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An Improve Energy –Efficient Distributed Unequal Clustering Protocol For Wireless Sensor Network

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Abstract – *In this paper an improve Energy aware distributed unequal clustering protocol is projected. The protocol is used for solving energy- hole problem in multi-hop wireless sensor network. In clustering parameters we have location of base station and residual energy. Based on these parameters, different competition radii are solve to node. In this protocol, by electing cluster heads considering number of nodes in the neighborhood in addition to the above two parameters. We are comparing two protocols. The inclusion of the neighborhood information for computation of the competition radius provides better balancing of energy in comparison with the existing approach. Therefore, the selection of next node, the relay metric is defined directly in terms of energy expense instead of only the distance information Used in the protocol and the data transmission phase has been extended in every round by performing the data collection number of times through use of major slots and mini-slots. The methodology used is same clusters for an every rounds and is effective in reducing the energy consumption.*

The performance of the proposed protocol has been calculated three different scenarios and compared with protocols through simulations. The results show that the proposed protocols in terms of network lifetime in every scenarios.

Key Words: **EEDUC, Energy hole, Wireless sensor network, Network lifetime, Multi-hop routing, Cluster-Head Selection, Heterogeneity.**

1. INTRODUCTION

A wireless sensor network consist of many small, light weighted, low cost wireless nodes. These nodes are randomly distributed at a remote location to sense physical data such as: Temperature, Humidity, Vibration, Pressure and Noise etc.

Lot of research work has been carried out in the last decade to address this challenge [1-3].WSNs are deployed for data gathering applications involving a large amount of area such as agriculture, forests , coal mines, monitoring of rail tunnels, etc. The base station is placed far away from the sensing filed in most of the cases. Data are gathered periodically by the base station. Clustering is the most of the technic to monitoring the networks [7-11]. Network offers greater lifespan the network with direct data transmission. It improve the lifespan gets improved by the factor of about 2 or 3 times with clustering [12].

There are many uses of clustering protocols in data aggregation networks. In bored network, usually there is large volume of traffic among the sensors, which leads to certain of interference and subsequently results into collisions. Clustering the sensors would minimize the number of long distance transmission and there result into saving of the energy. When the normal sensor node sleep times are drawn out, while cluster head coordinates the activities of its members nodes again resulting into energy saving [13]. This activity is executed TDMA based protocol [5, 11, 14, and 15]. Data aggregation at cluster head by the lower number of transmitted data packets, which helps reduction of the energy consumption of sensor nodes.

The clustering protocol has two steps, first is intra cluster that means within the clusters, and second is inter cluster, that means cluster to base station. Clustering depends on single hop transmission or multi-hop transmission [16, 17].

First clustering protocols use single hop communication for communicating inside the cluster, as the distance between sensors within the cluster. E.g. LEACH [11], LEACH-DT [15], HEED [18], etc. But our report based on Multi-hop communication between sensor nodes and cluster head. Sensor node and the cluster head is more energy efficient than single hop communication, when the propagation loss exponent is high. Multi-hop examples are LEACH [22], EADC [23], EDUC [24], etc.

Recently, much research has been carried out to address energy imbalance and mitigates energy hole problem for clustered WSNs. Number of strategies such as using node mobility[25,26], mobile sink, hierarchical deployment, non-uniform clustering, data compression and traffic aggregation etc. have been prosed for solving energy hole problem.

