Zonal Stable Election protocol for Wireless Underwater Sensor Network

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Abstract- In stable election protocol (SEP), sensors are randomly deployed in a region without considering the balancing energy consumption normal nodes and advanced nodes. The process of sending and receiving messages below the water by the help of sound propagation is known as underwater acoustic communication. Here, the motive of the work is to find the stability period, active nodes, expired nodes, output of LEACH (Low energy adaptive clustering hierarchy), SEP, Z-SEP (Zonal Stable election protocol). Focusing on stability period SEP and comparing the performance with LEACH and SEP, the simulation result shows that ZSEP has more enhanced stability period and throughput. Theoretical performance analysis of underwater acoustic sensor network is simulated using MATLAB.

Keywords- *LEACH, ZEP, Z-SEP, active nodes, expired nodes*

I. INTRODUCTION

Sensor nodes are randomly distributed with a chief sensor node at the centre of underwater network region. Comparing Wireless sensor network protocol with underwater sensor network, these sensor nodes are gather the information from environment and sends those data to base station for the next process. Similarly in case of underwater wireless sensor network, sensor nodes are collect the data or information from the sea and transmits those data to the chief sensor node. If we go by literature survey then different types of protocols are there for wireless sensor network. Implementing the same in underwater sensor acoustic network, there are protocols like Low Energy adaptive clustering hierarchy (LEACH), Stable Election Protocol (SEP), Threshold sensitive Energy Efficient sensor Network protocol (TEEN), Distributed Energy-Efficient Clustering Protocol (DEEC) etc. according to heterogeneous energy level. Main motive of these protocols that how we can transmit data more effectively. For this, we need to design a protocol which can work more constructively. LEACH is a protocol which is based on clustering process. The group of sensor nodes and cluster heads gather the information and transmit to the chief sensor node. For using the energy more efficiently we can form more number of clusters. Stable election protocol (SEP) is the expansion of LEACH. SEP is more efficient in energy as compared to LEACH. In LEACH, each node can be a cluster head but SEP, it is separated as normal and advanced nodes as compared to the required energy level. Advanced nodes uses more energy hence situated little away from the chief sensor node. Normal nodes requires less energy. To send information from nodes to chief sensor node minimum energy is required.

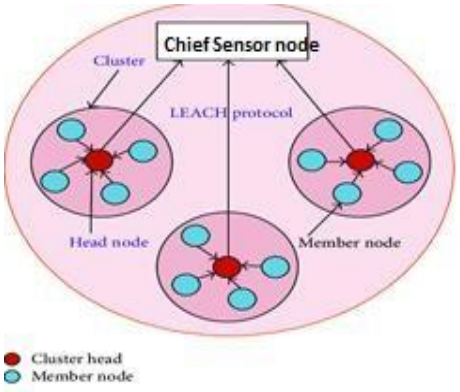

Fig. 1: LEACH cluster mode

The paper is organized as follows. Section II reviews investigation of LEACH and some basic protocols for proliferation. The proposed model for zonal election protocol described in section III. In section IV, we took the input parameters of SEP for simulation. At the end, we simulated the results of SEP, LEACH and Z-SEP. Also compared the results in section V.

II. LITERATURE REVIEW

LEACH [1] is a clustering protocol or an algorithm to know the usages of energy in underwater wireless sensor network. In homogeneous condition LEACH acts better as compared to heterogeneous environment. However, LEACH didn't work in heterogeneous environment. But, Stable election protocol is two level heterogeneous algorithm with normal and advanced nodes. In LEACH, each node has the possibility to become a cluster head but in SEP advanced nodes have more possibility to become cluster heads than normal nodes. SEP isn't sure about the efficient distribution of energy. Enhanced Stable Election Protocol (E-SEP) [3] was proposed and in ESEP one intermediate node was found and the energy of the intermediate node lies between the energy of normal node and advanced node. Demerits of E-SEP are same as SEP. Distributed Energy- Efficient Clustering Protocol (DEEC) [4] was proposed for multilevel hierarchy. In case of DEEC, high energy nodes have more possibility to become cluster heads.

