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Energy Efficient Optimal Distribution of Heterogeneous Nodes for Edge-Based Wireless Sensor Networks

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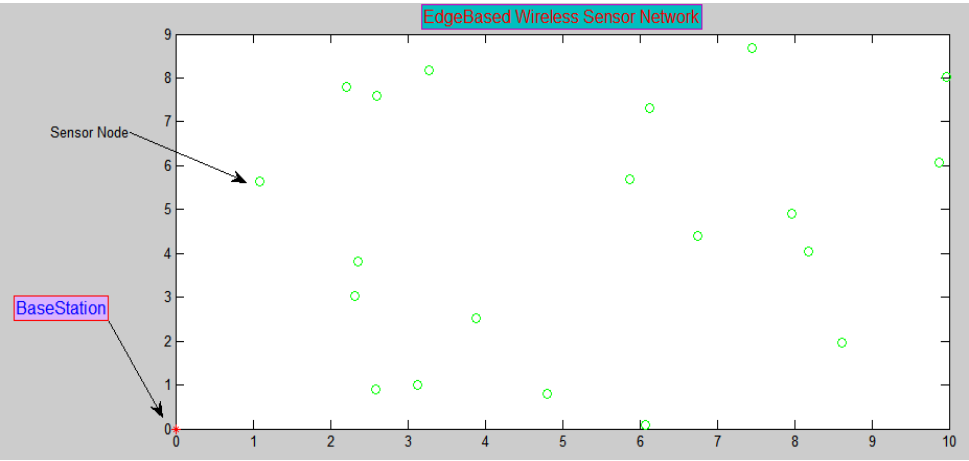
Abstract- ***Wireless sensor networks are well known for their diverse applications in the both home automation and remotes areas. In this paper, we are deploying the wireless sensor network into an environment where the proximity of basestation is near to external environment rather than in center of a network. These sensor networks are also called edgebased wireless sensor network where basestation lie in the corner of the network. In this paper we worked on optimal distribution and to maximize the life of the edgebased wireless sensor nodes using the heterogeneous nodes. In this we deployed the four types of heterogeneous nodes i.e. simple,advanced ,moreadvanced and mostadvanced with their increasing energies in the four areas respectively where nodes having less energy are near to basestation and these nodes are optimal distributed. The DEEC algorithm is used to do the communication among sensor nodes and basestation in each area. The proposed approach successfully increased the life of the sensor nodes , a high data delivery to basestation and distributed them optimally.***

Keywords: Edgebased , DEEC etc.

I. INTRODUCTION

Wireless sensor network is an emerging research field where every day these are being improved by the researchers in terms of routing of the packets, the throughput of the network etc. This research is dominated by the fact that wireless nodes has scarce amount of the resources in term of memory, processors etc and their diverse applications in home automation and hostile places force to be used in a very efficient way. [1] described the WSN stack layers and discussed various research topics and challenges in routing in sensor networks. In the wireless sensor network the basestation is a device which collects the data from the sensor nodes an supply this data to the outer world(human monitoring stations). The basesation is a not energy-constrained device but the sensor nodes in the network are enegy-constrained. The sensor nodes are battery-powered and cannot be recharged on the regular basis due to their deployment in the remote and hostile places such as forest area, volcanic eruption places etc. So the energy and life have been always critical parameters which we should look upon. The wireless sensor networks can be specifically used in an environment where the basestation has to be located in the corner of the network. These kind of networks are also termed as edge-based sensor networks. In this the basestation is located in the corner rather than in middle of the network and sensor nodes have to deployed in rectangular or circular way in the network field. The sensor network can be categorized into homogenous and heterogeneous network depending upon type of nodes. The network having same kind of nodes in the network i.e. each node has same kind of initial energy and equal probability of becoming the cluster head are termed as homogenous network. Whereas the network having the different kind of nodes of unequal energies and different probability of becoming the cluster heads. The Clustering[2] is process of doing the routing in the network where nodes make cluster taking distance or any another parameter into concern and the cluster members choose a cluster heads of their clusters and clusterhead is responsible for transferring the data to the basestation in behalf of their corresponding clusters' member nodes.



The edge-based sensor network are oftenly deployed in environment where basestation is preferred to be deployed in the outer portion of the network. Wireless sensor network is applied in diverse areas where there is a chances that network has to be modified according to the need of the environment. This results into different kind of sensor networks. In this paper section II describes the literature survey, section III gives our proposed approach, section IVgives the simulation results and section V concluded the paper.

