

An Energy efficient routing algorithm for heterogeneous Wireless Sensor Network

Priti Dwivedi¹, Ashok Kumar Rai^{2,*}

Abstract

Wireless sensing network is consisting of sensors and sink that is self-organized and infrastructure less network. Energy plays a very important role for the life-time, coverage and connectivity of network. In this paper, proposed protocol has two level heterogeneous wireless sensor network in which Residual Energy and distance of node from base station in which every sensing element node is taking into account to maximize the life time of network. Simulation results show that the proposed protocol improves the performance of network.

Keywords: Base Station, Cluster Head, Distance, Residual energy, Wireless sensor network.

INTRODUCTION

Wireless sensor network has important role in the field of horticultural perception, forecast, building complex perception, protection police examination, data catching from various sources. These applications required a wireless sensor network which has a long-life time and proper area coverage into the target region. Since the working head of this organization is to gather data from target territory through the sensors and send it to the base station, so the majority of the energy utilization is because of the getting and sending of information. Different conventions have been proposed to limit the energy utilization of organization because of which support cost can limit. Sensors in wireless sensor network are consist of power source, Transceiver, Microcontroller, external memory and analog to digital converter.

The rest of the paper organized as follows: The related work explained in Section II. Proposed algorithm with flowchart presented in Section III. The simulation result shown in Section IV. At last conclusion presented in Section V.

RELATED WORK

Area Coverage and energy consumption is always big challenge for WSN. These two factors always effect the cost and lifetime of the network. To overcome these types of issues, various protocols have been proposed. In [1] Ravindra Singh et al. presented a convention for division of organization in various levels by utilizing position based numerous methodologies. In this convention fluffy rationale is utilized for the CH choice and ideal course is find by position-based strategy. In [2] Leschi et al. presented a two-level heterogeneous convention with unmistakable edge energy for choice of CH. Two level heterogeneity lessen the consumption of energy for transmission of information to the BS.

*Author for Correspondence

Ashok Kumar Rai

¹M.tech Student, Department of Computer Science & Engineering, Buddha Institute of technology Gorakhpur (U.P), India

²Assistant Professor, Department of Computer Science & Engineering, Buddha Institute of technology Gorakhpur (U.P), India

Received Date: May,1,2021

Accepted Date: May,25,2021

Published Date: June,14,2021

Citation: Priti Dwivedi, Ashok Kumar Rai. An Energy efficient routing algorithm for heterogeneous Wireless Sensor Network. Recent Trends in Sensor Research & Technology. 2021; 8(1): 1–5p.

In [3] Lindsey et al. introduced a protocol in which global information of each node is maintained.

With global information sensor nodes are linked to each other and form a chain for the transmission of data from node to BS.

In [4] Vipul Narayan et al. presented a convention in which span of zone covered by single hub is utilized to limit the covering of hubs during territory coverage. It utilizes the residual energy of node as boundary to expand the lifetime of organization.

In [5] Ashok Kumar Rai et al. presented a convention for homogeneous organization in which energy utilization of organization is decreased by thinking about two boundaries. First boundary is the proportion of remaining energy of current node to the residual energy of organization and second parameter is the proportion of distance of current node to the summation of distance, all things considered. Node to the summation of distance of all nodes.

In [6] Vipul Narayan et al. presented a two-level heterogeneous convention in which sleep and awake idea is utilized to diminish the dispersal of energy during transmission of data.

In [7] Pooja Chaturvedi et al. presented a convention in which set of nodes are in dynamic express whose capacity is to cover the objective territory i.e., one dynamic node of set is continually checking the objective zone.

In [8] Pooja Chaturvedi et al. presented a convention in which lifetime of organization is improved by utilizing planning instrument. Booking is finished by the trust estimation of and inclusion likelihood of hub.

In [9] Pooja Chaturvedi et al. examined about cause for sensor openings and its effect on the exhibition of network in term of inclusion and availability.

