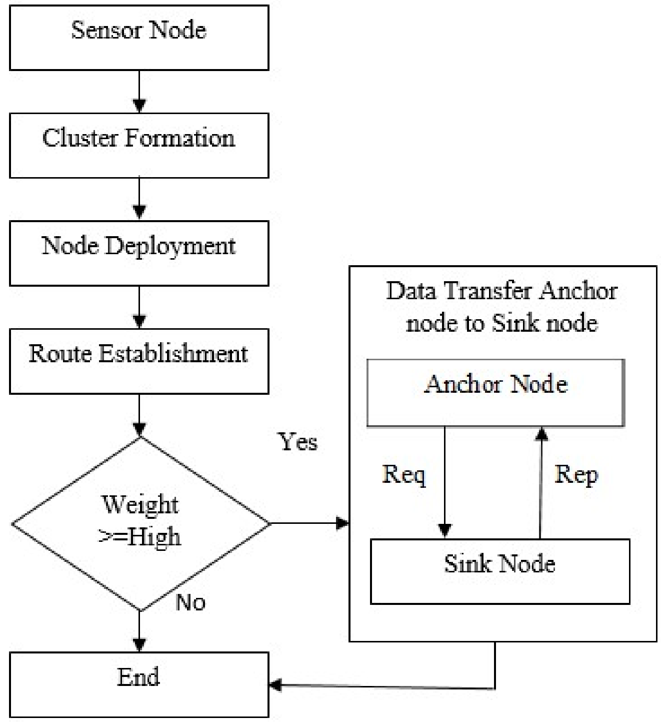

Figure 1: Flow chart for MGEERP protocol

Node Deployment

The network space is divided in equal size of cubes (or clusters); next deploy the nodes as per the requirement of network architecture. MGEERP consider 3D underwater wireless sensor network architecture as represent in Fig.2. The four various elements are their 1. Onshore monitoring centre, 2. Surface sink, 3. Anchor nodes and 4. Source nodes.

1. **Onshore monitoring center** is positioned at the surface water. Radio Frequency (RF) link is used for fetch the collected information from the sink node.

2. **Surface sink node** is communicated the RF link in onshore monitoring centre and acoustic link is used to communicate underwater nodes. Sink node transfer the data. Surface sink receive the data packets from the anchor nodes. The sensors are deployed in $\mathcal{Z}$-coordinate (depth) equals to zero as shown in Fig.2.

$$C_{isc}\left(\overline{CF}1_{isc}, \overline{CF}2_{isc}, 0\right) = \left(\frac{\sum_{i=1}^{4}}{4}\,\overline{CF}1_i, \frac{\sum_{i=1}^{4}}{4}\,\overline{CF}2_i, 0\right) \quad (3)$$

Where, a cube has corners of surface $\{(\overline{CF}1_{isc}, \overline{CF}2_{isc}, 0)\}_{i=1}^{4}$, surface-center C_{isc} of a cube C_i can be calculated by catching arithmetic mean given organized by this formula 3.

3. **Anchor nodes** are collecting the data from sensor nodes and forward the next hop anchor node. This procedure is continuing till the data packets are successful delivery at the surface sink nodes. Anchor node commutates through acoustic link with other source node and surface sink nodes. These are suspended at separate depths underwater with the help of a string as a cluster head in the center of each cube.

$$C_{ic}\left(\overline{CF}1_{ic}, \overline{CF}2_{ic}, \overline{z_{ic}}\right) = \left(\frac{\sum_{i=1}^{8}}{8}\,\overline{CF}1_i, \frac{\sum_{i=1}^{8}}{8}\,\overline{CF}2_i, \overline{z_i}\right) \quad (4)$$

Where, a cube has corners $\{(\overline{CF}1_{ic}, \overline{CF}2_{ic}, \overline{z_{ic}})\}_{i=1}^{8}$, centroid C_{ic} of a cube C_i

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calculate by this formula 4.

4. **Source nodes** are the normal sensor node. This node is fixed randomly within the network space. Marine environment data are collected by sensor node. These nodes also communicate with the acoustic link for forwarding the packets to the anchor nodes.

Broadcast joint message

Broadcast joint message allows the network components for reliable data circulate from source node to surface sink node. Deploy the all network components in network space. First, all network components are isolated from other components. Broadcast joint message spreads all network components layer by layer it's initiated by surface sink nodes. The broadcast joint message is only broadcasted by the surface sink nodes and anchor nodes. Ordinary source nodes are not accountable to broadcast the broadcast joint message, this method is reducing communication overhead and energy consumption.

