IJCSE International Journal of Computer Sciences and Engineering Open Access
Research Paper Volume-5, Issue-11 E-ISSN: 2347-2693

Energy Efficient Hierarchical Clustered Based Routing for Underwater Sensor Networks

K. Bansal[1], P. Singh[2]

[1]Dept. of Computer Science and Engineering, GZSCCET, Bathinda, India
[2]Dept. of Computer Science and Engineering, GZSCCET, Bathinda, India

**Corresponding Author: kbkashima4@gmail.com*

Available online at: www.ijcseonline.org

Received: 02/Oct/2017, Revised: 15/Oct/2017, Accepted: 06/Nov/2017, Published: 30/Nov/2017

Abstract- Sensor networks that are utilized underwater are usually called Underwater Wireless Sensor Networks (UWSNs). In UWSNs, nodes have limited source of energy, hence energy remains a main issue in underwater network. The lifetime of network decreases due to variation in energy consumption of nodes and creates network holes. This paper presents Energy Efficient Hierarchical Clustered based Routing Protocol (EEHCR). In this paper, the network is divided in regions based on energy, which are high energy nodes, intermediate energy nodes and low energy nodes. The nodes are allowed to perform switching between levels. When the energy of a node in higher level decrease below intermediate level, the node switch to low level and another node from intermediate level switch to higher level. In this way node survival time will be higher and results in enhancing network lifetime.

Keywords- UWSNs, routing protocol, EEHR, EEHCR

I. INTRODUCTION

Underwater Wireless Sensor Networks are created for exploration of underwater world. It is made to examine and gather all information from underwater area where human can't go on account of high cost and many other regions. In terrestrial network, radio waves are used for communication. But these waves are not used in underwater due to the high energy absorption of water. Therefore, communications in this network are based on acoustic signals which are characterized by propagation delays. Wireless sensor networks have been applied in many fields in recent years, because the sensor nodes can be deployed without any infrastructure and the network can monitor many dangerous or remote places that people cannot reach. At the same time, many of the latest researches related to UWSNs mainly focused on routing, coverage, and localization. UWSNs are characterized with low-cost micro sensor nodes with wireless capability, low power consumption for transmitting data, resource constraints, and battery energy limitation. Since sensor nodes have limited energy, it is urgent to introduce the energy-saving techniques in order to extend the lifetime of UWSNs.

Routing in UWSNs is very challenging due to many different reasons that distinguish UWSNs from other networks such as wireless ad hoc networks or cellular networks. Based on the network structure adopted, routing protocols for UWSNs can be classified into different groups such as flat network routing protocol, hierarchical network routing and location-based network routing. Clustering protocols minimizes many signaling problems because they do not have to manage the mobility pattern or information of the location of sensor nodes. As a result, it saves more nodes energy and increases the network lifetime. However, there are some applications such as animal tracking, search and rescue activities this assumption is not very realistic. Clustering network is effective and reliable way to organize UWSNs. As in clustering network, cluster head is responsible for transmitting the data packets collected from all the nodes in its cluster and also compress the data before transmitting it to the destination. In [2] author attempts to decrease the transmission distance while direct transfer to sink, as maximum energy is consumed during transmission. It also disturbs the energy balance of network, results some node dies very early. As the result the maintained respective distance and paths among nodes is disturbed, declining overall network performance. Author proposed a clustered hierarchy scheme, in which network is divided in to 4 regions. Equal number of nodes is deployed in all the regions and nodes deployed in 2 regions are of higher power than other two levels. This approach fails when the energy of nearest nodes is almost depleted. In this case routing is not possible as forwarder node died, and direct transmission consumes lot of energy. This is one of the biggest challenge in present approach.

In this paper we emphasize on reducing the energy consumption of the network by introducing new intermediate level. The network is divided into logical regions based on energy; some are high energy nodes, intermediate nodes and low energy nodes. The nodes are allowed to perform switching between levels, as per threshold energy. When the energy of a node in higher level decrease below intermediate level, the node switch to low level and another node from intermediate level switch to higher level. In this way node survival time will be higher and results in enhancing network lifetime.