II. LITERATURE SURVEY

Researchers have worked on the distribution of sensor nodes and longer life of the sensor nodes in the network. Mao and Hou have introduced a novel edge-based routing protocol, called BeamStar [3] for WSNs. In this the network was divided into sector and then sector into rings. The power controlled capability of base station scans the complete network with different power transmission levels (sector number (SN)) in different angles (ring number (RN)) to provide location information for the nodes. With this location information, sensor nodes can enroute sensed data to BS using controlled broadcasting mechanism.

Chen et al. proposed a routing protocol for edge-based sensor network, CHIRON [4]. It is based on BeamStar and chain based routing protocol ,PEGASIS[5]. It outperformed BeamStar in term of delay time and network lifetime. This protocol operates in four different phases. First phase is Group construction phase, where the network is divided into smaller groups using BeamStar. The nodes with same Ids make groups. Chain formation phase is the second phase. Here, PEGASIS chain formation process is used to construct smaller chains. Leader node election phase is the next phase in CHIRON. Node with maximum residual energy is elected as "Leader node" for the current round. Cluster Head (CH) to Cluster Head communication delivers data to destination node (BS). The CHIRON data transmission process is similar to that of PEGASIS protocol.

The BeamStar described a network partitioning mechanism to build energy efficient wireless sensor networks. The proposed mechanism, distributes network load uniformly with little control overhead on energy resources in the network. The uniform distribution of sensor nodes is done in the network which helped the network to distribute the load uniformly. The Proposed system elevated the average lifetime of sensor nodes as compared to cluster based protocol such as BeamStar , LEACH[6][7] etc.

LEACH is a routing protocol based on cluster formation where each cluster has a cluster head which is elected as: a random no is generated between 0 and 1 and this random no is compared with a threshold T(i) for that particular node i which is calculated as

$$T(i)=p/\ (1-p(rmod\ 1/p))$$

Where p is probability of getting selected as cluster head of a node i and r is round no. If T(i) is greater than the random no then that node I will become cluster head otherwise not. Leach improved the life of network to a large extent but this protocol was made to work in homogenous network.

The SEP[8] is a routing protocol which was developed for heterogeneous network. In this the importance of inserting the heterogeneous nodes in network was discussed and increased the stability period of the network by taking two type of node i.e. normal and advanced node. The normal and advanced nodes have unequal energy and different probabilities of becoming cluster head. The advanced node are preferred more to be cluster head than normal node. This increased the epoch time of the normal node by advanced node. This protocol outperformed the LEACH in term of stability period and lifetime of the network.

The DEEC[9] was extended version of SEP which increased the lifetime of the network by taking the concept of residual energy of each node and average energy of the network according to a particular round. The average energy corresponding to particular round is calculated as:

$$Ea=Et\left(1-\frac{r}{rmax}\right)/n$$

Where Ea and Et are Average and total energy of the n no of sensor nodes

The EDEEC[10] introduced another heterogeneous node super, along with the normal and advanced as present in SEP and DEEC algorithm is applied on these three types of nodes. The energy of super in more than that of advanced node. The EDEEC enhanced the life of the network and stability period of the network.

The TADEEC[11] introduced another type of node supadvanced along the nodes as in EDEEC but it did not increase the energy of the supadvanced beyond the energy of super node. Thus it has four types of nodes i.e. normal, advanced, super and supadvanced with their energies and probabilities of becoming clusterhead are given as:

$$p_i = \begin{cases} \frac{p_{opt}\times E_i(r)}{(1+a*m-m*m0*(a-((b+c)/2))\times E_a} & \text{if node is normal node} \\ \frac{p_{opt}\times E_i(r)\times(1+a)}{(1+a*m-m*m0*(a-((b+c)/2))\times E_a} & \text{if node is advanced} \\ \frac{p_{opt}\times E_i(r)\times(1+b)}{(1+a*m-m*m0*(a-((b+c)/2))\times E_a} & \text{if node is super node} \\ \frac{p_{opt}\times E_i(r)\times(1+c)}{(1+a*m-m*m0*(a-((b+c)/2))\times E_a} & \text{if node is supadvanced} \end{cases}$$

Where a, b and c are fractions with the energies of advanced,super and supadvanced nodes are increased respectively. and m and m0 are used to distribute the nodes into normal,advanced,super and supadvanced.