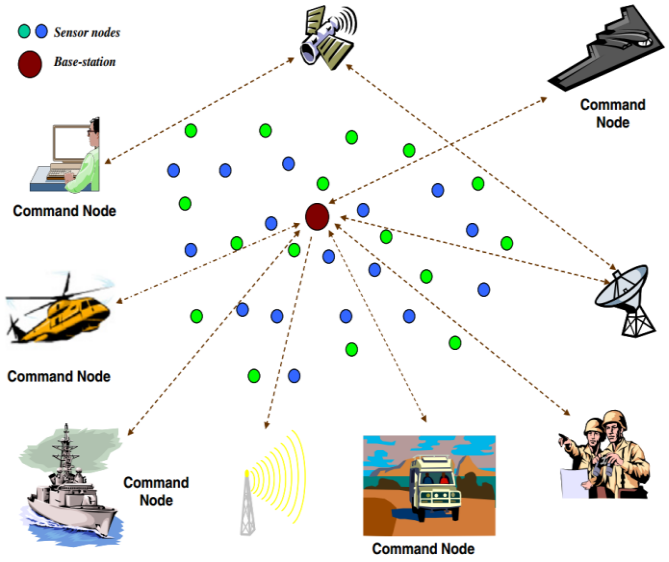

Fig 1 : An articulation of a sample WSN architecture for a military application

1.1 Base Station (BS)

This node contains highest node attributes in the network. It knows as sink node because it collects all the sensed data from all deployed sensor nodes in region via cluster heads.

1.2 Cluster –Head (CH)

Cluster-head is highest entity node within node a cluster. Cluster-head is liable for coordination between inter-cluster and intra-cluster communication, data assortment, data aggregation and communication with base station. A single node can't be the CH for entire period of operation. This is because CH node drains its energy faster than normal node due to added network load. Therefore CH rotates on next highest attribute node within the cluster.

1.3 Member Nodes

Member nodes are normal nodes. These nodes sense the data and forward it to CH or relaying the data from another distant sensor node to the CH.

2. LITERATURE SURVEY AND RELATED WORK

There are so many clustering schemes are available for optimize network operation. Each scheme proposes different CH selection process relied on different network attributes. Clustering algorithm has been based on the rotation of role of cluster head in every round and selecting cluster heads with more residual energy in order to enhance the lifespan of the network.

A protocol available in this category is low-energy adaptive clustering hierarchy (LEACH) protocol. The LEACH protocol one-hop communication between the nodes and to the base station. This makes large-scale networks. Many LEACH based protocols have been developed in the past which are improvements over the LEACH protocol, such as LEACH-DT [15] or a multi-hop variant of LEACH, called as M-LEACH [1]. A hybrid energy-efficient distributed (HEED) clustering algorithm is proposed in reference 18, which select cluster head according to not only the node residual energy but also intra-cluster communication costs. It uses multi-hop communication among the cluster heads for inter-cluster communication. It is successful in prolonging the network lifetime but not so effective in balancing the communication load as node's closer to BS still die faster. Another protocol, the distributed energy efficient clustering algorithm (DEEC), is available [26]. In DEEC, cluster heads are chosen by a probability that is based on the ratio of residual energy of a node and the average energy of the network. In all these energy-efficient clustering schemes, although periodic rotation of cluster head function sees that nodes run through energy more evenly, but it is not effective in avoiding the energy hole problem of many-to-one data gathering wireless sensor networks.

Many methods have been proposed in literature for mitigating the energy hole problem and maximizing the network lifetime.

Energy hole problem are categorized into three parts-First is traffic compression and aggregation. Large initial energy node can be deployed in the area consuming lager energy. Second type is node distribution [29, 30]. Node can be deployed in the area near the base station. Third is based on transmission range adjustment [25, 26,].this is the solve energy hole problem by adjusting the radii of sensor communication ranges in reference.

In last few research have explored the strategies to extenuate the energy hole problem in hierarchical (cluster based) WNSs. Many energy efficient algorithm have been developed using equal and unequal size clustering protocols technique. Unequal size clustering only to counter the problem of uneven energy consumption among sensor nodes of the network. The first protocol using unequal cluster size is an unequal cluster size mode [8], it is better balancing of energy dissipation among the nodes. It achieved an improvement of 10–30% over the equal clustering size strategy, depending on the aggregation efficiency of CH nodes. This is data gathering applications, which efficiently the network nodes using unequal clustering and multi-hop routing.

Besides this unequal clustering to solve energy imbalanced, work has also been done using energy efficient multi-hop routing for saving the energy. An energy efficient multi-hop routing protocol is one of the

best protocol. It uses BS to select particular paths for data transmission between source nodes and base station.BS energy for performing routing paths selection and other control messages broadcasts, it reserves the energy of network nodes. Unequal cluster based routing protocol [29,30] is another algorithm proposed for considering the hot spot problem in multi-hop sensor networks.

It also forms unequal cluster sizes through using uneven competition ranges, and for inter-cluster communication, it uses a geographic and energy-efficient routing protocol. The protocol is used in this paper residual energy and transmission distance parameters to balance the energy consumption for network.