II. RELATED WORK

MudassirIjaz et al. [1] has proposed Energy Efficient Hybrid Clustering Routing Protocol for UWSNs. In this paper author proposed various mechanisms for energy balance and deploying sensor nodes that consumes less energy in underwater networks for energy efficiency. As the remaining energy of a node in the network is used, immediately the node dies and creates energy holes in the network which decrease the overall network performance. These holes also affect the data flow of the network. EEHC is the enhanced version of DBEBH protocol. EEHC improves the lifetime of the network by decreasing the number of data transmissions and aggregation. The simulation results prove that lifetime of the network and throughput has increased.

Muhammad et al. [2] had proposed Energy Efficient Hybrid Routing Protocol for UWSNs.. In this paper the direct transmission distance for transmitting the data is decreased which is further refined to the sub neighbor region. This protocol is hybrid between the multi-hop and direct transmission. In this proposed work, there are four regions which are created in the form of semi circles and just beneath the sink. All the regions are of different radii. There is equal number of nodes deployed in each region. Neighboring lists of the nodes are created on the basis of their distance to a sink. The energy of the nodes in the region 1 and 2 is high than other two regions. Simulation results prove that there is enhancement in network lifetime and there is also reduction in energy consumption of the network.

I.Snigdh et al. [3] presents development of a lifetime prolonging algorithm for underwater sensor networks. The proposed algorithm balanced the energy consumption of the nodes, with the different parameters which are related to the sensing field like energy, attenuation, and path loss component. The aim is to increase the node lifetime and hence maximize the lifetime of network. The simulation results show that OEB strategy can achieve balanced power consumption per node throughout the network and hence increases the network lifetime.

Syed Zarar et al. [4] had proposed Increased Throughput DB-EBH Protocol in Underwater Wireless Sensor Networks. Author suggests that the utilization of energy of the nodes always remains a main problem in the advancement of underwater sensor networks. In this paper author check for all the conditions to be fulfill. Instead of direct transmission of data packets to sink, the node will transmit the data by using multi hop transmission. Thus results in saving their energy, which maximizes the lifetime of the network and have better throughput as compared to DBH.

FatemehFazel et al. [5] had proposed Random Access Compressed Sensing for Energy Efficient Underwater Sensor Networks. This proposed scheme is suitable for long-term deployment of underwater networks. In each frame some nodes are randomly selected to take part in the sensing process, and then by using the random access it shares the channel. Some packets may get collide at the center due to random access. The network utilizes the idea of adequate sensing probability to account for the packet loss that occurs due to collisions. Many packets are received with this probability, which are required for field reconstruction. This scheme increases the network lifetime.

AgnihotriSinha et al. [6] presented a review on under water acoustic sensor networks. This paper describe research directions in MAC, short range acoustic communications, localization protocols and time synchronization for high latency acoustic networks, application level time scheduling and long duration network sleeping.

Jenq-Shiou et al. [7] had proposed Energy Efficient Clustering Scheme for Prolonging the Lifetime of Wireless Sensor Network with isolated nodes . This paper proposes a clustering method called REAC-IN. In REAC-IN, cluster heads are chosen on the bases of weight and it is examined according to the remaining energy of each node and the regional average energy of all nodes in each cluster. Algorithms which are based on clustering and improperly designed can cause the nodes to become isolated nodes from CHs. When these isolated nodes communicate with the sink, consumes a large amount of energy. The simulation results shows that the performance of the algorithm used in REAC-IN improves the network lifetime and stability of a network as compared to other algorithms used in other protocols.

TayyabaLiaqat et al. [8] had proposed Depth-Based Energy-Balanced Hybrid Routing Protocol for UWSNs. In this paper, author concludes that energy is always the main issue of wireless network. Also, the less consumption of energy by the networks cannot be the solution as a whole, as the variation in energy consumption creates network holes which results in the network partition. DB-EBH is the enhanced version of EBH protocol as it improves the network lifetime by balancing the energy consumption of the nodes by using its hybrid technique. Simulation results also show that burden of data transmission over the nodes is highly reduced.