The [12] compared the performance of protocols used in the homogenous and heterogeneous wireless sensor networks. It found that heterogeneous network protocols outperformed the homogenous network protocols in term of throughput, stability period and lifetime of the network.

III. PROPOSED APPROACH

In this research, we proposed a distribution of sensor nodes in edge-based network so that sensor nodes can cover whole the network and they can be distributed optimally. In this, we divided the network into four portions with area1,area2,area3 and area4.The area1,area2,area3 and area4 are in their increasing order. Thus sensor nodes are placed so that they can cover whole of the area. The areas are in increased order as move away from the basestation. Thus smaller area region is nearer to basestation and largest area is far away. The four areas are made so that nodes can be distributed in an optimal way and sensor nodes are get over in a particular region after deployment. This deployment of the sensor nodes are done randomly on the environment field. Here we have taken a scenario of forest where our information collector(Basestation) is located at the corner of the forest rather than deployment in the middle of the forest. This basestation is collected further to main monitoring station through internet and basestation aggregate the information form sensor node and send to the main monitoring system via internet. As we have seen the usability of the implanting the heterogeneity in the nodes, so we also utilized in our network. In this paper we have taken four types of nodes i.e. simple, advanced, moreadvanced and mostadvanced. These names are given due to their initial energy value. The energies are in their increasing order as we go from simple to mostadvanced. The simple nodes are placed in area1,advanced nodes are placed in area2,more advanced nodes in area3 and mostadvanced are done in the area4.The nodes are placed in their increasing energy in the network field moving from area1 to area2 so they can cover a large range of sensing area in their respective areas. These four areas communicate with the basestation in the following way:All the four areas apply the clustering of the sensor nodes for collection of the data. In area1 the sensor nodes are very high in number and they make clusters of the nodes with each cluster nominate a clusterhead which collect the data from its corresponding cluster members. The Cluster head is selected for the LEACH cluster head method but we also applied the DEEC algorithm while selecting cluster head. All clusters which are formed will elect clusterheads and a superior clusterhead will be chosen based on the energy so a cluster head having highest energy will be superiorclusterhead(sch1) among the clusterheads for the first area i.e.area1.The areas2 will again make clusters and their clsuterheads according to DEEC. These clusterheads will choose superior cluster head(sch2) according to the energy.In the third and fourth areas the only one cluster is made for each cluster. The clusterhead is choosen for each cluster according to the DEEC. In first area the sch1 will collect data from all other cluster heads.In area 2 the sc2 will collect data from all other cluster heads of that region. While cluster heads of the regions and 4 will collect data from sensor nodes of their respective areas. The Four cluster heads i.e. sch1,sch2 ,cluster heads for third and fourth areas will choose a masterhead cluster head(mch) for the network.The mch will collect data from sch1,sch2 clusterheads for regions 3 and 4. The mch will send the collected data to the Basestation. The Basestation will the data to the Main monitoring station through internet(Human monitoring station).

For area1

sch1=maxenergy(ch1,ch2….,ch_i) i is the no of clsuterheads for region1

For area2

sch2=maxenergy(ch1,ch2….,ch_i) i is the no of clusterheads for region1

For region3 and 4 ch3 and ch4

mch=maxenergy(sch1,sch2,ch3,ch4)

Energy of the nodes are:

simple=Eo,advanced=Eo(1+a),moreadvanced=Eo(1+a1)

Mostadvanced=Eo(1+a2) where a<a1<a2

IV. SIMULATION AND RESULTS

In this research,we have simulated our network in matlab software[14]. Our network scenerio consist of approx. 12*14 square kilometers.This whole is divided into four unequal sectors i.e. area1,area2,area3 and area4.These regions are made in this way such that area1 will be near to basestation and smallest area while area4 is largest and farthest to the basestation.In this, we have deployed simple nodes in area1,advanced in area2,moreadvanced in area3 and mostadvanced in the area4.So that energetic nodes can cover more area and less energetic can cover less area. The nodes are deployed randomly and in this way so that they can cover whole of area in optimal way. The simulation parameters are listed in Table 1.The results are taken in term of the alive nodes in the network at particular round,dead nodes in a round,data sent to the basestation and clusterheads formed in the round. The data is compared protocol such as LEACH,DEEC,ClusterbasedProtocol etc.

