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Improved Stability period by Mobile Sink based Energy Efficient Adaptive Threshold Clustering Hierarchy Algorithm for WSN

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Abstract: The important issue in the wireless sensor network is scalability and stability due to huge number of sensor node, their deployment and density. When the network size increases it become necessary that scalable and energy efficient routing is imperative. With static sink energy hole problem or hot spot is a major problem in WSN. The sensor nodes which are located near to the sink, act as relay for those of the nodes which are far apart from the sink. This causes the lifetime of the network reduced. In this paper mobile sink and heterogeneity of the nodes extends the stability period. Heterogeneous network model gives the three different energy levels of the sensor nodes. In this paper we propose to improve the stability period of the wireless sensor network by using mobile sink based energy efficient adaptive threshold clustering hierarchy algorithm. Here we use hybrid routing protocol APTEEN which gives overall snapshot of the network at periodic intervals and also react to time critical situations. The results obtained from the proposed algorithm have been compared with that obtained from MSIEEP protocol. It can be assessed from results that the proposed algorithm works better than MSIEEP. The simulation result is performed in MATLAB.

Keywords: Mobile sink, stability, energy efficient, Heterogeneous.

I. INTRODUCTION

In twenty first century wireless sensor network is one of the most important technologies. Wireless sensor network mainly consist of the tiny sensor nodes. Many surrounding parameters such as pressure, heat and temperature are monitored by wireless sensor nodes. The sensor nodes powered by limited power supply [1] and these power supplies are unable to change or recharges because of large number of sensor nodes are deployed in the network. The application of the wireless sensor network [2] includes habitant monitoring, environment monitoring, surveillance systems, medical, military, traffic analysis etc. We analyze the impact of the network heterogeneity in terms of node's residual energy in this paper. It is assumed that a number of nodes in the network are equipped with more energy and rests of the nodes are having lesser energy. This idea is the base of a heterogeneous network. There are several applications where this concept of heterogeneity benefits [3]-[4] the overall life of the WSN. This benefit is the driving force for our effort in this field.

Applications which are benefitted from this concept are those where re-energization of network nodes is required. In the WSN, network nodes have limited energy which forces the requirement of re-energization of the network by adding some net network nodes to keep the WSN live. To avoid this, some nodes with higher energy can be placed in the network which makes the overall network heterogeneous in terms of node energy. One factor involved in placement of heterogeneous nodes is cost of the nodes. The cost may not always allow placing the network nodes in the optimal position as proposed in paper [5]. Sensor nodes sense the data and send the data report towards the sink node which is also the processing center [6]. The network design shall be very considerate about the energy consumption as it is very important factor to maximize the network lifetime. The batteries which are integrated part of the sensor are very tough to replace and even the location of the sensor nodes may not be very easy to access. The conventional transmission approaches like direct transmission method and Minimum transmission energy method do not work very efficiently and they result in sensor nodes' loading imbalance causing some of the network nodes to die faster. In case of direct transmission method, packets are directly to the sink node. In this process the sensor nodes which are far apart from the sink send data over larger distance and deplete their energy faster.

This causes the sensor nodes to die sooner as compared to nodes which are closer to the sink. Since the basic concept of WSN is to manage the energy consumption very efficiently, it can be achieved by using mobile sink. The mobile sink will go near to the sensor node and thus the energy consumed by the sensor node in transmitting the data will be low. The mobile sink also reduces the delay in data collection for all the nodes in the sequence. This paper organised as: Section I gives introduction about proposed technique and explain, section II gives a brief review on previous work done on mobile sink and stability

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by using mobile sink and heterogeneity section III explain the proposed algorithm and section IV provides simulation result and section V and VI give conclusion and future scope of the proposed work.

II. RELATED WORK

Many approaches have been proposed for improvement of the stability in wireless sensor network. Some of them are discussed here:

In [7] authors proposed EDEEC protocol. In this paper three different type of nodes have been proposed for increasing the network lifetime and its throughput. The architecture of the network taken in this work is similar to the heterogeneous model. The simulation results shows in the paper show that the proposed protocol performs better than Stable Election Protocol (SEP).

In [8] author explained a clustering mechanism called Developed Distributed Energy-Efficient Clustering technique for heterogeneous WSNs. The cluster head selection probability is progressively and proficiently changed in this paper. The results obtained from simulation show that this particular protocol is more efficient as compared to SEP and we can gain approximately 30% in terms of network lifetime using this protocol.