Another method, an energy –distributed unequal clustering protocol [24]. It is based on cluster head rotation. In this energy consumed in cluster head rotation is minimized by node to be cluster head only during the network lifetime. It achieves energy efficiency but limitation on the only singe hop transmission.IN unequally cluster multi-hop routing protocol is proposed, when each cluster has diffident size based on the distance to base station.

Recently base station mobility based energy balancing unequal clustering protocol[29],which used improve cluster head replacement and shuffled leaping protocol for the network clustering. The cluster head selected continuously and reducing the frequency of cluster head replacement. It's save energy. Depending upon the weight and etc.

3. PRELIMINARIES

An improved EEDUC protocol are the network considered here consist of N number of sensor nodes deployed randomly M*M sensor field. The nodes has different initial energy. The BS is far away from the sensor filed and location is assumed to be known to each node. The cluster heads can transmit their data directly with BS. The data message and controlled message transmit through wireless links. Now it is assumed that data sensed by the nodes are highly correlated.

3.1 Energy model

The transmission consume energy in running radio electronics circuity and the transmit amplifier circuitry ,whereas the receiver's energy consumption is only in radio electronics part[11,20].This also depends on transmission distance , both the free space εfs and multipath fading εmp channel models are used. If the distance is to less than a threshold level, the free space model is used or multipath model is used. When transmitting the *l*-bit data to a distance *d*, the radio expends according to Eq. (1)

Etx (l, d) =Etx-elec (l) +Etx-amp (l, d)

$$=l*Eelec + l* \varepsilon fs* d^2,\ d<dth \quad (1)$$
$$l*Eelec+l*Emp*d^4,d>=dth$$

When we are receiving l-bit data the radio expends according to Eq.2

$$Erx\ (l) = Erx\text{-}elec\ (l)$$
$$= lEelec. \quad (2)$$

3.2 Data aggregation model

In this work for Data aggregation model [7, 20].It is cluster head collect the data form its member nodes and aggregation it's a single packet of fixed length respects of number of received packets.

4 IMPROVED EEDUC PROTOCOL MECHANISM

The clustering method used to EEDUC protocol. This operates in rounds. Nodes deployed each node first computes distance from the base station. On the basis of the received signal strength, each node its distance to base station. This protocol has two phase: Setup phase, Steady phase, which data transmitted take place.

Setup phase has divided in further three phase duration T1, T2, and T3 respectively.

Each node then cluster according to Eq. (3)…

$$E_{avg\_res} = \left(\sum_{j=1}^{m} S_j . E_r\right)/nb \quad (3)$$

Where Sj = one node, Er = residual energy of Sj, nb= neighbors node. After T1 has timed out, the operation of next phase that is T2 duration. Sub phase cluster head are chosen. At the end of information collection phase each node calculated its wait time for broadcasting head message to Eq. (4).

$$t = \begin{cases} \frac{Eavd\_reg}{Er} T_2 V_r & , E_r \geq E_{avg-res} \\ T_2 V_r & , E_r < E_{avg-reg} \end{cases} \quad (4)$$

Where Er=current residual energy of the node, Vr=real value randomly distributed in cluster head.

The improve EEDUC schemes is based on the EEDUC protocol [28]. It uses a different competition radius rule for producing unequal clusters. Only the distance between the node and BS and the residual energy of the nodes is taken into account. The competition radius for the proposed scheme is a function of distance to the BS, the residual energy of CH, and number of neighbor nodes. Nodes with higher residual energy greater distance from the BS, and lower number of neighbor nodes should have larger competition radius for it. Following formula given Eq. (5) is used.

$$Rc = \left(1 - \alpha\left(\frac{dmax - d\,sj, BS}{dmax - dmin}\right) - \beta\left(1 - \frac{Er}{Emax}\right) + \gamma\left(1 - \frac{Sj(nb)}{nbmax}\right)\right) Rmax \quad (5)$$

Where α, β, γ= are the weight in (0,1) , Rmax =radius transmission maximum value ,dmax and dmin=maximum and minimum distance of nodes from BS, d(Sj , BS)=distance of jth node from BS, Er=node residual energy, Emax=maximum value of initial energy the nodes in the network, Sj(nb)=number of neighbor nodes of jth node and nbmax =the maximum value of neighbor nodes.