Table 1. Set Of Simulation Parameters

Parameters	**Value**
Area	Approx.(12*14)

	square kilo meters
Basestation	(0,0)(in m)
Initial Energy	0.5J
Transmission Energy	50nJ/bit
Receiver Energy	50nJ/bit
No Of Nodes	100
Free space Amp Energy	10pJ/bit/m^2
Multipath Amplification Energy	0.0013pJ/bit/m^4
Message Size(B)	4000 bits
Round	20000
Aggregation Energy	5nJ/bit/packet
P(for area1)	0.20
P(for region2)	0.25
P(for area3 and area4)	1
M	0.5
m0	0.2
No of nodes(area1,area2,area3,area4)	(50,40,5,5)

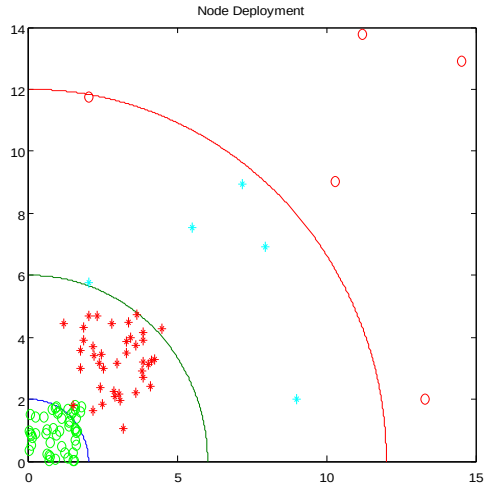


Fig 2. Figure 2.Wireless sensor Nodes deployment in the

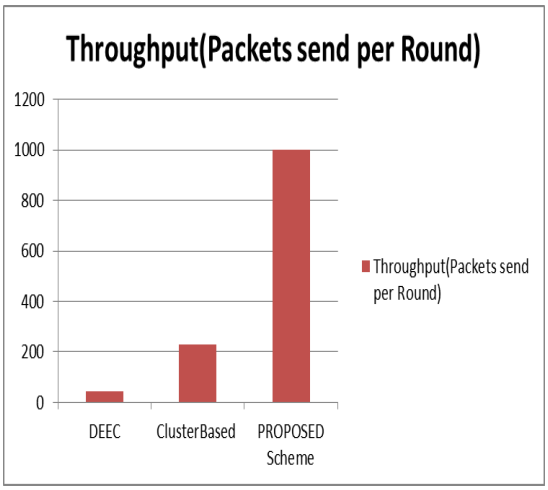


Fig 3. Showing the throughput of various protocols

Here in the results we can observe in the Fig. 3 that the throughput of the our proposed approach is higher than previous protoocols.Also data send to the basestation is extremely high.In the Fig.4 the dead nodes vs rounds is plotted

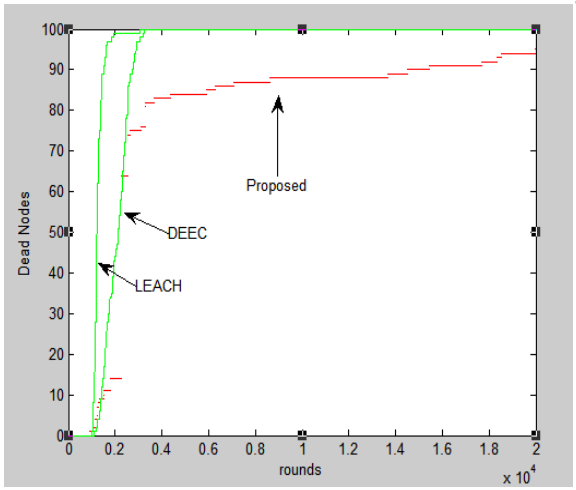


Fig.4.Showing the Dead Nodes vs Rounds

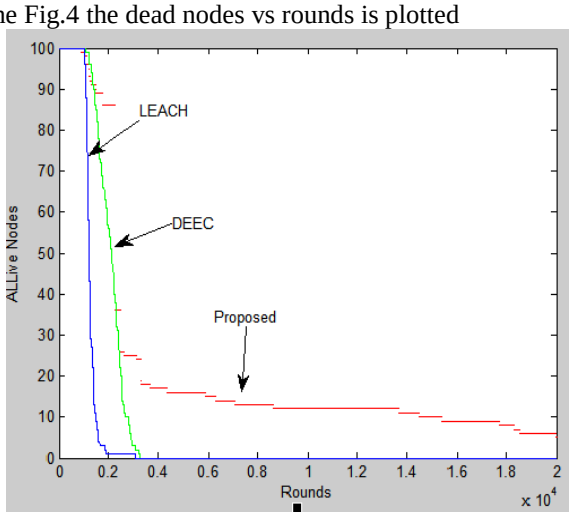


Fig.5.Showing the Allive nodes vs Round.