In [10] Pooja Chaturvedi et al. proposed the convention dependent on scheduling of node which improves the inclusion and availability of network. Three variables i.e., residual energy, Number of nodes chooses for the CH and distance are consider for cluster system.

In [11] Vipul Narayan et al. examined about different issues for inclusion just as connectivity in the network and proposed a convention for the arrangement of these issues.

In [12] Vipul Narayan et al. presented staggered heterogeneous convention for the issues emerge because of creatures in the inclusion and connectivity of network.

In [13] G. Smaragdavis et al. presented a convention in which two levels heterogeneity ideas is presented.

Nodes Level 1 are called ordinary node and level 2 is called progressed node. Likelihood to choose CH in Normal hub is $P_{nrm} = P_{opt}/1 + m\alpha$ and for advance node is $P_{adv} = P_{opt}(1 + \alpha)/1 + m\alpha$ where α is the extra energy factor for advance node.

In [14] A. Kashaf et al. presented a convention which have three degree of heterogeneity. Node's level 1 is called ordinary node, level 2 is called intermediate node and level 3 are called advance node. Like SEP convention it additionally has diverse threshold energy for various levels. It additionally utilizes the hard and delicate threshold idea which increment the lifetime of network.

In [15] Parul Saini et al. presented a convention for three level heterogeneous network in WSN. Staggered heterogeneous idea improves the presentation of network in term of packet conveyance and life time of network.

In [16] T. N. Qureshi et al. proposed a convention for four level heterogeneous networks. The determination Cluster Head is relying on the residual energy of node. This network is more steady and has better life time anticipation when contrasted with the DEEC, DDEEC and EDEEC convention.

In [17] A. Preethi et al. proposed a convention dependent on energy level of nodes which is ordered into four classifications. The choice of Cluster Head into the network is relying on the area of node and its energy capacity. This improves the effectiveness just as unwavering quality of the network.

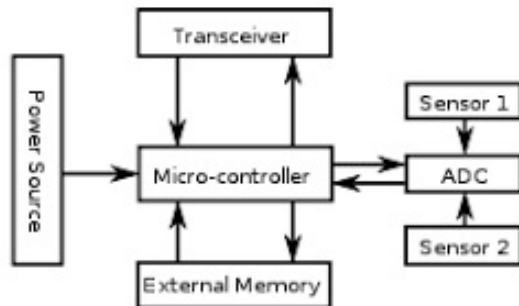


Figure 1. Component of Sensor.

PROPOSED PROTOCOL

Sensors are sent nearby 100 100x100 meter². The region is separates into two areas with various heterogeneity levels. Diverse heterogeneity level of area has particular threshold energy for the choice of group head which is rely on their lingering energy and distance of node from base station. Following convention characterizes the standards for the choice of cluster head.

Step 1: Initially all nodes are deployed in area R in two regions R_1 and R_2 with initial energy E_{01} and E_{02}

Step 2: Each node generates random value between 0 and 1

Step 3: Selection of CH is done according to threshold value

$$T(n) = \begin{cases} p & \text{if } n \in G \\ (1-p * (\text{mod}(r, 1/p))) * (E_{re}/\text{to_energy}) * (\text{di_ratio}) & \text{otherwise} \end{cases}$$

Where

T (n) is threshold

p is Optimal Election Probability of a node to become CH

r is current round

E_{re} is RE of node n

to_energy is total RE of all nodes

$$\text{di_ratio} = \frac{\text{Nodes distance from the sink}}{\text{Total distance}}$$

Step 4: If the value of node is less than $T(n)$ it becomes CH

Step 5: If the value of node is not less than $T(n)$ it is expected

To join nearest CH

In above protocol initially all nodes are deployed in area R in two regions R_1 and R_2 with initial energy E_{01} and E_{02} . Each node generates the value between 0 and 1 in distinct region for the participation for the selection of cluster head. Selection of CH is done according to threshold value.