But source node can receive the Broadcast joint message for evaluate its current cube and elected anchor node to send the data packets. Information in broadcast joint message is keep by all network components in routing table and updated after the end of the beacon interval. Normally, the protocols use random jitters as beacon intervals to ignore the packet collisions. The random jitter for setting the beacon interval. The path established for calculate the weight value. Weight greater than or equal one the condition is true routing path is established.

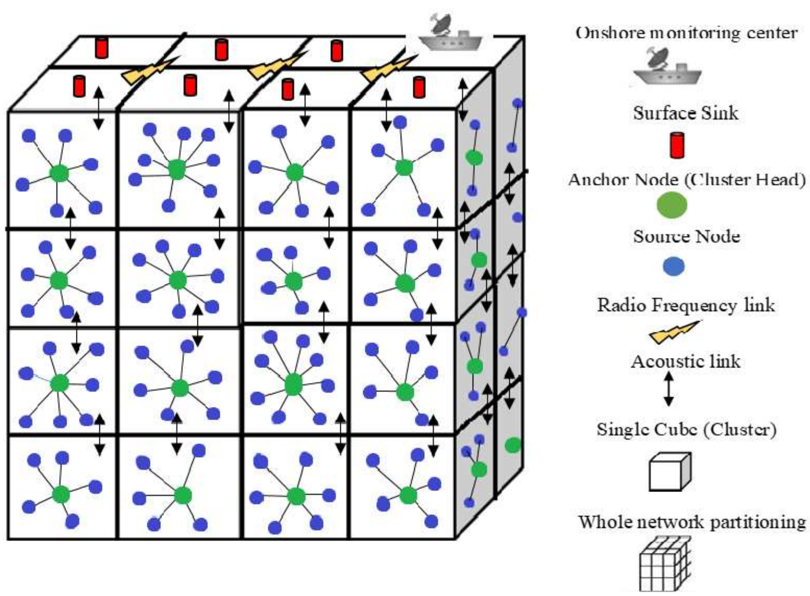

Figure 2. 3D UWSN network architecture

MGEERP Routing Protocol

This section describes the proposed Multi path Grid based Energy Efficient Routing Protocol (MGEERP). The MGEERP protocol follows network architecture portray in Figure 2. Initially, all network components are isolated from each other. They can identify their visibility by beacon message is broadcasted. The beacon process is used to share the nodes local

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information (surface sinks and CHs) with neighbouring CHs and normal source nodes.

Any source nodes can determine a path towards their designated CH, while CH can obtain information that can be reached towards surface sinks with the help of neighbouring CHs. After establishing the routing path through a random beaconing process, the source node begins to send senses data only to the respective CH. This way, the end-to-end delay and energy consumption is reduced and then network life is increased. The following mechanism is used to data transmission.

A) Data Transmission Mechanism for Anchor node:

Anchor node collect the information's in local source nodes and cube information of cube-ID from the routing table. Anchor node has to send data packets at the surface sinks for which it scans the routing table. They scan the routing table, find any nearest surface sink. The Cluster head of the lower cube will identify the adjacent cluster head as a next-hop that is at a lower depth level than it.

B) Data Collection by the Surface Sinks:

The multiple surface sinks are involved to gather the data from its only trailing clusters, using acoustic link. Finally, surface sink forwarded to the onshore monitoring center by using RF link.

Algorithm: MGEERP Protocol
Step 1: Network division for cluster formation in grid manner of sensor node.
Step 2: Node deployment based on the underwater depth level.
Step 3: Acoustic link is used to communicate one anchor node to another anchor node.
Step 4: The data transformed according to the weight value. When the weight value >= High.
Step 5: Transmit the data packets from anchor node to source node by set the cube-ID and AH-ID.
Step 6: Anchor Head (AH) contains information of location of source node and cube information of cube-ID from the routing table.
Step 7: AH send the data packets to surface sinks for which it selects the current routing table for find out the nearest surface sink.
Step 8: When the Hello Message is used for check the route establishment from anchor node to surface sink node.
Step 9: The acknowledgement is received form the sink node then the data is transfer from anchor node.
Step 10: The data packets will successfully reach the destination with minimum energy consumption.

RESULTS AND DISCUSSIONS

In this paper, the proposed protocol MGEERP gives better results compared to the other

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protocols. The performance appraisal of the proposed MGEERP protocol includes the following parameters such as packet delivery ratio, average end-to-end delay and total energy consumption. The proposed protocol, in comparison with other protocols, increases the packet delivery ratio and reduces the average end-to-end delay. Total energy consumption is measured in joules, and the energy consumption of each node is reduced.

