

# Enhanced Cluster Head Selection Approach for small scale and large scale network in WSN for improving energy efficiency

M.SELVALAKSHMI<sup>1</sup>, Dr.M.K.JEYAKUMAR<sup>2</sup>

<sup>1</sup> Research Scholar, Department of Computer Application, Noorul Islam Centre for Higher Education, Kumaracoil, Kanyakumari Dist, Tamilnadu, India

<sup>2</sup> Professor, Department of Computer Application, Noorul Islam Centre for Higher Education, Kumaracoil, Kanyakumari Dist, Tamilnadu, India

## Abstract

The plight of amassing life expectancy of WSN is the key concern faced by the researchers in general. Numerous terms of methods and techniques are familiarized to overcome the energy depletion problem in WSN. The foremost hitch in WSN is nothing but the selection of Cluster Head (CH). CH is used to upkeep the member nodes to consume its energy with data transmission. In this study we hosted an improved CH selection algorithm based on LEACH protocol. Base Station (BS) acts as a major role to designate the CH by its residual energy and distance between the node and BS. After electing CH, BS broadcast a message to CH and informs the Cluster members for that cluster. From the simulation result, the improved algorithm could minimize the energy consumption in WSN and it increases the lifetime of network as well.

**Keywords:** Sensor node, Cluster Head, Energy Efficiency, WSN.

## I. INTRODUCTION

WSN is a wide distributed network it consists of a large amount of sensor nodes for sensing, computing, and transmitting the data. WSN plays a major role in various applications for the purpose of area monitoring, Health care monitoring, Environmental monitoring, Earth sensing, Industrial monitoring, Intruders detection etc. A number of protocols are used to identify how the nodes will interconnect with other nodes and how it diffuses the data between one another in wide network. Different types of routing protocols are used to increasing the lifetime of Sensor Nodes (SN) and consuming the energy, because all the sensor nodes are battery driven, charging the battery is not possible in wide distributed network.

Clustering method is used to diminish the energy convention in routing protocols. It enlarges the

scalability, fault tolerance, data aggregation, maximize the network lifetime, Load balancing etc.

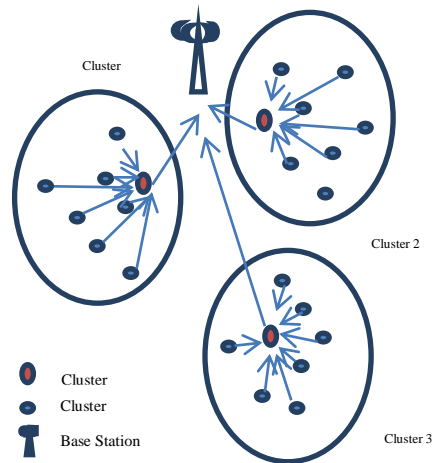


Fig 1. Clustering Technique

In Fig 1. Sensor nodes transfer the data to the CH and CH forward the data to the BS. BS is placed at a center position of the location area to gather the information from the sensor nodes. Electing CH is the important task for energy consumption, CH supports to remove the correlation data in the cluster, and it aggregates the data and transmits the data to the BS. For transferring the data from CH to BS, a number of methods are introduced to interconnect with the BS alike Single hop communication, Multi hop communication etc. In Single hop communication the sensor nodes directly communicate with the BS. In Multi hop communication SN handover the data to CH directly. CH communicates BS with the assistance of Sink node. Sink node receives the data from the CH transmit the information to BS.

Some familiar protocols which are used to prolonging the lifetime of SN in WSN like LEACH, HEED,

SEECH etc. The above stated protocols are grounded on clustering procedures. LEACH is the basic protocol for all clustering procedures. It elects the CH by rotation scheme. Likewise every algorithm uses different kinds of approaches used to elect CH. CH election is the first step to increasing the energy of each node. If the CH energy reaches low or the node is dead then Reclustering is introduced to elect the CH. At the time of Reclustering other node can't communicate the BS. Node drops its energy by saving the data itself. Memory size of each node is less for every SN, so it is not able to store more data. Sometimes Hot spot issue may occur.

The rest of this paper projected to resolve the complications which are correlated to avoid Reclustering, Hot spot issue, energy hole in WSN. The remaining section organized by the following topics such as Section II Related works it describes the prior paper which emerges the CH election, Section III suggests ECHS-A approach, Section IV demonstrate the Experimental analysis, Finally, Section V states the conclusion and future ideas.