$$T(n) = \begin{cases} p & \text{if } n \in G \\ (1-p * (\text{mod}(r, 1/p))) * (E_{re}/\text{to_energy}) * (\text{di_ratio}) & \text{otherwise} \end{cases}$$

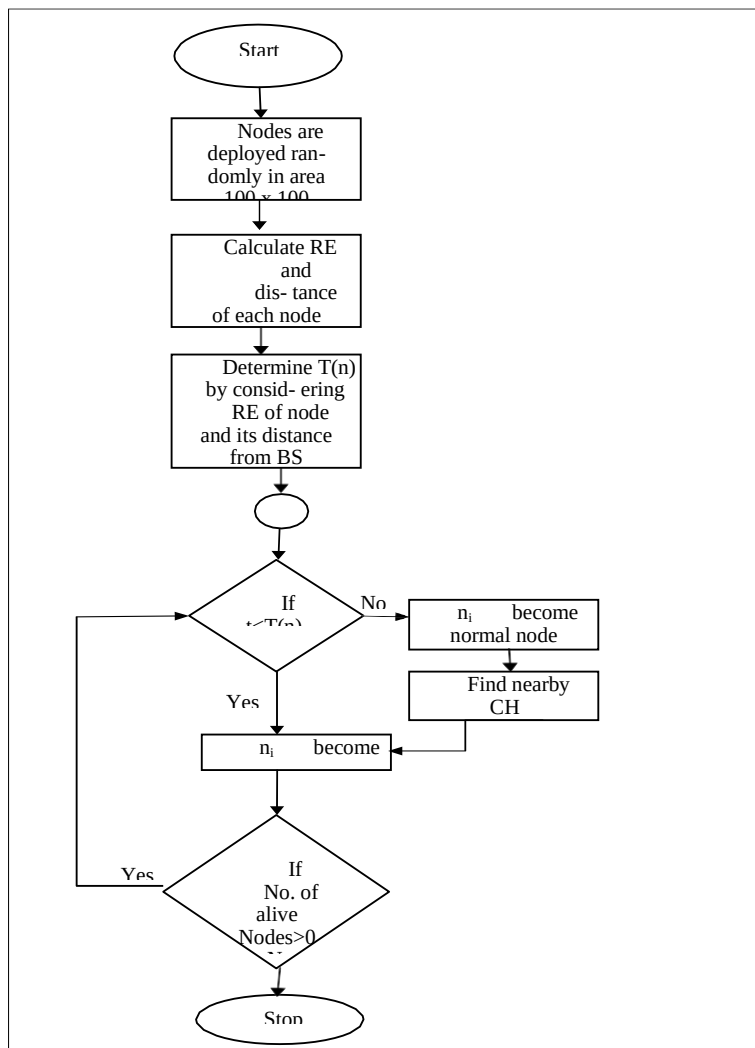
0
if $n \notin G$ Where
T (n) is threshold
p is Optimal Election Probability of a node to be- come CH
r is current round

E_{re} is RE of node n

to_energy is total RE of all nodes

$$\text{di_ratio} = \frac{\text{Nodes distance from the sink}}{\text{Total distance}}$$

If the value of node is less than $T(n)$ it becomes CH and if the value of node is not less than $T(n)$ it is expected to join nearest CH. If no. of alive nodes > 0 then again above process is repeat (Fig. 2)



SIMULATION RESULT

Proposed protocol (modified LEACH) is simulated in this section by using MATLAB and is compared with LEACH protocol in terms of network lifetime, average energy consumed by node per transmission and operational node per transmission.

Table 1. Parameter specifications for the network.

