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Enhanced Network Life using Four-Level Heterogeneous Clustering Scheme

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ABSTRACT: Wireless sensor network is investigated as prominent field of research due to its continuously expanding applications. This area is still struggling various challenges, the major are resource limitation, security, self-organization and fault tolerance. To curtail the network lifetime is one of foremost area for researchers. Numerous cluster based approach are being used in homogenous and heterogeneous environment for energy conservation. The proposed protocol is using clustering approach and is based on four level heterogeneous models, making use of probability function used for cluster head election based on enduring energy of node which dynamically varies, resulting in balance energy consumption. The Simulation results shows that proposed protocol is showing enhancement in network stability, compared against existing scheme EDEEC and DEEC .

KEYWORDS: Heterogeneous, Clustering, Cluster head, Network lifetime, Energy

I. INTRODUCTION

Wireless Sensor Network (WSN) is considered to be one of the most significant technologies used for assessing several substantial features of environment. The micro sensor deployed may be used for sensing different parameters such as temperature, atmospheric pressure, rainfall, water level and body area parameter. [1] The teeny and present location sensor nodes comprised of four main segments; microprocessor, sensing unit, power unit and transceiver section. There are various types of sensors available in the market depending on its application such as pressure sensors, light sensors, temperature sensors, seismic and infrared sensors. These sensors sense physical parameters, process them and store the data. The sensed data is collected, aggregated and finally transmit to the sink which may be gateway to another network. The sensor node communicates with each other and to base station through radio/wireless communication. [2]

WSN is subject to various issues and challenges like resource limitation, fault tolerance and self-organization. Energy is being viewed as one of the key resource being utilized in communication, processing and performing sensing operations. As network operates in harsh environment and nodes are battery powered, energy conservation becomes one of the prime areas of concern for researchers. Number of energy efficient protocols has been developed in the past and still researchers are putting constant effort in this direction.

Cluster based routing protocols have emerged as key role player in enhancing energy efficiency. In clustering methodology, master node is chosen based on certain parameters like distance, location and energy of node. Member nodes perceive the information from environment, transfer the information to its master node (CH), then CH do summation of information, remove the redundant information and finally transfer data to the sink for further analysis [3].

This paper presents a heterogeneous network model comprising of nodes with four different energy levels. Nodes are classified as normal, advance, super and ultra, based on their energy levels. The ultra-node charge with highest initial energy, after that it super nodes, then comes advance nodes and in last normal nodes have lowest initial energy. A dynamic weighted probability function is defined which is making selection of CH founded on residual energy of node. Since ultra-nodes carries highest energy among other nodes, they have maximum chances to be elected as cluster head. The cluster head node use up more energy than other member nodes, as it is performing the task of collecting data from different nodes, aggregating it and finally sending it to the base station. Hence after some rounds, the high energy nodes

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are more likely to exhaust their energy. In order to avoid penalizing high energy nodes, the defined protocol dynamically adjusts the probability function for cluster head selection where after some rounds when remaining energy of high energy node comes in range of normal one, their election probability will be same as that of normal one i.e. they will be treated as normal node in terms of cluster head selection.

II. RELATED WORK

This section gives overview of various cluster based protocols, providing solution for enhancing network stability and energy conservation. LEACH [4] is cluster based approach used for homogenous environment where energy load is scattered by dynamically created cluster and further cluster head is selected according to prior optimal probability. Further PEGASIS [5] is chain based protocol where information is send and received through neighbouring node. HEED [6] is also clustering algorithm, being used for homogenous environment using cluster head based on residual energy of node and network topology.

SEP [7] maintains well distribution of energy. The two level of nodes are define here. The likelihood of becoming CH is higher for advance nodes than normal one. DEEC [8] is protocol where probability for selection of CH is on basis of two main parameters: remaining power of sensor node and average power of WSN. DDEEC [9] is improving further network performance by balancing the distribution of energy equally among nodes. Enhanced DEEC [10] is DEEC based protocol adding another level of heterogeneity. The selection of CH is based on threshold value computed by suggested fraction of cluster heads for the network and number of times node has become CH up to now.