**II. RELATED WORKS**

Each clustering procedures follows the basic protocol LEACH (Low Energy Adaptive Clustering Hierarchy). Main intention of this protocol is to diminish the depletion of energy and keep the clusters in order to advance the lifetime of WSN. Some of the protocols listed below.

**A. LEACH-C (LEACH-Centralized)**

LEACH-C is a centralized protocol. In this protocol, CH selection is performed by BS. Base station receives the residual energy from each sensor node and calculates the average energy and its calculate the distance between the SN and BS. It uses the K means optimal clustering by using the simulated annealing algorithm. Simulated annealing algorithm is used to minimize the energy dissipation of normal node. Average energy  $E_{avg}$  is calculated by the equ 1.

$$E_{avg} = \frac{\sum_{i=1}^N E_i}{N} \tag{1}$$

$E_i$  is in the process of stating the lingering energy of the  $i^{th}$  node.  $N$  exacts the number of nodes in the network location.

If average energy is less than the energy of any sensor node than the node becomes CH it announced by BS. BS broadcast the information to the CH election and waits for the reply. If it receives the acknowledgment, all the controls transferred to the CH. The elected node broad cast message to the SN and form the cluster.

Upto cluster formation no node can transfer the data. If the node is not located near to the CH then the node not able to communicate easily. It uses GPS (Global Positioning System) to identify the location of each sensor node. TDMA is used to transmit the data. It consumes energy but it is costly to implement everywhere [5] and it swelling the waiting time for making cluster.

**B. sLEACH (Solar aware LEACH)**

In this sLEACH sensor nodes are activated and performed on the basis of solar power. It uses the centralized clustering algorithm and it supports the distributed clustering algorithm. Each node sends its residual energy and solar power status to the BS. If the node has high solar power and the node is present near the Base station then the node becomes CH. If the node losses its energy because of sun duration, at that time battery energy of each sensor node is calculated. Node has highest energy it act as a CH. If solar power increases then again CH election occurs to change the CH. Frequently CH election occurs depends upon solar power. It may increases the hot spot issue and energy hole in the WSN. It may lose its data during the transmission [7].

**C. TL-LEACH**

TL-LEACH is an extended protocol of LEACH. In Fig 3. It shows the structure of TL-LEACH protocol. CH is selected randomly depends upon the bottom up approach TL-LEACH. The layer-1 CHs are selected from the layer-0 sensor nodes, and then the layer-2 CHs are selected from the layer-1 CHs. Even though this approach is fully distributed, however, some results of previous work show that partially or semi-distributed control would lead to better performance.

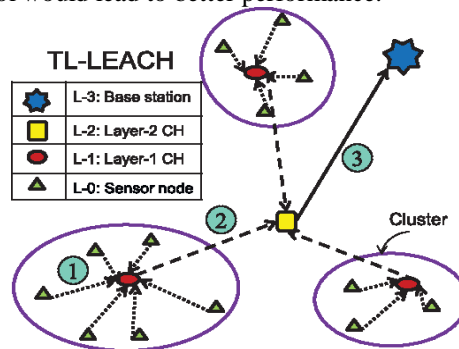


Fig 2.TL-LEACH

It allows using multiple CH for transmitting the data from one CH to BS. So for each and every time the CH lose its energy to found the CH to transmit the information. It is not easy to elect the CH. Moreover it

contains two layers and each layer should contain the CH to collect the information.

### III. PROPOSED WORK

In this paper, we proposed algorithm to enrich the cluster Head selection (ECHS-A) to avoid Reclustering, Hot spot issue and energy hole. CH election is a vital role in WSN to improve the energy efficiency and prolonging the lifetime of the network. ECHS-A is similar to LEACH-C. In LEACH-C base station elect the CH, and broad cast the message to CH. After receives the information CH broadcast message to the nearby node. But in this proposed ECHS-A all the mechanisms such as CH election, Cluster formation, Message broadcastings are done by BS. So it can easily increase the lifetime of the network and it consumes more energy.

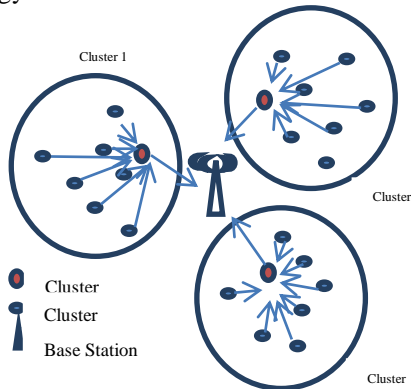


Fig 3. ECHS-A

In Fig 3. ECHS-A, BS is placed at the center position and remaining SN is deployed randomly. Once the SN is deployed its location never fluctuates. At the time of deployment BS receives all the information about the SN. Information about the node is exposed below in Table1.