Parameter	Specification
Area R	100 x 100
Number of nodes (N)	100
Initial Energy	$E_{01}=1.5 \text{ J}$, $E_{02}=2 \text{ J}$
E_{elec}	$50 \times 10^{-9} \text{ J}$
E_{amp}	$100 \times 10^{-12} \text{ J}$
Data bits	4000 b
Sink.x	50
Sink.y	200
% of CH	0.05
Energy for transmission (ETX)	$50 \times 0.000000001 \text{ J}$
Energy for receiving data (ERX)	$50 \times 0.0000000001 \text{ J}$
EDA	$5 \times 0.000000001 \text{ J}$

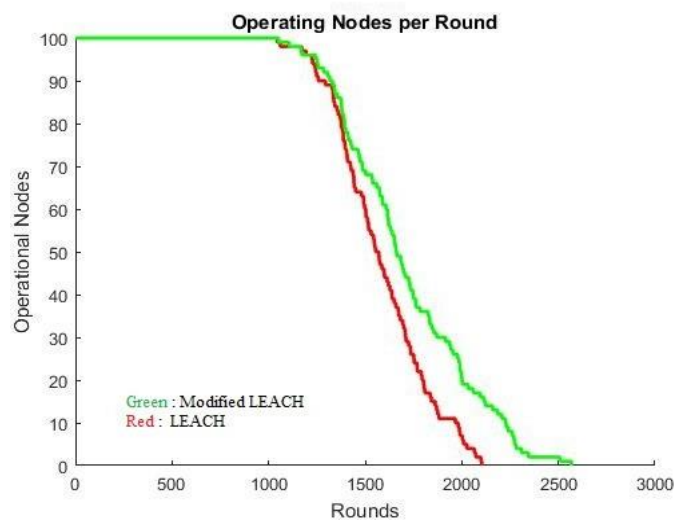


Figure 2. Network life time in terms of Alive nodes.

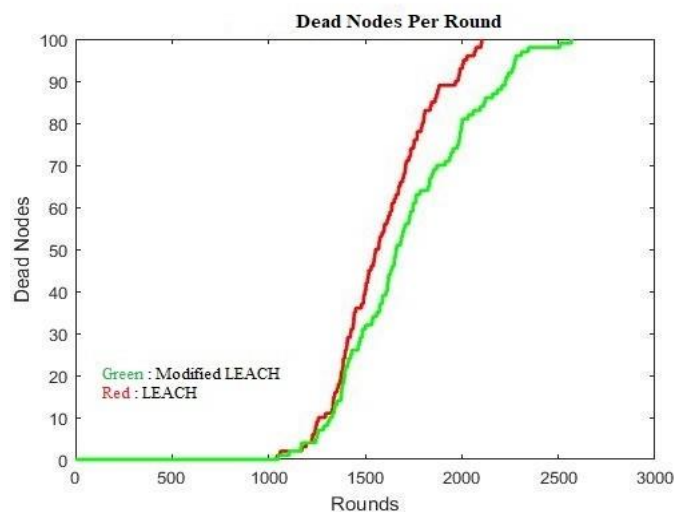


Figure 3. Network life time in terms of dead nodes.

Table 2. Network life time in terms of Alive nodes.

Area (100*100) m ²	No. of Nodes 100	No. of Nodes 100
No. of Alive Nodes in 2100 Rounds	LEACH	Modified LEACH
	00	18

Table 2 shows the no. of alive nodes for 2100 rounds in which LEACH have 00 alive nodes whereas proposed protocol (Modified LEACH) has 18 alive nodes.

Table 3. Network life time in terms of Alive nodes.

Area (100*100) m ²	No. of Nodes 100	No. of Nodes 100
No. of Dead Nodes in 2100 Rounds	LEACH	Modified LEACH
	100	88

Table 3 shows the no. of dead nodes for 2100 rounds in which all the 100 nodes are dead in LEACH protocol whereas in proposed protocol (modified LEACH) have only 88 nodes are dead (fig. 3)

