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APIT- HEER (Hybrid Energy Efficient Reactive Protocol for Wireless Sensor Networks)

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Abstract:
The clustering Algorithm is a kind of key technique used to reduce energy consumption. It can increase the scalability and lifetime of the network. Clustering divide the sensors node into groups, so that sensors communicate information only to cluster heads and then the cluster-heads communicate the aggregated information to the base station, saves energy and thus prolonging network lifetime. In this paper, we propose an energy efficient cluster-head selection algorithm for heterogeneous wireless sensor networks, which is called APIT - HEER (Hybrid Energy Efficient Reactive). This protocol has use APIT based distance to improve the performance of HEER protocol further. APIT does not allow two CHs within the range of each other; therefore proposed algorithm always select optimum number of CHs. The proposed HEER has shown significant improvement over available with respect to network lifetime. The cluster-heads are elected by a probability based on the ratio between residual energy of each node and the average energy of the network. Moreover, to conserve more energy, in this we introduce Hard Threshold (HT) and Soft Threshold (ST). Finally, simulations show that our protocol has not only prolonged the network lifetime but also significantly increased stability period.

Keywords*: Wireless, Sensor, Networks, Energy, Hybrid, Cluster, Reactive*

1. Introduction

A Wireless Sensor Network (WSN) consists of a large number small sensor nodes communicating among themselves and they are typically deployed in quantity to sense, monitor and understand the physical world. A sensor is a device which measures a physical quantity and converts it into the signal which is used by instrument. A wireless sensor is the smallest unit of a network that has unique features, such as, it supports large scale deployment, mobility, reliability, etc. WSNs are not limited to science and engineering, but they are also included in other popular applications such as the military, water monitoring, infrastructure monitoring, government security policy, habitat monitoring, environment monitoring, and earthquake monitoring, are few examples. A sensor network consists of a discrete group of independent nodes with low cost, low power, less memory, and limited computational power that communicate wirelessly over limited frequencies at low bandwidth [1. Efficiently organizing sensor nodes into clusters is useful in reducing energy consumption. Many energy-efficient routing protocols are designed based on the clustering structure. The clustering technique can also used to perform data aggregation [2], which combines the data from source nodes into a small set of meaningful information. Under the condition of achieving sufficient data rate specified by applications, the fewer messages are transmitted, the more energy is saved localized algorithms can efficiently operate within clusters and need not to wait for control messages propagating across the whole network. Therefore localized algorithms bring better scalability to large networks than centralized algorithms, which are executed in global structure. Clustering technique can be extremely effective in broadcast and data query [3]. Cluster-heads will help to broadcast messages and collect interested data within their own clusters.

In this paper, we study the performance of the clustering algorithm in saving energy for heterogeneous wireless sensor networks. In the sensor network considered here, each node transmits sensing data to the base station through a cluster-head. The cluster-heads, which are elected periodically by certain clustering algorithms, aggregate the data of their cluster members and send it to the base station, from where the end-users can access the data. We assume that all the nodes of the sensor network are equipped with different amount of energy, which is a source of heterogeneity. The new nodes added to the networks will own more energy than the old ones. The advance nodes are equipped with more energy than the normal nodes [4].

In this paper, we propose and evaluate a new energy-efficient clustering scheme for heterogeneous wireless sensor networks, which is called APIT-HEER. In APIT-HEER, the cluster-heads are elected by a probability based on the ratio between the residual energy of each node and the average energy of the network. After the no. of round the status for each node is different according to its initial and residual energy. The nodes with high initial and residual energy will have more chances to be the cluster-heads than the low-energy nodes. Thus APIT-HEER can prolong the network lifetime, especially the stability period, by heterogeneous-aware clustering algorithm. Simulations show that APIT-HEER achieves longer network lifetime and more effective messages than other classical clustering algorithms in the heterogeneous environments.

2. Heterogeneous WSNS Model

In this work, we have analyzed a heterogeneous sensor network environment. There are p is the percentage of advance and normal nodes having a times more energy than the normal nodes that are distributed randomly over the sensor field. A cluster head election process is considered based on the battery power and residual energy of the node. In our approach, advanced nodes have higher probabilities to become a cluster head in a particular round than the normal nodes. The proposed heterogeneous network model doesn't effect on the spatial density of the network but changes the total initial energy of the network. Note E_0 the initial energy of the normal nodes, and m the fraction of the advanced nodes, which have more energy than the normal ones. Thus there are mN advanced nodes whose individual initial energy equations is given below[3]:

$E_1=E_0.(1+a)$

Where,

E_0=Energy of a normal node

E_1=Energy of advanced node

a is the boost up energy for the protocol

The total initial energy of the new heterogeneous sensor network model is given by equation(5):

$E_{total} = N(1 \_ m)E_0 + NmE_0(1+ a)= NE_0(1 + am)$.