EEHC [18] is energy efficient heterogeneous cluster scheme where cluster head is selected in distributed manner. The weighted election probability which is based on residual energy of node is used for selection of cluster head. The scheme is effective in increasing life time of network in comparison to LEACH. SDEEC [19] is routing protocol for heterogeneous network. This protocol is providing balanced cluster head election as it is using stochastic technique. EEICCP [20] is energy efficient inter cluster coordination protocol, based on multi hop clustering scheme which minimize energy usage by uniformly distributing loads of energy among all the nodes. EEICCP outperforms conventional protocols that send data directly to base station through their respective cluster head. Novel energy efficient multi hop protocol [21] for heterogeneous environment where every node elected itself as CH on basis of its preliminary energy comparative to others. Here global knowledge of energy is not required. It uses multi hop approach for data communication from cluster head to base station In Link aware clustering algorithm [22] cost effective routing pathway is used, in terms of reliability and energy efficiency. The cluster is formed using PTX (Predicted Transmission Count), clustering metric based on node status and link condition. SOSAC [23] is self-organized and smart adaptive clustering scheme using three sub procedures to alter fitness value with respect to time. Heterogeneous LEACH [24] was based on distributed routing protocol. It has been investigated the effect of heterogeneity of nodes in enhancing the network lifetime.

III. PROPOSED ALGORITHM

A. *Design Considerations:*

The protocol is using heterogeneous network model, in which nodes are categorized based on its energy level. As SEP, DEEC operate on two levels of nodes, the EDEEC support three level heterogeneity. The proposed protocol nodes classified as four types based on its energy. The model is using assumptions as follows

- The sensor network area to be monitored is of dimension M X M.
- The randomly installed sensor nodes are motionless.
- The locality of sink is at center of field having no resource constraint.
- The nodes are alike in computation and communication ability but differ in initial energy.

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B. *Description of the Algorithm:*

The scheme is separated into following main parts

1. Node Deployment
2. Cluster Head Selection
3. Cluster Formation
4. Energy and Communication

B.1 Node Deployment

```
Procedure Node Deployment
N:Number of sensor nodes
1.Intilize m,m0,m1 // fraction of  advance, super and ultra-nodes
2. Initialize x, y, z
// x,y,z are energy enhancement factor
3. calculate no. of normal, advance ,super and ultra-nodes
3.Select random location for all types of nodes
4. Assign initial energy values
5. For nodes 1 to n
6.Initialize nodes  type as Non- CH
7. All nodes belong to set G
// G set contains node eligible to become cluster head
8. End
```

B.2 Cluster head selection

```
Procedure CH selection;
Initialize countCH=0
For I 1 to n
1.Calculate average energy of network Ea
2. Calculate alive nodes
3. Define their residual energy
4. if (node energy>Er)// Er is reference energy=.7*E0
5. Calculate probability of  node Pi to become CH
// Pi for normal,advance,ultra and super is calculated based on residual energies of node
6.Else
7. Redefine Pi based on Er
8. Endif
9. Node belongs to Set G
10. Choose random number(0,1)
11.Calculate Threshold function  Th of node
12.If  rand num<Th
13.Node elected as CH for round r
14. Update the probability of node
```

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B.3Clusering

```
Procedure cluster formation
1.For all Non CH nodes
2.Begin
3. dist2= distance(mindisCH, node)
4. dist1=distance (node , sink)
5. if dist2<dist1
6.Node join mindisCH
7.END
```

B.4 Energy and Communication

```
Procedure Communication;
1.If node=CH
2.collect data from CH members
3.Aggregate the data
4.Send data to base station
5 Compute energy consumption of CH
6. if node=Non CH
7.Trasmit data to CH
8. Compute energy consumption of node
9. END
```

IV. SIMULATION RESULTS

The simulation studies involve comparing of proposed protocol with existing schemes two and three level. The various simulation parameters for getting results are mentioned in table 1

Parameter	Value
Network field	100x100
No. of nodes	100
E_o	0.5J
p_{opt}	0.1
ε_{mp}	0.0013pj/bit/m4
ε_{fs}	10 nJ/bit/m2

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E_{elec}	50nj/bit
E_{DA}	5 nJ/bit/signal
L	4000 bits

Table 1: Simulation Parameters

Test Cases:-
The cases are prepared based on varying the number of nodes of different types and also their energy enhancement factor. The protocols are simulated and their results are presented in table 2 and table 3.The network lifetime parameter considered are first node dead, tenth node dead and last node dead.