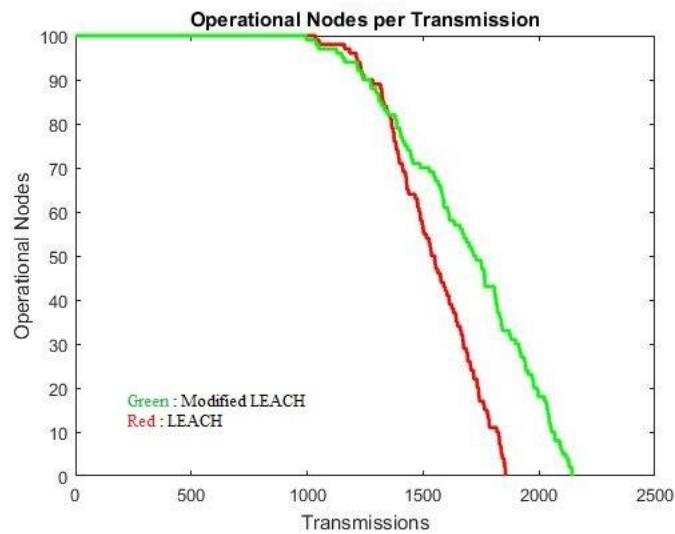


Figure 4. Performance of LEACH and Modified LEACH in terms of operational nodes per transmission.

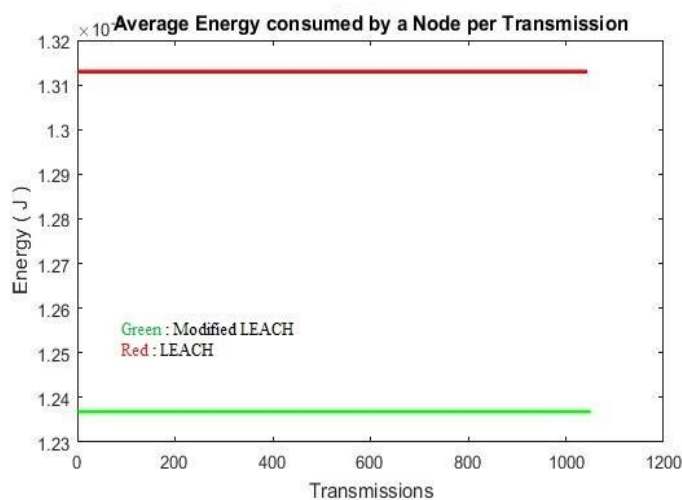


Figure 5. Average energy consumption of node per transmission.

Table 4. Network lifetime in term of no. of rounds.

Area (100*100) m ²	No. of Nodes 100	No. of Nodes 100
No. of Rounds	LEACH	Modified LEACH
	2100	2600

Table 4 shows the network lifetime in term of no. of rounds in which LEACH go up to 2100 rounds whereas proposed protocol (Modified LEACH) goes upto 2600 rounds

Table 5. Average energy consumption of node per transmission.

Area (100*100) m ²	No. of Nodes 100	No. of Nodes 100
Average Energy Consumption	LEACH	Modified LEACH
	1.314	1.236

Table 5 shows the Average energy consumption of node per transmission in which LEACH have energy consumption of 1.314J where as proposed protocol (Modified LEACH) has power consumption of 1.236. Clearly proposed protocol has less energy consumption as compare to the LEACH(fig. 4-5).

CONCLUSION

LEACH protocol is used to improve the lifetime of WSN, but RE and distance of node from BS is not considered in it. In this paper the modified LEACH algorithm is proposed which consider the both RE as well as distance of node from BS. Simulation results shows that the modified LEACH algorithm is superior to the original LEACH algorithm in terms of network lifetime, energy consumption in transmission of packets and no. of rounds. It is analyzed that the modified LEACH algorithm lifetime is 18.18% more as compare to the traditional LEACH algorithm.