The cluster heads transmit the data packets to the BS directly relaying. If the distance from cluster head to BS is greater than threshold distance. So relay node selection is done as one of the neighbor nodes from the candidates forwarding to a parameter **E**relay. Eq. (6)

$$Erelay = d^2(Si, Sj) + d^2(Sj, BS) \quad (6)$$

So in EEDUC protocol, the node having smallest Erelay in the forwarding candidates set gets selected as relay node for forwarding the data to the BS. After we are calculating Relay. Eq. (7)

$$relay = (Sj.Er\ Sj.count * ERx * DM - (Sj.count) + 1 * EDA * DM - ETx * DM *)/Emax \quad (7)$$

Now after completing the proses, another round of protocols runs comprising of the set up phase and steady phase.

5. PROTOCOL ANALYSIS

The following are the characteristics of the improve EEDUC protocol.

A. In Eq. (4), cluster head selection based on ratio of the average residual energy and the remaining energy of the nodes. This helps in prolong network the network lifetime as the nodes having more remaining energy are selected.
B. Cluster head selected whole network. As Eq. (4) wait time is less than or equal to duration T2 of cluster head.
C. Unequal clusters is based on distance to the BS. Residual energy on nodes and number of the neighbors. It helps balancing of the energy.
D. The relay metric used is defined directly in terms of energy, so it helps in prolonging the lifetime by selecting the router more efficiently for sending the data to BS.
E. Clustering reduces as the cluster setup is retained for a few rounds. Therefore the energy consumption of the network less and network lifetime.

6. PERORMANCE EVALUATION

Additional parameters required for simulations are listed below.

Table 1
Simulation parameters.

Parameter	value
Network area	200 m × 200 m
Base station location	(250,100)
No. of nodes	100
Initial energy of nodes	0.5–1.5J
Data packet size	500 bytes
Eelec	50nJ/bit
εfs	10 pJ/bit/m2
εmp	0.0013 pJ/bit/m4
EDA	5 NJ/bit/signal
Rmax	110 m
Threshold distance	87.7 m
α, β, γ	0.3333

In proposed method of computing radius and relaying and the technique of division of data transmission phase into major and mini slots separately, the results of the proposed protocol, the improved EADUC, are shown in two steps in the subsequent sections. In the first implementation, namely improved EADUC 1, the proposed protocol uses the method of clustering and relaying only without incorporating the division of data transmission phase. In the second implementation, namely improved EADUC 2, the method of clustering and relaying along with the technique of division of data transmission phase is incorporated. The number of mini-slots is taken as 3 and major slots as 2 while simulating the EADUC 2 protocol. The energy efficiency of the proposed protocol is compared with the EADUC protocol and the HUCL protocol. For comparison, the simulation parameters and the scenarios considered are same in all the protocols and the basic mechanism of the HUCL protocol operation without compression is considered.

7.RESULTS PARAMETERS

The simulation was performed in MATLAB tool.In this simulation the energy model and data aggregation model

used are as explaning section3.1 and section3.2.The following performance metices are useed in this paper:

- Number of cluster heads:
  Node distribution in each scenario in this section.
- Average energy consumption every round:
  Average energy consumption by all the node of the network in one round.
- Residual energy:
  Total residual energy calculating in this section.
- Network Lifetime:
  Measured data collection rounds, time in this section.
- Number of alive nodes:
  Nodes are alive to round .