SN id	Location (X,Y)	Initial Energy
-------	----------------	----------------

Table 1

SN id is denoted the Sensor node identification number. Each Sensor has a unique id.

Location (X,Y) helps to identify the location of the node is where it is deployed

Initial Energy is same for all-inclusive node at the time of deployment.

These information supports to calculate the residual energy of each sensor node for CH election. CH election is based on Residual energy and location of the node. Threshold value is assigned by default, and it calculates the average energy in WSN by the equ 2.

$$RE = \sum_{N=1}^{i=N} \left( \frac{R_i[N]}{N_i * IE_i} \right) * 100 \quad (2)$$

In equ 2.  $R_i$  denotes the remaining Energy of the node,  $N$  denotes Number of nodes,  $IE$  denotes Initial Energy of each node. If Threshold value is less than the average energy of the node then automatically the node which has greater energy and location of the node is near to the BS becomes CH. Once the calculation is made by BS, It updates the array. The reorganized array information are enumerated in Table2.

SN id	Loc (X,Y)	IE	RE	CH no	Round No	Threshold value
-------	-----------	----	----	-------	----------	-----------------

Table 2

Each and every time the order of an array is changed depends upon the residual energy. Location between the nodes and BS is calculated by the equ 3.

$$D_i = \sqrt{(NX_{x2} - NX_{x1})^2 + (NY_{y2} - NY_{y1})^2} \quad (3)$$

$NX$  and  $NY$  denote the Number of nodes in  $X$  position and  $Y$  position. No need to calculate the distance for each round because once the nodes deployed location of the node never changed. BS calculates the distance by equ 3. to find the location of the nodes and it store it into the array.

In equ 4. It allows the updation by calculating the residual energy and it replace the values.  $Y_i$  denotes the old energy and  $RE$  denotes remaining energy after the data transmission.  $SN$  is used to update the new  $RE$  into the array.

$$SN_i = \sum_{N=1}^{i=N} (RE - RE_{y_i}) \quad (4)$$

Array is sorted based on the maximum value of residual energy  $\max(RE)$  and shortest or minimum distance between the node  $\min(D_i)$  is calculated BS by the equ 5.

$$SN_i = \max(RE) \wedge \min(D_i) \quad (5)$$

Using equ 4 and equ 5 tends to supporting to elect the CH. Once the Array is sorted the highest value of an array in the list becomes CH. CH is assigned by the BS then it finds the cluster member for the CH. Cluster members are chosen by the BS by the way of range. Each Sensor node has the range 250mm, BS calculates the range between CH and Cluster member nodes.

If the distance of the SN is near to the BS then the node can communicate directly (single hop communication). Otherwise the SN is grouped under some clusters each cluster is formed by BS with CH. CH receives the information from the entire node in cluster and pass the information to BS. Suppose the BS not able to get the response from any node then the node declared as isolated node. It can communicate the nearby node and

pass the information to the CH. In Fig 4. shows the procedure of CH selection through the base station.