Salvador Climent et al. [9] had proposed an Energy Efficient and Robust Architecture for UWSNs. This paper presents a EDETA-e routing protocol which minimizes the energy consumption. In this, nodes are organized in the form of clusters and when nodes have no need to be awake that time they uses the concept of low power modes. Also the protocol adds the mechanisms for fault tolerance and has time constrained properties. Result shows that there is reduction in the energy consumption and delays.

Ning Li et al. [10] presents A Survey on Underwater Acoustic Sensor Network Routing Protocols. In underwater wireless sensor networks, the transmission of data packets from source node to destination must be effective and reliable. The design of routing protocol is an appealing point for researchers. In this paper, all the routing protocols in underwater sensor network are divided into different groups based on different creteria such as the non-cross-layer design routing protocol, the traditional cross-layer design routing protocol, and the intelligent algorithm based routing protocol.

III. METHODOLOGY

In our proposed work the dividation of network is done on basis of energy in logical regions that are high energy nodes, intermediate energy nodes and low energy nodes. The nodes are allowed to perform switching between levels, as per threshold energy. When the energy of a node in higher level decrease below intermediate level, the node switch to low level and another node from intermediate level switch to higher level. This methodology provides an immune system and nodes survival time will be higher. More survival nodes results in enhancing overall network performance. As the previous paper worked on distance base level and we have made three levels which are divided into node levels i.e. normal nodes, intermediate nodes and advance nodes which are heterogeneous in nature. In our proposed work there are three zones defined in which nodes are divided on the basis of their energies. The nodes having the maximum energy consider as advance nodes rest are normal nodes and intermediate nodes can be calculated according to a formula between the advance nodes and normal nodes. The flow of our proposed work can be seen in figure below:

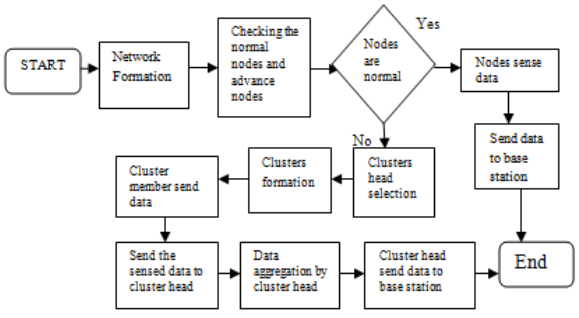

Figure1. Data transmission in EEHCR

Our work could be explained as:

1. First of all, network formation is there.
2. Checking of nodes whether it is normal node or not. If it is normal then data is been sensed by it and conveyed to base station. On the other hand if it is not normal node then cluster head selection and formation of clusters will take place.
3. Cluster member will sense data and send to cluster head.
4. Data aggregation takes place by cluster head and cluster head send data to base station.
5. End.

This is a general overview how the whole networks works for us. For the election of cluster head, the probability of nodes is to be calculated, which are dependent on energy, so calculations are done with the help of below formulas:

$\mathcal{P}_{nmr}=\mathcal{P}_{opt}/\ 1+m.\alpha+b.\mu,$
$\mathcal{P}_{int}=\mathcal{P}_{opt}\ (1+\mu)/\ 1+m.\alpha\ +b.\mu$
$\mathcal{P}_{adv}=\mathcal{P}_{opt}(1+\alpha)/\ 1+m.\alpha+b.\mu$

IV. RESULTS AND DISCUSSION

Under water wireless sensor network has been used for communication in the dense medium so that data can be easily transmitted through transmitter and receivers. In the process of communication UWSN heterogeneous network has been used for data transmission. In this process three different types of nodes have been deployed so that network lifetime can be enhanced. In UWSN nodes have been divided into advanced energy, normal energy containing nodes and intermediate energy nodes. In this process clustering has been done so that data can be easily transmitted through cluster head. Zone distribution has been done in the proposed work so that normal nodes that are deployed in the network have been used for data transmission directly to base station. Node switching has been done in the proposed work on the basis of energy levels, as energy of the advanced nodes comes under intermediate level then nodes are automatically switched to intermediate nodes group. Advanced nodes and intermediate energy level nodes have been under goes the process of clustering so that data can be easily transmitted through cluster head selection. Cluster head selection has been done on the basis of probability value and energy value. On the basis of these value cluster head has been selected for each round so that data can be easily transmitted in data aggregation manner. Various performance evaluationparameters have been analyzed in the proposed work so that validation of the proposed system can be done. The illustration of the performance metrics have been illustrated below.