In case of SEP we can find normal nodes and advanced nodes established randomly. If most of the normal nodes establish far away from the chief sensor node then it requires more energy during the transmission of data which results, decrease in output information and shortening in stability period. To overcome these inadequacies we divide the whole sensor network in an area where corner nodes require more energy to transmit data to the chief sensor node as it takes more energy for the transmission. So, we place the normal nodes near the chief sensor node so that it takes less energy to transmit the data. If we send the data directly to the main senor node via advanced node, it consumes more energy and to save energy of advanced nodes, we use clustering algorithm [5-10].

III. PROPOSED Z-SEP METHOD

Zonal stable election protocol (ZSEP) is the extension of Stable election protocol which transmits data via cluster head followed by direct transmission; popularly known as hybrid approach of the protocol. Here, the network entire region holds normal nodes and advanced nodes with the chief sensor node at the centre.

A. Basic Network Architecture

In most of the routing protocols of network region, nodes are established randomly and energy of these nodes isn't bring into effective.

Assuming the network region into three different sector: Sector 0, Main Sector 1, Main sector 2. On the basis of required energy nodes are dispersed with in these three sectors.

Assuming 'x' as high energy node among the n number of total nodes which supplies 't' time of extra energy as compared to other nodes. And this can be considered as advanced node and '(1-x)*n' as normal node.

Dispersing all the nodes among the above three sectors:

Sector 0: Only normal nodes are found randomly.

Main sector 1: Half of the advanced nodes can be found and placed randomly.

Main Sector 2: Rest of the advanced nodes can be found and also placed randomly.

To reach high efficiency, we have arranged the nodes in this type. As we know that normal nodes have less energy than advanced nodes.

From the beginning we have already discussed that those nodes require more energy that can be located near the chief centre node and other nodes like advanced nodes can be located far away from the chief centre node during data transmission.

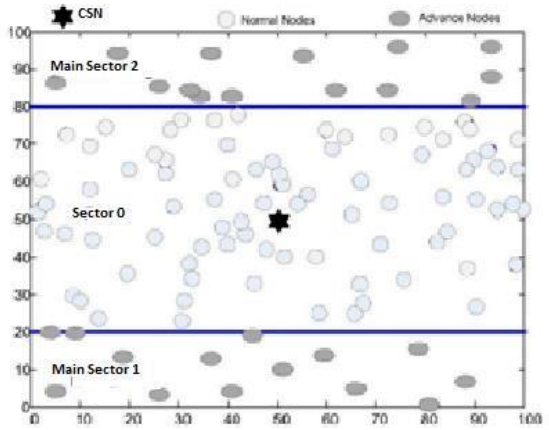

Fig. 2: Basic Network Architecture

B. Transmission Operation of Z-SEP

To transmit data Z-SEP uses the following two methods:

i. Direct transmission of data

Without establishing a cluster head the normal nodes transmits the information to the chief sensor node. These nodes have low energy which can sense encircle of network region or the surrounding and collects information then transmits directly to the main sensor node.

ii. Transmission of data via cluster head

Advanced nodes placed in Main sector 1 and Main sector 2 transmits the data to the chief sensor node via cluster head. On the basis of clustering algorithm, a node is nominated as cluster head in Main sector 1 and Main sector 2. This cluster head collects the data from the nodes and send to the chief sensor node. Development of clusters is only relevant for

advanced nodes.

Considering the optimum number of clusters as X_{opt} and n number of advanced nodes. SEP optimum cluster head probability can be given as [1]:

$$P_{r_{opt}} = \frac{X_{opt}}{n}$$

Generating a random number from 0 to 1 for the advanced node and if this number is less or equal to threshold $Th(n)$ for nodes and that can be used as cluster head. Threshold $Th(n)$ is given by [3]:

$$Th(n) = \frac{P_{r_{opt}}}{1-P_{r_{opt}}(r \times mod(\frac{1}{P_{r_{opt}}}))} \text{ if } n \in R \text{ or}$$

0 otherwise

Where R is the set of nodes which is not being a cluster head in the previous $\frac{1}{P_{r_{opt}}}$ rounds. To become a cluster head the probability for advanced nodes can be given as:

$$P_{r_{adv}} = \frac{P_{r_{opt}} \times (1+t)}{1+(t,X)}$$

Similarly the threshold for the advance node can be given by:

$$Th(adv) = \frac{P_{r_{adv}}}{1-P_{r_{adv}}(r \times mod(\frac{1}{P_{r_{adv}}}))} \text{ if } adv \in R' \text{ or}$$

0 otherwise

R' is the set of advanced nodes that have not considered as cluster head in the $P_{r\ adv}$ round.