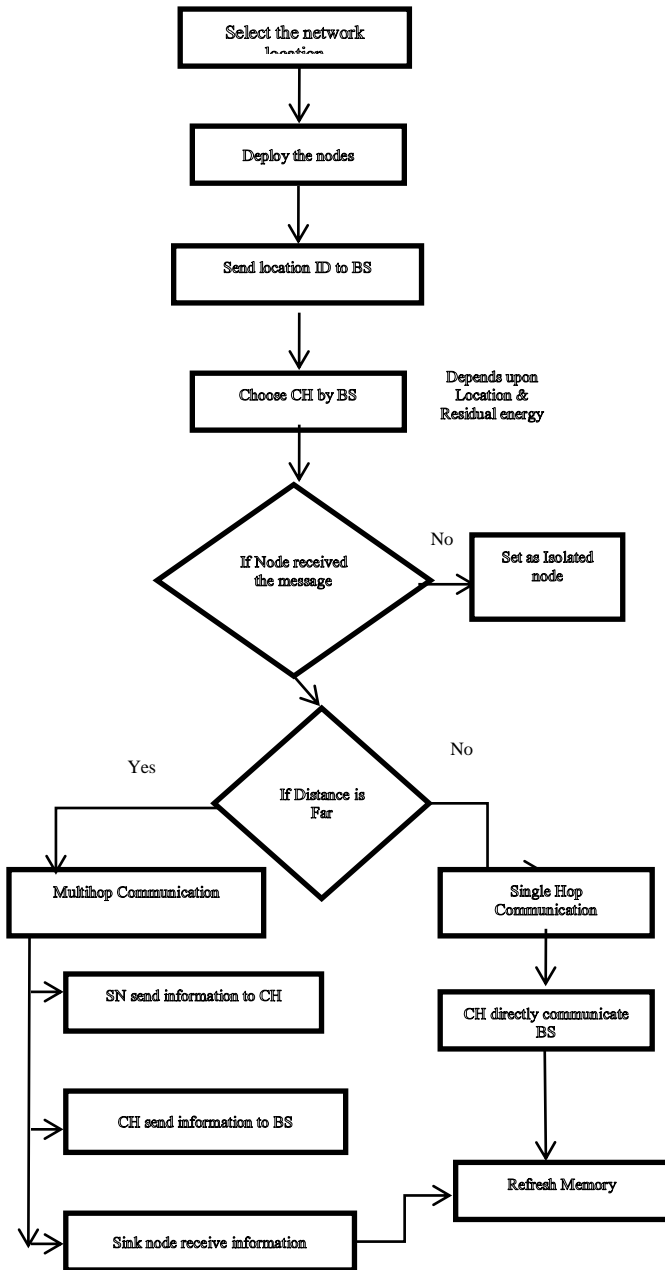


Fig 4. Flow diagram

In Alg 1. It shows the steps to elect the CH in efficiently and effectively to improve the lifetime of sensor node.

1. Deploy N number of nodes
2. Place BS at  $B_{loc}=[N_A_x/2, N_A_y/2]$
3. Create array to store the information  $a[n]$   
Send all Parameter information to BS
  - i.  $BS \rightarrow SN_{id}, SN_{loc}, IE$
4. For  $R=0, i=0; i \leq n; i++$
5. if  $SN_{(E_i)} == SN_{(E_j)}$  Then
  - i) Calculate the Distance between the node and BS using
  - ii)  $D_i = \sqrt{(N X_{x2} - N X_{x1})^2 + (N Y_{y2} - N Y_{y1})^2}$
6. Else
7. Calculate the RE
  - i)  $RE_{(x)} = \text{Remaining energy} - \text{Stored energy}$
  - ii)  $RE = RE + RE_{(x)}$
8. if  $CH_{(s)} = \max(RE) \ \&\& \ \min(D_i)$  then
  - i) Sort the array  $a[n]$
  - ii) Check the  $T_i > CH_{(s)}$  then
  - iii) Assign the least used CH it means no change.
9. else
10. elect the  $a_i[n] = CH_i$
11. end if
12. end if
13. End for

Alg 1. ECHS-A

This experimental analysis is done in network simulator (NS2) with equal number of parameters. In Table 3. represents the simulation parameter setting. Parameters selection also helps to improve the protocol, size of the network is increases then the remaining parameters may change. A set of parameters are mentioned below for the experimental analysis.

Table 3. Parameter Settings

Width of the Network	1000m
Height of the Network	1000m
No. of Nodes	50 to 250
BS Location(x,y)	500,500
Initial Energy	100J
Energy consumption for sleeping	0J
Simulation Time	40ms
Data packet Size	500 bytes
Bandwidth	1Mbps
Communication Range	250mm

**IV. EXPERIMENTAL ANALYSIS**

**A. Energy Efficiency in WSN**

Energy level of each node in the WSN is identified by its residual energy. As per the exploration Fig.5 shows the comparison of energy efficiency of numerous algorithms that comforts to increase the energy in SN. During this analysis ECHS-A compared with TL-LEACH, the proposed approach shows the best result to escalate the efficiency of the SN. Experimental data value is shown in Table 4.

**Table 4**

No.of nodes	ECHS-A	TL-LEACH
50	12.1637	13.9221
100	12.0298	13.4533
150	11.9649	13.0436
200	11.4336	13.7602
250	11.3628	12.4125

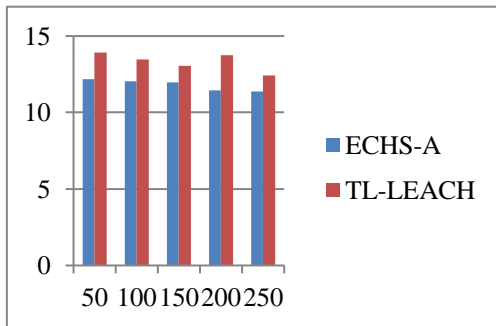


Fig: 6 Comparison of Energy Efficiency using various s numbers of node

**B. Energy Consumption in WSN**

Energy consumption upturn the network lifetime and it aids to raise the energy efficiency. In Fig 6. The graph exhibits the energy consumption of SN. The overall energy consumption of SN is similarly a central indicator to evaluate the network lifetime, network enactment and consistency in WSN.[8] The simulation result identifies the less energy consumed algorithm which helps to increase the energy efficiency in the WSN. ECHS-A consumes less power than the TL-LEACH.Experimental data value is Table 5.