PERFORMANCE METRICS

a. Packet delivery ratio (PDR): Packet delivery ratio is calculating number of packets send from the source node to how many packets are received in sink node.

$$PDR = \frac{\Sigma\, Number\ of\ Packets\ received}{\Sigma\, Number\ of\ packets\ send} X\ 100\% \quad (5)$$

b. Average end-to-end delay (E2E): Average end-to-end delay mention to the time taken for a data packet to be transmitted covering a network from source node to sink node. This formula 6 is used to calculate E2E.

$$Avg.E2E = \frac{\sum_{n=1}^{D_{rx}} (Arrival\ Time_n - Send\ Time_n)}{D_{rx}} \quad (6)$$

c. Total Energy Consumption: Calculate the how much of energy is used to overall network transfer the data from source to destination. This formula 7 is used to calculate the energy consumption.

$$Avg.EC = \sum_{n=1}^{\mathcal{N}} Tx\ Pow_n + Rx\ Pow_n + Idle\ Pow_n \quad (7)$$

EXPERIMENTAL RESULTS

Case 1:

Table 4.1 shows the packet delivery ratio of proposed MGEERP protocol. The EMGGRP and CDEERP protocols are provide the packet delivery ratio of 5.8 and 6.2 percentage for 50 nodes, respectively. Instead of being used, MGEERP proposed protocol offers a 6.8 percent packet delivery ratio for 50 nodes. While, the proposed routing protocol performance is better than existing protocols when increasing number of nodes, from that MGEERP protocol increases the speed of the packet delivery ratio. In Figure 4.1 shows the performance evaluation in packet delivery ratio of proposed protocol. In this case get total number of packets transmitted from source node to surface sink node, since formula 5 used to calculate received packets divided by total number of packets. Below table is depicted by using this formula 5 according to the number of nodes increased.

Table 4.1. Performance evaluation of proposed protocol for Packet Delivery Ratio

Protocols	No. of Nodes						
	50	100	150	200	250	300	350
MGEERP	6.8	7.3	7.8	8.2	8.7	8.9	9.2
CDEERP	6.2	6.8	7.2	7.6	8.1	8.4	8.9
EMGGR	5.8	5.7	6.5	6.8	7.2	7.5	7.8

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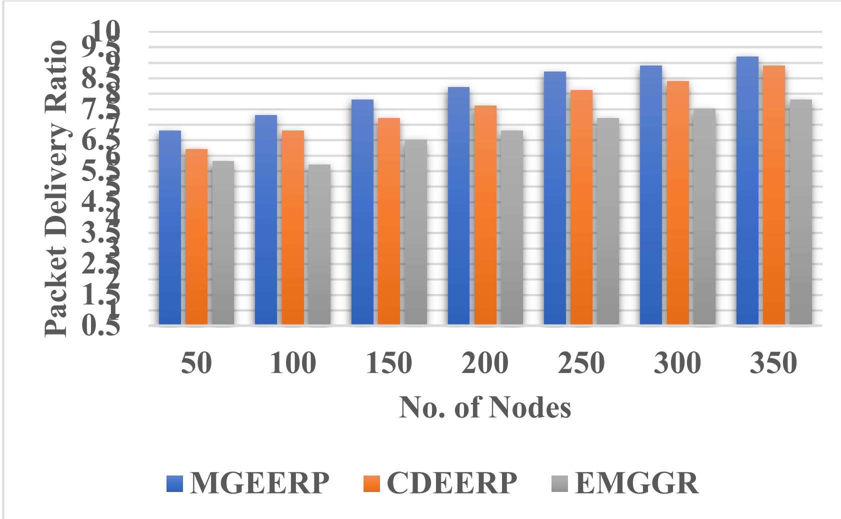

Figure 4.1: No. of Nodes versus Packet Delivery Ratio

Case 2:

Table 4.2 shows the end-to-end delay of proposed routing protocol MGEERP reduce the end-to-end delay. When comparing the existing protocol with proposed protocol of MGEERP provides better performance than existing protocols when increasing the number of nodes at that time end-to-end delay reduced in seconds. EMGGRP and CDEERP increase the end-to-end delay 11.6 and 10.5 seconds respectively for 50 nodes. But proposed protocol MGEERP reduces the end-to -end delay 9.1 seconds for 50 nodes, respectively.

Since the proposed protocol is reducing the end-to-end delay in seconds when increase the number of nodes. In figure 4.2. shows the performance evaluation of proposed protocol for end-to-end delay. For this case using formula 6 for calculating the end-to-end delay in seconds by using arrival time subtracted from send time, divide by destination. This table is depicted by using this formula 6 for different number of nodes.

