GEDEEC: Genetic Enhanced Distributed Energy Efficient Clustering for Heterogeneous Wireless Sensor Networks

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Abstract - **Wireless Sensor Network contain large number of sensor nodes .key challenges in wireless sensor network is saving energy and extend the network life time. In this paper, we proposed a genetic based routing protocol for heterogeneous network: GEDEEC. Our proposed protocol achieves more stability period ,lifetime and more battery consumption as compare to other protocol like SEP,DEEC,EDDEC.**

General Terms

Wireless Sensor Network, Routing Protocol, GEDEEC.

Keywords

Wireless sensor network, Clustering algorithms, GEDEEC,SEP, DEEC.EDEEC.

1. INTRODUCTION

Wireless sensor network has a number of autonomous nodes and important task of Wireless sensor network, collect data from a node and send to the base station. Wireless sensor network used to monitors different parameter related to agriculture ,smart parking ,health care, weather quality ,nature disaster monitoring such as temperature, humidity, weather station , noise ,free parking slot the monitoring of these parameter allows to minimizes the money and time as well as maximize the results. Deployment of a sensor network in all the application can be planted manually. Each sensor node contains sensors, memory, processor, radio transceiver. Basic component of wireless sensor network are:

- Position finding system
- Mobilize
- Sensor unit
- Processing Unit
- Power Unit

Here Power Unit contain the power generation Sensor unit contain sensors and Analog and Digital Convertor. Processor Unit Contain the Processor and storage [5].efficiency of sensor node depend on the routing protocol used. Routing protocol are used to manage the data transference in Wireless sensor network[5][6].Wireless sensor network can be classified in to four ways, according to

The way of routing paths are established,

The network structure,

The protocol operation,

The initiator of communications. But one main categories of routing protocols are: based on the network structure [6].
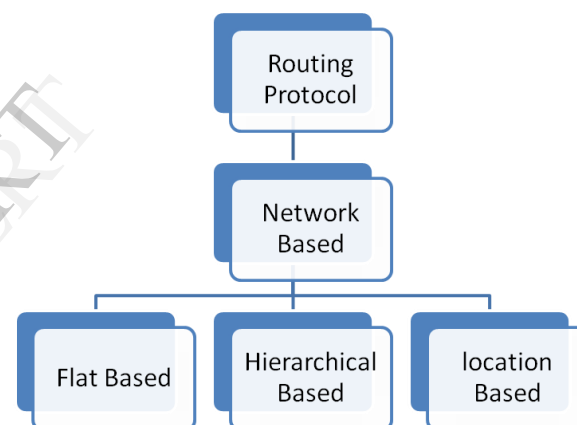

Fig. 1 Types of routing protocol

Network structure based routing protocol can be divided in to flat-routing, hierarchical-based and location-based routing. In hierarchical based routing protocol clustering techniques is used. Clustering is a key technique to decrease battery consumption and increase the network life time. Clustering can be done in two types of networks: Homogeneous networks and Heterogeneous networks. The nodes having the same energy level are called homogeneous network . LEACH[10], PEGASIS, HEED are the algorithms design for the homogeneous networks..LEACH is a one of the first and most useful Homogeneous clustering protocol. The nodes having the different energy level are called Heterogeneous Network .SEP, DEEC, DDEEC, EDEEC are algorithms design for the heterogeneous Wireless sensor networks [3]. The algorithms designed for homogeneous network are unable to treat nodes which have the different different energy .so this protocol do not work efficiently under heterogeneous network. It extends the lifetime and stability of the network.

2. RELATED WORK

Heterogeneous Networks, Nodes have the different different energy level like two level, three level, multi level. So CH consume more energy in heterogeneous network as compare to homogenous networks. Two level heterogeneous WSNs contain two Energy level of nodes,

- Normal nodes
- Advanced nodes[1].