**Table 5**

No of nodes	ECHS-A	TL-LEACH
50	87.8363	86.0779
100	87.9702	86.5467
150	88.035	86.9564
200	88.5700	87.2398
250	88.6372	87.5875

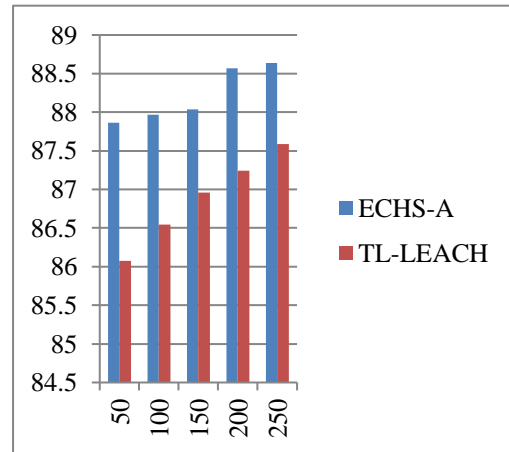


Fig: 6 Comparison of Energy Consumption using various numbers of nodes

**V. CONCLUSION**

In this paper, Enhanced cluster head selection (ECHS-A) approach is proposed to elect a CH in effective manner. In most of the clustering protocol in WSN application, CH selection is based on random or by the residual energy calculation it creates a Hot spot issue. At the time of Reclustering, energy hole occur node cannot transfer the data at the time SN in WSN loss its energy. To avoid the above drawbacks, the proposed work supports to improve the energy efficiency and avoid the problems easily. This proposed approach is compared with TL-LEACH, as per the simulation result it shows the Energy efficiency and it consumes more energy by the enhanced cluster head selection. In the future, we will analyze how to apply this approach in large scale network using IOT.

**REFERENCES**

- [1] Gao, H., Cao, J.: "Quantum-inspired bee colony optimization algorithm and its application for cognitive radio spectrum allocation", J. Central South Univ. (Sci. Technol.), 2012, 12, p. 25
- [2] G. Ferrari, P. Medagliani, S. Di Piazza, and M. Martal `o, "Wireless Sensor Networks: Performance analysis in indoor scenario", EURASIP Journal on Wireless Communications and Networking, Volume 2007, Article ID 81864, 14 pages.
- [3] Jenq-ShiouLeu, Tung-Hung Chiang, Min-Chieh Yu, and Kuan-Wu Su, "Energy Efficient Clustering Scheme for Prolonging the Lifetime of Wireless Sensor Network with Isolated Nodes" IEEE COMMUNICATIONS LETTERS, 2013.
- [4] Jin-Shyan Lee, Tsung-Yi Kao, "An Improved Three-Layer Low-Energy Adaptive Clustering Hierarchy for Wireless Sensor Networks": DOI 10.1109/IJOT.2016.2530682, IEEE Internet of Things.
- [5] Liao, Q., Zhu, H.: "An energy balanced clustering algorithm based on LEACH protocol", Appl. Mech. Mater., 2013, 341, pp. 1138–1143.

- [6] Selvalakshmi, Jeyakumar, “*Performance Analysis of Energy Efficient Algorithm In Wireless Sensor Network*”, International Journal of Management, Technology and Engineering, Volume 8, Issue XII, Dec 2018.
- [7] T.Voigt, A.Dunkels, J.Alonso, “*Solar-aware clustering in wireless sensor network*”, Proceedings. ISCC 2004. Ninth International Symposium on Computers And Communications (IEEE Cat. No.04TH8769)
- [8] W. Wang, Q. Wang, W. Luo, M. Sheng, W. Wu, and Li Hao, “*Leach-H: An improved routing protocol for collaborative sensing networks*,” in Proc. Int. Conf. Wireless Communications & Signal Processing, Nanjing, China, Nov. 2009, pp.1-5.
- [9] Z. X. Deng and B. S. Qi, “*Three-layered routing protocol for WSN based on LEACH algorithm*,” in Proc. IET Conf. Wireless, Mobile & Sensor Networks, Shanghai, China, Dec. 2007, pp. 72-75.