How to form a cluster?

Once a cluster head is nominated then it relay a message to the nodes and nodes take the decision for the cluster head for the current round. This phase of formation of cluster is known as cluster formation phase.

The very next step to the cluster formation phase is, each and every node transmits the information to the cluster head at the allocated time slot. And this phase can be shown in fig. 3.

After receiving the information from the nodes. Cluster head transmits the data to the chief sensor nodes and this phase is known as transmission phase. This can be shown in fig. 4.

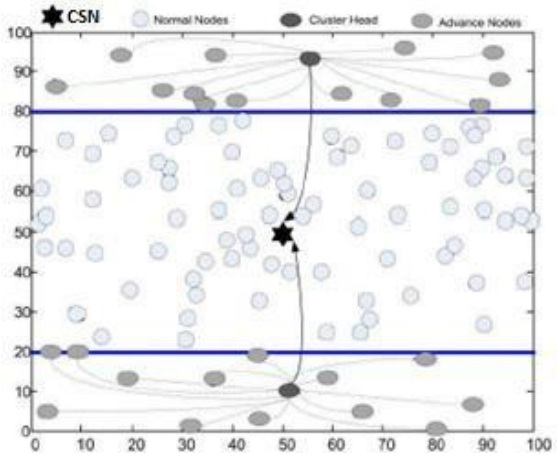

Fig. 4: Cluster head transmitting the information to the chief sensor node

Clusters cannot be formed by normal nodes because of less energy than advanced nodes and cluster heads requires more energy than cluster members.

IV. SIMULATED RESULTS

Here, we analyse the proposed method ZSEP and compare between the SEP and LEACH. Considering 100 nodes in 150*150 network region the chief sensor node placed in the Sector 0. Consider some input variable mentioned in the table 1 and concentrate on the throughput and stability period of LEACH, SEP and ZSEP. And the results are implemented in MATLAB.

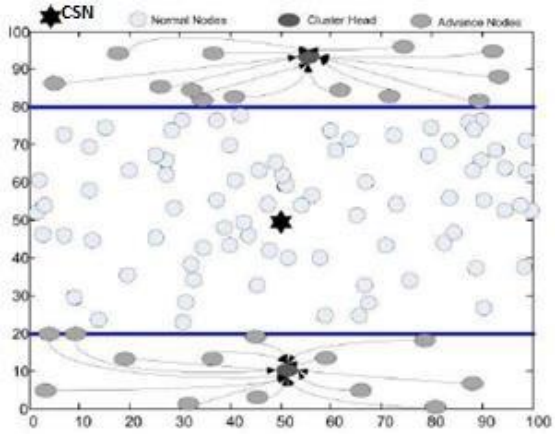

Fig. 3: Nodes sending data to cluster head

Table 1: Input variables for simulations

Parameter Characteristics	Input Value
Area of network region	150*150
Number of nodes	100
Initial energy	5J
Data in term of bits	3000bits
Threshold energy	1J
Advanced nodes	50
Sector 0	50
Main sector 1	25
Main sector 2	25

V. RESULTS AND DISCUSSIONS

Here, we compared the results of SEP and LEACH. And our proposed protocol introduced heterogeneity in LEACH to access the same protocol.