E_0 = Energy level for the normal node $Eo(1+a)$ = Energy level of advanced nodes

N = Total number of nodes

N_m = Number of advanced nodes

M = Refers to the fraction of advanced nodes

N(1-m) = Number of normal nodes

E_{total} = Total initial energy of the network is the sum of energies of normal and advanced nodes[2].

$$E_{total} = NE_0 (1 + am) \quad ..(1)$$

The above Equation shows that's[2], The two level heterogeneous WSNs contain a_m times more energy as compared to homogeneous WSNs. SEP protocol contain two level of energy nodes.

Three level heterogeneous WSNs contain three Energy level of nodes

- Normal
- Advanced and
- Super nodes.

E_0 = Energy level for the normal node $Eo(1+a)$ = Energy level of advanced nodes

$Eo(1 + b)$. = energy of super nodes, and supr nodes contain b times more energy as compare to normal nodes.

N = Total number of nodes

Nmmo = Total number of super nodes

Nm(1 − mo) = Total number of advanced nodes

$$E_{total} = NE_0\left(1 + m(a + m_0 b)\right)$$

As compare to two level of networks three level networks nodes contains (a + mob) times more energy [2,1].

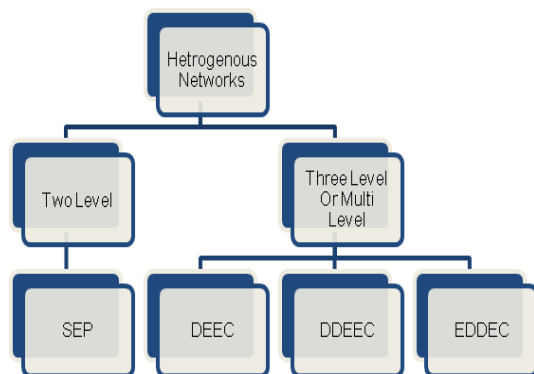DEEC, DDEEC and EDEEC protocol contain the three level of energy nodes.

Fig. 2 Protocol for Hetrogenous networks protocols

EDEEC follows the thoughts of DEEC and Its has three level of energy level. To increase the network life time super node is used. EDEEC used the three level heterogeneous networks. It contains the normal node, advanced node and super node. Probability function of EDEEC is follows[1]:

$$P_i = P_{opt}E_i(r)/\left(1 + m(a + m_0\,b)\right)E(r)$$

if S_i is the normal node

$$P_i = P_{opt}(1+a)E_{i(r)}/\left(1 + m(a + m_0 b)\right)E(r)$$ if S_i is the advanced node

$$P_i = P_{opt}(1+b)E_i\,(r)/\left(1 + m(a + m_0\,b)\right)E(r)$$

if S_i is the super node[2].

Threshold for cluster head selection for all three types of nodes is as follows:[2].

$$T_{(Si)} = P_{i/1-Pi(r mod\ 1/pi)}$$
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EDEEC perform well under the multi and three heterogeneous wireless sensor networks. and it contain normal node, advanced node and super node to increase the network life time. In EDEEC, super nodes have more energy as compare to normal and advanced nodes so super nodes have more chance to become CH. When super node die. Then advanced nods have more probability to become CH , and when Advanced node die, then normal nodes can become the CH.

So from the Eq. 2 its show that the EDEEC protocol performs better as compare to other heterogeneous networks protocol.

3. PROPOSED WORK

Number of schemes were to make the communication more energy efficient like SEP, DEEC, EDEEC[2]. But these protocols are not considers as realistic approaches due to their limited level of heterogeneity .Our proposed scenarios are based on EDEEC.

To increase the stability time and for efficient energy utilization .We propose Genetic based EDEEC(GEDEEC) routing protocol schemes. In our proposed protocol network is divided in to no. of clusters. And one of the node acts as cluster head (CH) an remaining des are Cluster member(CM)[4].CH aggregate data from the node and send to the BS.CH selection process in GEDEEC is same as EDEEC protocol. GEDEEC protocol uses the concept of three level heterogeneous network. It contain three types of nodes[8].

- Normal Node
- Advanced Node
- Super Node.