And it can be observed that the nodes are lesser dead with the rounds in our proposed scheme as compared to the DEEC and LEACH. Here the heterogeneity concept makes the nodes in our proposed scheme to live longer than other previous schemes. In case of Allive nodes our proposed scheme is performing better than LEACH,DEEC etc. The Cluster-Heads formation is very high in our proposed scheme as shown in Fig 6.

V. CONCLUSIONS

This research paper used the benefits of optimal distribution and heterogeneity and implement in the edge based wireless sensor network. These techniques helped to scale up the data sent to the basestation and it has outperformed the previous protocols used in the wireless sensor networks. This proposed scheme increased the throughput to 10 times of the previous protocols. The heterogeneity compensated the energy consumption of the nodes and increased the lifetime of the network. Optimal distribution helped to deploy the nodes in an optimal way and made the clustering better. So this protocol outperformed the DEEC and clusterbased Beamstar protocol in term of throughput. Also in case of Dead Nodes and Allive nodes, Our proposed scheme is outperforming the previous schemes for doing routing in edgebased network such as LEACH,DEEC and ClusterBased Protocol.

REFERENCES

[1] F. Akyildiz, W. Su, Y. Sankarasubramaniam, and E. Cayirci, "A survey on sensor networks," IEEE Communications Magazine, vol. 40, no. 8, pp. 102–114, 2002.

[2] W. H. Li and C. Y. Yang, "A cluster-based data routing for wireless sensor networks," in Algorithms and Architectures for Parallel Processing, vol. 5574 of Lecture Notes in Computer Science, pp. 129–136, Springer,Berlin, Germany, 2009.

[3] S.Mao and Y. Hou, "BeamStar: An edge-based approach to routing in wireless sensor networks," IEEE Transactions On Mobile Computing, vol. 6(11), pp. 1284–1296, 2007.

[4] C. K. Ho, H. J. Ming, and H. C. Chuan, "CHIRON: An energy efficient chain-based hierarchical routing protocol in wireless sensor networks," in Wireless Telecommunications Symposium (WTS 2009), 2009, pp. 1–5.

[5] S. Lindsey and C. Raghavendra, "Pegasis :power-efficient gathering in sensor information systems," in IEEE Aerospace Conference Proceedings, no. 3, 2002, pp. 1125–1130.

[6] W.Heinzelman, A. Chandrakasan, and H. Balakrishnan, "Energy-efficient communication protocol for wireless sensor networks," in the Proceeding of the Hawaii International Conference System Sciences, Hawaii, January 2000.

[7] W.R. Heinzelman, A.P. Chandrakasan, H. Balakrishnan, "An applicationspecific protocol architecture for wireless microsensor networks", IEEE Transactions on Wireless Communications 1 (4) (2002) 660-670.

[8] 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.

[9] L. Qing, Q. Zhu, M. Wang, "Design of a distributed energy-efficient clustering algorithm for heterogeneous wireless sensor networks". ELSEVIER,Computer Communications 29, 2006, pp 2230- 2237.

[10] Parul Saini, Ajay.K.Sharma, "E-DEEC- Enhanced Distributed Energy Efficient Clustering Scheme for heterogeneous WSN", in: 2010 1st International Conference on Parallel, Distributed and Grid Computing (PDGC - 2010).

[11] Anamika Chauhan and Amit Kaushik, "TADEEC : Threshold Sensitive Advanced Distributed Energy Efficient Clustering Routing Protocol for Wireless Sensor Networks," International Journal of Computer Applications (0975 – 8887),Volume 96 No.23 June 2014.

[12] Amit k. Kaushik , "Performance Evaluation of Proactive and Reactive Routing Protocols in Wireless Sensor Networks",In International Journal of Computer Applications (0975 – 8887), *Volume 110 – No. 16, January 2015.*

[13] MATLAB 7.4.0(R2007a) www.mathworks.com