A. Performancemetrics

The performance metrics for evaluation are:

Network lifetime: Network lifetime is the time till the death of the first node in a network when the node energy is fully exhausted.
Alive nodes: The number of nodes having enough energy for communication in a network.

Packets to BS: The total number of data packets received at base station in every round.

B. Performance discussion

In figure 2 and 3 the network lifetime of EEHR and EEHCR is compared. As in EEHR when the energy of nearest nodes is almost depleted, routing is not possible as forwarder node died and direct transmission consumes lot of energy. But in EEHCR, the network is divided into 3 regions. When the energy of a node in higher level decrease below intermediate level, the node switch to low level and another node from intermediate level switch to higher level. In this way node survival time will be higher and results in enhancing network lifetime.

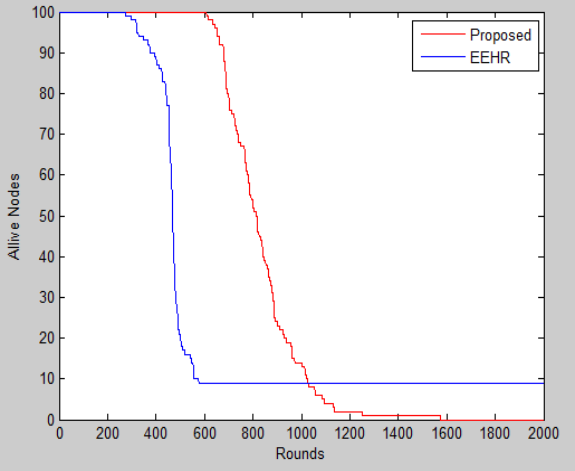

Figure2. Alive nodes per round

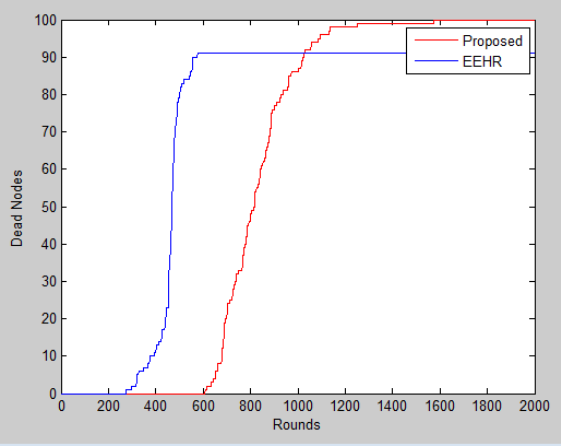

Figure3. Dead nodes per round

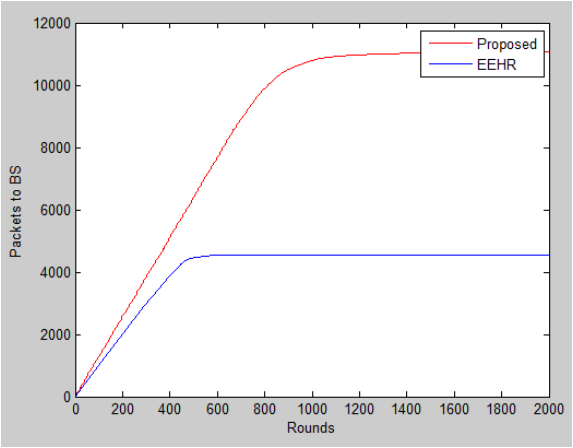

Figure4. Packets received at BS

Figure 2, 3, 4 represents the alive nodes and dead nodes, total number of packets received at base station respectively. In EEHR due to early death of nodes, the total number of packets received at base station decrease. But in EEHCR the ratio of alive nodes is better than EEHR which directly increases the total number of packets received at base station.