Probability of CH selection based on ratio of initial energy and residual energy.

Formula for average energy of rth round:

$$E(r) = \frac{1}{N}\,E_{total}\,\left(1 - \frac{r}{R}\right)$$

$$R = \frac{E_{total}}{E_{round}}$$

$$E_{total} = NE_0\big(1 + m(a + m_0 b)\big)$$

$$E_{round} = L\big(2N E_{elec} + N E_{DA} + K \in_{mp} d_{BS}^4 + N \in_{fs} d_{toCH}^2\big)$$

Here,

E(r) = Average energy of rth round.

R = Total round

r = number of round

K = No. of cluster

E_{DA} = Data aggregation cost expanded in CH.

d_{BS} = Avg distance between CH to BS.

d_{toCH} = Avg distance between CM to CH.

Probability too become CH for current round of three types of nodes given as:

$$P_i = P_{opt} E_i(r)/\big(1 + m(a + m_0 b)\big)E(r)$$

if S_i is the normal node

$$P_i = P_{opt}(1 + a)E_{i(r)}/\big(1 + m(a + m_0 b)\big)E(r)$$ if S_i is the advanced node

$$P_i = P_{opt}(1 + b)E_i(r)/\big(1 + m(a + m_0 b)\big)E(r)$$

if S_i is the super node[2]. ………..[3]

At starting of each round, node decides whether to become CH or not all depend on threshold values[5][8]:

$$T_{(Si)} = P_{i/1-Pi(rmod\ 1/pi)}$$
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In above the equation P_{opt} is equal to reference value for average probability pi.. In our proposed protocol values of P_{opt} is calculate using genetic algorithm[3][9].

1.Choose the initial population of individuals

2.Evaluate the fitness of each individual in that population

3.Repeat on this generation until termination (time limit, sufficient fitness achieved, etc.):

4.Select the best-fit individuals for reproduction

5.Breed new individuals through crossover and mutation operations to give birth to offspring.

6.Evaluate the individual fitness of new individuals
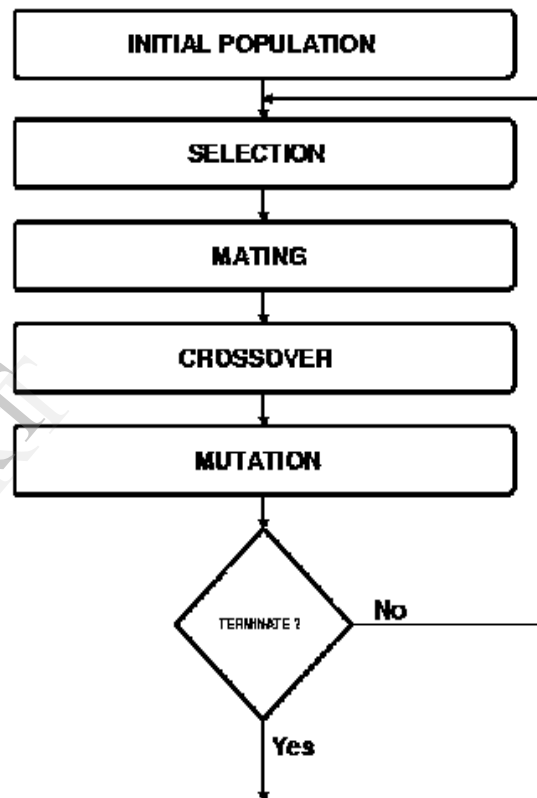
7.Replace least-fit population with new individuals

Fig. 3 flow chart for genetic Algorithm

4.CONCLUSION

In Wireless sensor network, protocol for heterogeneous network can work on two level, three level, multi level heterogeneous networks. Genetic algorithm is used to determine the optimal probability for cluster head formation in WSN. GEDEEC perform better as compare to other protocols like SEP,DEEC,EDEEC. It has best performance in terms of stability period and network life time.

4. ACKNOWLEDGMENTS

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