Table 4.2. Performance evaluation of proposed protocol for End-to-End Delay

Protocols	No. of Nodes						
	50	100	150	200	250	300	350
MGEERP	9.1	7.4	5.4	4.9	3.4	2.8	2.6
CDEERP	10.5	8.5	6.5	5.5	4.5	3.5	3.0
EMGGR	11.6	9.6	7.4	6.8	5.7	4.8	4.2

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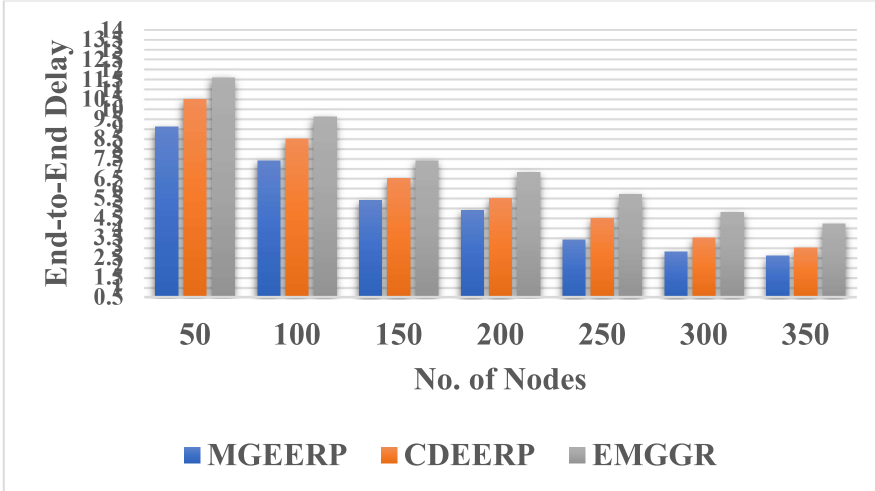

Figure 4.2: No. of Nodes versus Average End-to-End Delay

Case 3:

Table 4.3 shows the total energy consumption of proposed MGEERP protocol. EMGGRP and CDEERP of existing protocols increase the total energy consumption in Joules 130 and 110 joules respectively for 50 nodes. Here, the proposed method of MGEERP protocol reduces the total energy consumption 90 joules for 50 nodes. When increases the number of nodes at the same time the total energy consumption is reduced in joules. So, the network lifetime is increased when using proposed protocol instead of existing protocol.

In Figure 4.3. shows the performance evaluation of proposed protocol for total energy consumption. For this case using formula 7 for calculating total energy consumption of transmitting packets from source node to sink node. Transmitting power is added to receiving power and it's added to ideal power. Here ideal power means remaining power. This table is depicted by using this formula 7 for different number of nodes.

Table 4.3. Performance evaluation of proposed protocol for Total Energy Consumption

Protocols	No. of Nodes						
	50	100	150	200	250	300	350
MGEERP	90	170	200	320	400	450	580
CDEERP	110	190	250	380	420	510	610
EMGGR	130	230	290	410	490	550	650

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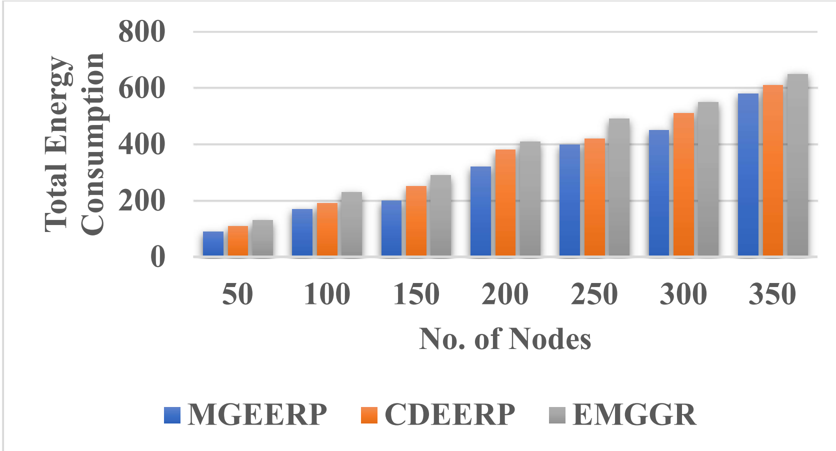

Figure 4.3: No. of Nodes versus Total energy consumption

CONCLUSION

The propose MGEERP protocol is focused mainly on energy efficiency in data packet transmission. The protocol uses the powerful anchor node (cluster head) to increase the battery life of normal underwater sensor nodes and reduce energy consumption compared to existing protocols. Using this protocol decreased the end-to-end delay. Therefore, the proposed MGEERP protocol provides more accurate results than existing protocols and reduces total energy consumption.

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