V. CONCLUSION AND FUTURE SCOPE

UWSN has been emerging field of networking that has been used for sensing information from the underwaterenvironment. Due to dense medium rather than air atmosphere data transmission is not an easy process more energy has been consumed that reduces the network lifetime. In the proposed work a novel approach that is EEHCR has been proposed that divides whole network into three various zones on the basis of energy. On the basis of energy normal nodes, advanced nodes and intermediate nodes have been deployed and used for data sensing and transmission using clustering approach. In the proposed work various parameters have been evaluated that has been used for performance evaluation of proposed work. These parameters are network life time and total number of packet transmitted to base station. On the basis of these parameters one can conclude that proposed approach provide better results as compare to existing approaches.

Future Scope: In future we need to find the respective application scenarios for this scheme with all the related factors taken into consideration. This technique needs to be implemented in underwater wireless sensor network with mobile nodes, since mobility was not taken into account in this work. The effects of very large node densities need to be investigated. Multi-hop routing was adopted in this work. The feasibility of using the clustering technique and data aggregation needs to be tested in the same wireless sensor network. In this work, security problem was not tackled at the transport layer. It means to devise this scheme from transport level view point needs to be explored.

REFRENCES

[1] M. Ijaz, N. Javaid, and H. Maqsood, *"An Energy Efficient Hybrid Clustering Routing Protocol for Underwater WSNs,"*IEEE 3rd Int. Conf. Eco-friendly Comput. Commun. Syst., no. JANUARY, 2016.

[2] M. Muhammad, N. Javaid, S. Hussain, T. Hafeez, H. Maqsood, and S. Zarar, "*EEHR: Energy Efficient Hybrid Routing Protocol for Underwater WSNs,"*Proc. - 2015 10th Int. Conf. Broadband Wirel. Comput. Commun. Appl. BWCCA 2015, pp. 20–26, 2016.

[3] I. Snigdh, R. Khichar, and N. Gupta, "*Lifetime Prolonging Algorithm for Underwater Acoustic Sensor Network 1,"* Middle East J. Sci. Res., vol. 13, no. 6, pp. 818–822, 2013.

[4] S. Zarar *"Increased throughput DB-EBH protocol in underwater wireless sensor networks,"*Proc. - IEEE 30th Int. Conf. Adv. Inf. Netw. Appl. Work. WAINA 2016, no. March, pp. 571–576, 2016.

[5] F. Fazel, M. Fazel, and M. Stojanovic, *"Random access compressed sensing for energy-efficient underwater sensor networks,"* IEEE J. Sel. Areas Commun., vol. 29, no. 8, pp. 1660–1670, 2011.

[6] A. Sinha and I. Yadav, *"Review on Under Water Acoustic Sensor Network,"*Int. J. Sci. Eng. Technol. Res., vol. 5, no. 4, pp. 1269–1275, 2016.

[7] A. Rana, M. Bala, Varsha, "*Performance Analysis of Energy Efficient Clustering Protocol in WSN*", International Journal of Computer Sciences and Engineering, Vol.5, Issue.3, pp.1-5, 2017.

[8] T. Liaqat, N. Javaid, S. M. Ali, M. Imran, and M. Alnuem, *"Depth-based energy-balanced hybrid routing protocol for underwater WSNs,"*Proc. - 2015 18th Int. Conf. Network-Based Inf. Syst. NBiS 2015, pp. 20–25, 2015.

[9] S. Climent, J. V. Capella, N. Meratnia, and J. J. Serrano, *"Underwater sensor networks: A new energy efficient and robust architecture,"*Sensors, vol. 12, no. 1, pp. 704–731, 2012.

[10] N. Li, J.-F. Martínez, J. Meneses Chaus, and M. Eckert, *"A Survey on Underwater Acoustic Sensor Network Routing Protocols,"*Sensors, vol. 16, no. 3, pp. 414, 2016.

Authors Profile

Kashima Bansal graduated from Punjab Technical University in 2015 with a bachelor's of technology in Computer Science and Engineering. She is currently pursuing M.tech in Gaini Zail Singh College Bathinda. Her research interest includes mobile ad-hoc networks, network security.

Dr. Paramjeet Singh is a Professor of Computer Science at Gaini Zail Singh College Bathinda. He has published many research papers. His main research work focuses on networking, softwa re systems, and computer graphics.