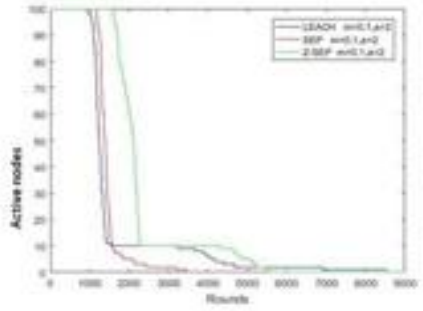

Fig. 5: Active nodes at fraction 0.1

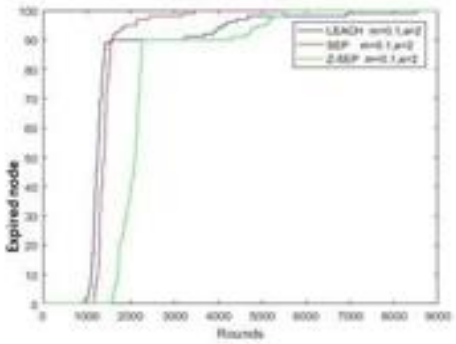

Fig. 6: Expired nodes at fraction 0.1

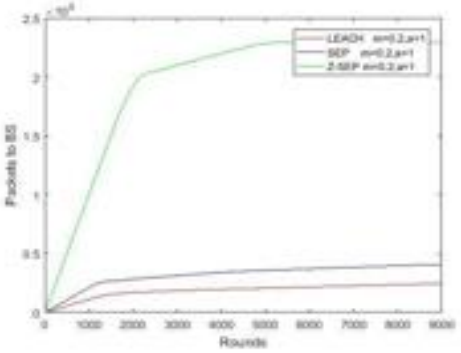

Fig. 7: Throughput of SEP, Z-SEP and LEACH

VI. CONCLUSION

Proposed Z-SEP shows better simulation results than LEACH and SEP in the form of active nodes and throughput. Here, normal nodes are distributed in Sector 0 to minimize the energy consumption and also helps in data transmission to the chief sensor node. According to result, the stability increases by 50% in the distribution of different nodes as per their energy requirements.

VII. REFERENCES

[1] Geinzelman, W. R., Chandrakasan, A., & Balakrishnan, H. (2000, January). Energy-efficient communication protocol for wireless micro sensor networks. In System Sciences, 2000. Proceedings of the 33rd Annual Hawaii International Conference on (pp. 10-pp). IEEE.

[2] Smaragdakis, G., Matta, I., & Bestavros, A. (2004). SEP: A stable election protocol for clustered heterogeneous wireless sensor networks.Boston University Computer Science Department.

[3] Aderohunmu, F. A., & Deng, J. D. (2009). An Enhanced Stable Election Protocol (SEP) for Clustered Heterogeneous WSN (No. 2009/07). Discussion Paper Series.

[4] Qing, L., Zhu, Q., & Wang, M. (2006). Design of a distributed energy efficient clustering algorithm for heterogeneous wireless sensor networks. Computer communications, 29(12), 2230-2237.

[5] Manjeshwar, A., & Agrawal, D. P. (2001, April). TEEN: a routing protocol for enhanced efficiency in wireless sensor networks. In 1st International Workshop on Parallel and Distributed Computing Issues in Wireless Networks and Mobile Computing (Vol. 22).

[6] Akyildiz, I. F., Su, W., Sankarasubramaniam, Y., & Cayirci, E. (2002). Wireless sensor networks: a survey. Computer networks, 38(4), 393-422.

[7] Abbasi, A. A., & Younis, M. (2007). A survey on clustering algorithms for wireless sensor networks. Computer communications, 30(14), 2826-2841.

[8] B. Das, "Enhancement of lifetime of acoustic sensor using PEGASIS algorithm in UWA-SN," academic science, Vol. 2, Issue. 9, pp. 534-545, 2017.

[9] B. Das, G. Mishra, S. Kanungo, B.K Sahoo, "Performance improvement through interference mitigation techniques in Transmitted Reference UWB system used in WPAN overlay systems" *IEEE African Journal of Computing & ICT*, vol. 8, no. 3, pp. 189-204, Sept. 2015.

[10] B. Das, B. Subudhi, B. B. Pati, "Employing nonlinear observer for formation control of AUVs under communication constraints", *International Journal of Intelligent Unmanned Systems*, vol. 3 Iss: 2/3, pp.122 – 155, Nov. 2011.