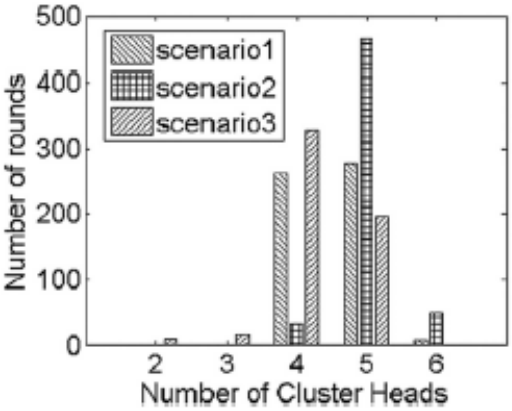

Fig.2 Average number of cluster head

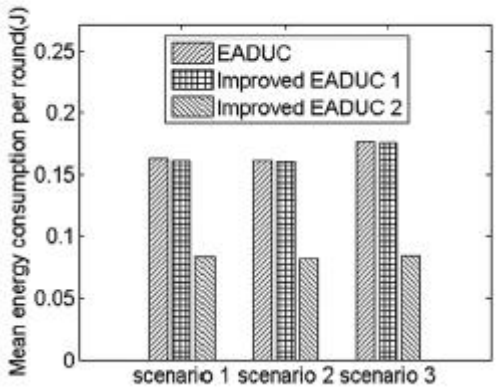

Fig.3 Average energy consumption of network

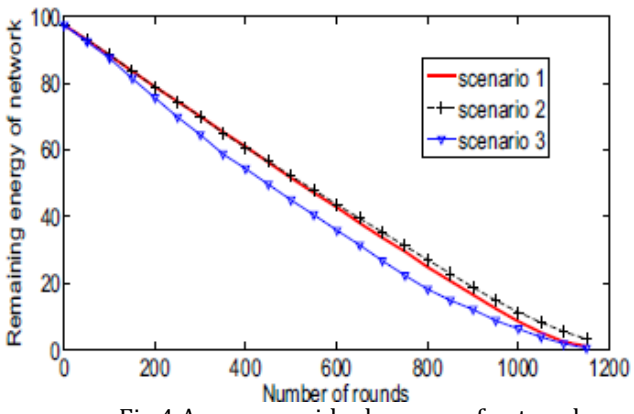

Fig.4 Average residual energy of network

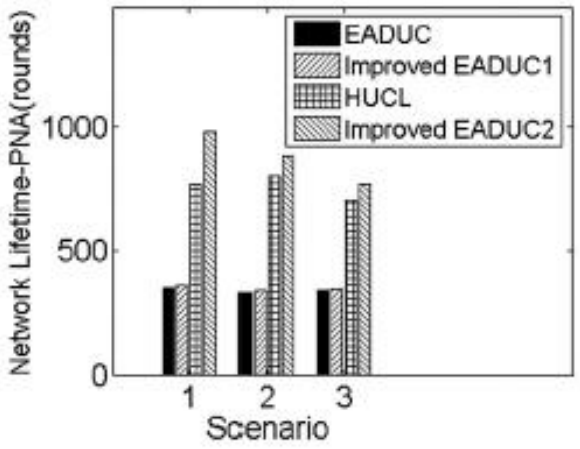

Fig.5 Network lifetime when nodes are alive

8. CONCLUSION

In this paper an energy–efficient distributed unequal clustering protocol in wireless sensor network. It has been extended in order to improve the lifetime of wireless sensor network. The unequal cluster approach has been exploited in this work. The cluster formed are of unequal size using uneven radius. The cluster near to base station have smaller size than clusters that are far away from Base station. Nodes has uneven radius using multiple factors, distance to base station, the residual energy and number of the neighbors. This protocol is used balancing clusters. To reduce energy consumption, Increase the scalability and give the prolong network. Relay node selection for forwarding the data towards the base station is based directly in term of energy. In this scenario compared to the EEDUC and HCUL protocols.

The outcome of this study will be useful for solving the energy hole problem in data gathering network.

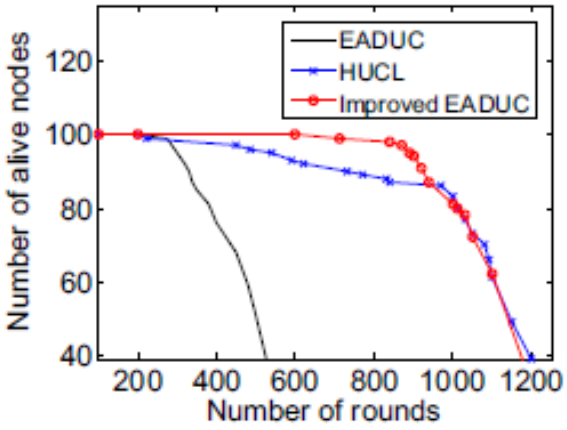

Fig.6 nodes alive with respect to round

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