For multi-level heterogeneous networks, initial energy of sensor nodes is randomly distributed over the close set $[E_0, E_0 (1 + a_{max})]$, where E0 is the lower bound and a_{max} determine the value of the maximal energy. Initially, the node si is equipped with initial energy of E_0 (1 + ai), which is ai times more energy than the lower bound E_0[8]:

$$E_{total} = E_0(N + \sum_{i=1}^{N} a_i)$$

In this work, we have approached to assign a weight to the optimal probability of a sensor node (p_{opt}) to become cluster head in a particular round. This weight must be equal to the division of the initial energy of each node by the initial energy of a normal node. If all the nodes are homogeneous, all the nodes will become cluster head once every $1/p_{opt}$ round which is coined as epoch of the network. In order to maintain the minimum energy consumption in each round within an epoch, the average number of cluster heads per round per epoch must be constant and equal to p_{opt} .n. In our approach the average number of cluster heads per round per epoch is equal to n.(1+p.a+k.b). In the weighted election probabilities for normal and advanced nodes are defined. In our three tier node scenario, the weighted election probabilities for the normal and advanced nodes are as follows:

$$P_{nrm} = \frac{p_{opt}}{1 + p.a + p.b}$$

$$P_{adv} = \frac{p_{opt}}{1 + p.a + p.b}.(1 + a)$$

3. APIT-HEER Protocol

A In this section, we describe APIT-HEER, which improves the stable region for clustering process for a reactive network in homogeneous and heterogeneous environment. We use the initial and residual energies of the nodes to become CH similar to that of DEEC. It does not require any global knowledge of energy at any election round. In this protocol during the election of cluster head the minimum distance between the two clusters is maintained i.e. no two cluster in this protocol will exist in same area of the other cluster. So for the election of the other cluster head a distance is calculated by using the APIT localization algorithm. When cluster formation is done, the CH transmits two threshold values, i.e. HT and ST. The nodes sense their environment repeatedly and if a parameter from the attributes set reaches its HT value, then the node start to transmits data. The Current Value ( ) on which first transmission occurs, is stored in an internal variable in the node called Sensed Value (SV). This reduces the number of transmissions. Now the nodes will again transmit the data in same cluster period when $CV - SV \geq ST$. That is, if CV differs from SV by an amount equal to or greater than ST, then it further reduces the number of transmissions.

4. Throughput In Proactive And Reactive Protocols

Proactive protocols sense their environment and transmit data periodically. They consume energy continuously with time due to periodic transmission on the other side of proactive protocol, reactive protocol is application dependent. It senses the environment periodically but transmits data only when its CV reaches to absolute value of the attribute. As data transmission consumes more energy than data sensing, so, in reactive network the throughput can be minimized or maximized as per its application [4]. The throughput in reactive networks is inversely proportional to the network lifetime or its stability period. If transmissions are less the stability period and network lifetime will be prolonged as CV does not reach the absolute value. However, if the CV reaches HT value (absolute value) repeatedly then maximum number of transmissions will occur and nodes will die quickly [8].

5. Simulation Results

In this section, we evaluate the performance of the APIT-HEER via MATLAB simulations with field has dimensions of 100 × 100 square units. The number of nodes in the field is n = 100. The distance of base station is 150 from the network. Our goals in conducting the simulation are as follows.

- To modify HEER using APIT algorithm.
- The main objective is to increase the Stability Period of WSN

- The performance evaluation will be done by taking the result from the proposed strategy and will be compared with available techniques in the same field.

No. of nodes	100
Initial energy, $E0$	0.1Joule
BS Location	(150,150)
Percentage of advanced nodes, m	0.3
Energy of advance nodes	$E0(1+a)$

Table 1: Parameters used in our simulation

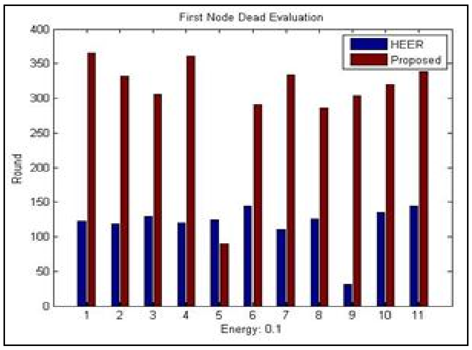

Figure 1: First Node Dead Comparison

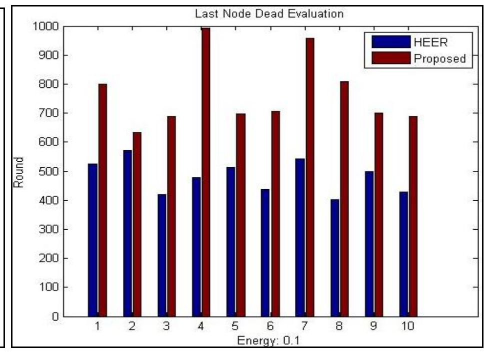

Figure 2: Last Node Dead Comparison

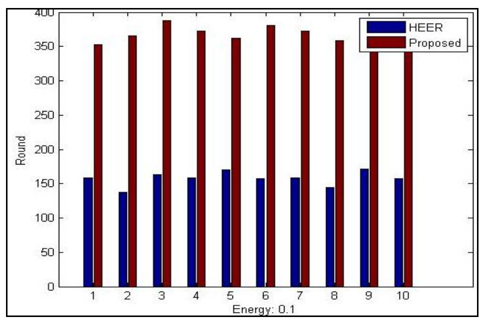

Figure 3: Tenth Node Dead

As in the fig1 the stability period of the HEER protocol is very short than the proposed APIT-HEER protocol as the first node in HEER protocol die at the steady rate. So the same in the fig 2 last node die steady in the network as compared to the proposed APIT-HEER protocol.

Initial Energy	**HEER Protocol**			**APIT-HEER Protocol**		
	First Node Dead	**Tenth Node Dead**	**Last Node Dead**	**First Node Dead**	**Tenth Node Dead**	**Last Node Dead**
0.1	122	158	526	366	353	801
0.01	1	13	35	19	28	42

Table 2: Comparison OF HEER and APIT-HEER

6. Conclusion

In this paper we modify HEER protocol by using APIT based distance to improve the performance of HEER protocol further. APIT does not allow two CHs within the range of each other; therefore proposed algorithm always select optimum number of CHs. The simulation result shown which present that the proposed HEER has shown significant improvement over available with respect to network lifetime.

7. References

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