REFERENCES

1. Ravendra Singh, Itika Gupta and A. K. Daniel , "Position based energy-efficient clustering protocol under noisy environment for sensor networks using fuzzy logic technique," (27-29 Aug. 2014); London, UK, IEEE. 09 October 2014.
2. Loscri V, Morabito G, Marano S. A two-levels hierarchy for low-energy adaptive clustering hierarchy (TL-LEACH). In IEEE vehicular technology conference 2005 Sep 25 (Vol. 62, No. 3, p. 1809). IEEE; 1999.
3. Lindsey S, Raghavendra CS. PEGASIS: Power-efficient gathering in sensor information systems. In Proceedings, IEEE aerospace conference 2002 Mar 9 (Vol. 3, pp. 3-3). IEEE.
4. Vipul Narayan and A.K Daniel, "A Novel Protocol for Detection and Optimization of Overlapping Coverage in Wireless Sensor Network " International Journal of Engineering and Advanced Technology, 2019; 8(6S):1-6.
5. Ashok Kumar Rai and A.K. Daniel , " An Energy Efficient Routing Protocol for Wireless Sensor Network" Test Engineering and Management, ISSN:0913- 4120, pp.12556-12563, May-June 2020.
6. Vipul Narayan, A.K Daniel and Ashok Kumar Rai , "Energy Efficient Two Tier CH Based Protocol for Wireless Sensor Network " International Conference electrical and Electronics Engineering, Feb 2020.
7. Pooja Chaturvedi, AK Daniel "An energy efficient node scheduling protocol for target coverage in wireless sensor networks" Fifth International Conference on Communication Systems and Network Technologies pp.138-142, April 2015
8. Pooja Chaturvedi, AK Daniel "Trust Based Target Coverage Protocol for Wireless Sensor Networks Using Fuzzy Logic" International Conference on Distributed Computing and Internet Technology pp.188-192, 2016
9. Pooja Chaturvedi, AK Daniel "Recovery of holes problem in wireless sensor networks" International Conference on Information Communication and Embedded Systems (ICICES2014), pp.1-6, Feb 2014
10. Pooja Chaturvedi, AK Daniel "A novel sleep/wake protocol for target coverage based on trust evaluation for a clustered wireless sensor network" International Journal of Mobile Network Design and Innovation, Inderscience Publishers (IEL), 2017
11. Vipul Narayan and A.K. Daniel. "Wireless Sensor Network Design Consideration" National Conference on Emerging Dimension in Artificial Intelligence and Soft Computing (TECHCON-2019) held on October 19- 20, (2019).
12. Vipul Narayan, and A.K. Daniel. "Multi-Tier Cluster Based Smart Farming Using Wireless Sensor Network" 3rd International Conference on Big Data & Computational Intelligence (ICBDICI-2020)
13. G. Smaragdakis, I. Matta, A. Bestavros, "SEP: A Stable Election Protocol for clustered heterogeneous wireless sensor networks." in: Second International Workshop on Sensor and Actor Network Protocols and Applications (SANPA 2004), 2004.
14. A. Kashaf, N. Javaid, Z. A. Khan and I. A. Khan, "TSEP: Threshold-sensitive stable election protocol for WSNs" International conference on Frontiers of Information Technology, Feb 2013.
15. Parul Saini, Ajay. K. Sharma, "E-DEEC- Enhanced Distributed Energy Efficient Clustering scheme for heterogeneous WSN", Parallel Distributed and Grid Computing (PDGC), IEEE, 2010 1st International Conference on, 6 January 2011.

16. T. N. Qureshi, N. Javaid, A.H. Khan, A. Iqbal, E. Akhtar, M. Ishfaq, "BEENISH: Balanced Energy Efficient Network Integrated Super Heterogeneous Protocol for Wireless Sensor Networks", The 4th International Conference on Ambient Systems, Networks and Technologies (ANT 2013), Volume 19, 24 June 2013, Pages 920-925
17. A. Preethi, E. Pravin, D. Sangeetha, "Modified Balanced Energy Efficient Network Integrated Super Heterogeneous Protocol", 2016 Fifth International Conference On Recent Trends In Information Technology, © 2016 IEEE