Case1:

Input	No. of Nodes	Protocols	Network life time parameter		
m = .5,m_0 = .2, m_1 = .7, x = 1.5, y = 2, z = 2.5	Normal=50% Advance=40% Super=7% Ultra=3%	 DEEC EDEEC Proposed	FND 1240 1148 1374	TND 1446 1669 1952	AND 3188 7410 8118

Table 2: Comparison of FND, LND, AND for different protocols using case 1

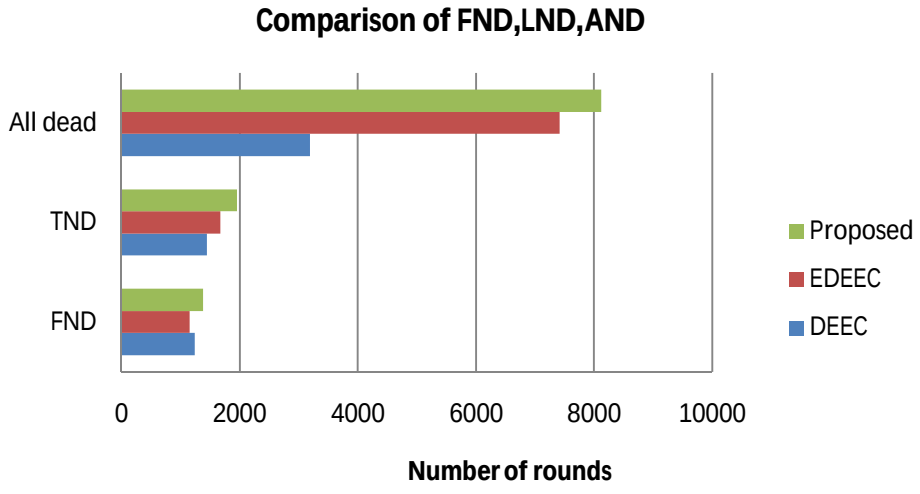

Figure 1: Comparison of FND LND AND using case 1

Case2:

Input	No. of Nodes	Protocols	Network life time parameter		
m = .5, m_0 = .3, m_1 = .2, x = 1.5, y = 2, z = 2.5	Normal=70% Advance=24% Super=3% Ultra=3%	 DEEC EDEEC Proposed	FND 1208 1124 1453	TND 1486 1469 1829	AND 2779 7121 8574

Table 3: Comparison of FND LND AND for different protocols using case 2

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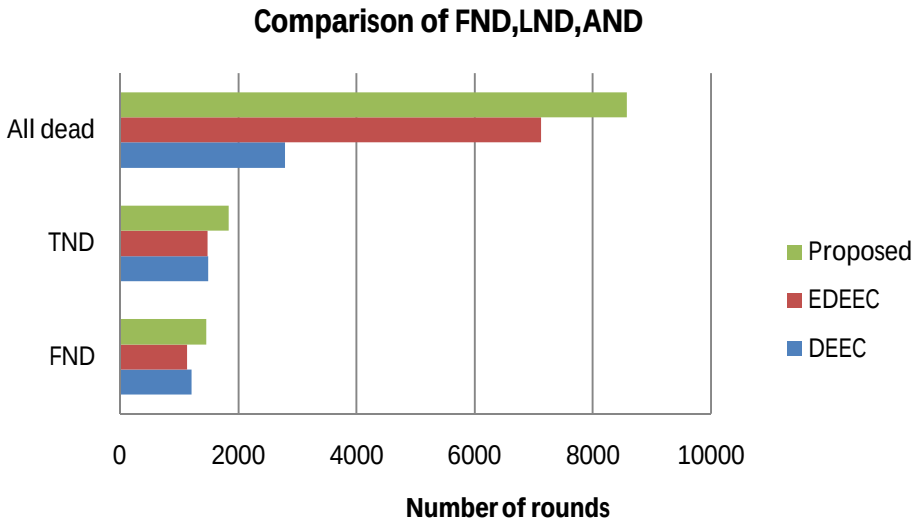

Figure 2: Comparison of FND LND AND using case 2

V. CONCLUSION

The mentioned scheme is energy aware heterogeneous routing protocol possessing four levels of nodes. Further it is considered to be adaptive protocol where cluster head is selected dynamically in more balanced way. The said protocol is saving nodes of network, in turns improving network lifetime.

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