In [9] this paper, the authors examine some heterogeneous and homogeneous networks and protocols related to them. Five different routing protocols based on clustering technique have been evaluated in this paper for finding out their efficiencies. These protocols are namely: Distributed Energy Efficient Clustering (DEEC), Threshold Sensitive Energy Efficient Sensor Network (TEEN), Low Energy Adaptive Clustering Hierarchy (LEACH) and two protocols deduced from TEEN which are Hierarchical Threshold Sensitive Energy Efficient Sensor Network (H-TEEN) and Clustering and Multi-Hop Protocol in Threshold Sensitive Energy Efficient Sensor Network (CAMPTEEN). Work done in this paper is concentrated about increasing the network lifetime by using mobile sink concept for hierarchical routing protocols. The protocols are evaluated for mobile as well as static sink.

In [10] this paper the author discusses about Genetic Algorithm-based Energy-Efficient adaptive clustering hierarchy Protocol (GAEEP). The basic idea of this algorithm is to select optimum number of cluster heads within the network and effectively find their position so as the energy consumption is reduced in data transmission. The simulation has been performed for homogeneous and heterogeneous both type of networks. The simulation results show that the protocol improves the network lifetime and energy consumption over previously used protocols in both the cases.

In [11] it has been proposed that a mobile sink based adaptive immune energy efficient clustering protocol (MSIEEP) reduces the problem of energy hole creation. The author focuses to reduce the energy consumed in sending the control packets and communication packets. Adaptive Immune Algorithm (AIA) is used by MSIEEP to assist the mobile sink in the movement. In this paper the author compares the protocol MSIEEP with other protocols by using MATLAB. It is found that MSIEEP is more efficient in terms of energy consumption as compared to other protocols discussed in the paper.

III. PROPOSED ALGORITHM

The proposed concept uses N number of sensor nodes. These sensor nodes are assumed to be uniformly scattered in a M X M square area. With no loss of generality, the base station location is considered to be at the center of the region taken. The proposed concept initially takes heterogeneous [12] WSN model having three levels followed by energy consumption model proposed by us. Depending on the energy levels of the sensor nodes, a heterogeneous WSN may have two, three or multiple types of nodes.

The network proposed by us consists of three types of nodes namely super node, advanced node and normal node. The initial energy contained in the normal node is E0. The number of advanced nodes is the network is fraction m and the energy contained in the advanced node is "a" times greater than that contained by the normal nodes i.e. E0(1 + a). The number of super nodes in the network is taken as fraction m_0 and the energy contained [13] in these is considered to be " b " times greater than that contained in the normal nodes i.e. E0(1 + b). Since, N is the total number of nodes in the sensor network, the count of nodes specified as super node in the network as per discussion above is Nmm_0, the number of advanced nodes is $N(1-m_0)$ and the number of normal nodes is N(1-m). When the rounds of the sensor nodes start, at each round start it is decided by nodes whether to become cluster head or not. This decision is based on threshold. The threshold for cluster head selection is selected as per following formula:

$$Th(Si) = \begin{cases} \frac{pi}{1-pi\,(r \bmod \frac{1}{pi})} & \text{If } Si \in G \\ 0 \quad otherwise \end{cases}$$

Here, G is the set of nodes in round r which have the eligibility to become the cluster head and p is the required probability for the cluster head. The probability of selection as cluster head is more for super node and advanced nodes as compared to that of normal nodes.

Once the cluster head selection process is over, the selected CH receives the attributes from user. These attributes like soft threshold (ST), hard threshold, count time (CT) and schedule are broadcasted to the sensor nodes i.e. cluster members continuously [14]. Whenever the sensor node senses a data value which is higher than the HT, the value is stored as a internal variable and the value is sent to the CH through schedule following TDMA scheduling method assigned to it.

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The purpose of using a mobile sink is to make the network more energy efficient and increase its overall lifetime as well as to provide more flexibility to the network. The usage of mobile sink balances the energy consumption among the sensor nodes and reduces the hotspot creation in the network.

The decision of movement of the mobile sink is made based on the overall residual energy of wireless sensor nodes at any region in the WSN.

Every data packet sent to the CH contains a field to record the position information and residual energy of the nodes having maximum and minimum residual energy. The nodes which come in the path of can access these fields and can change its value if they qualify as node having least or maximum residual energy.

The sink upon receiving the packets from the network nodes reads then and comes to know about the location of the sensor nodes which have the maximum and minimum residual energy, The decision of the next destination of the mobile sink is based on this data received from some of the network's sensor nodes, The location of the node having maximum residual energy is chosen as the next location for the destination of mobile sink.

IV. SIMULATION RESULT

The simulation of the proposed algorithm has been done using MATLAB 2013b. The simulation result is compared with that obtained with the MSIEEP protocol (Mobile Sink Based Adaptive Immune Energy Efficient Clustering Protocol).

In the simulation 200 number of nodes have been taken which have been randomly distributed in a 200X200 square area field. The initial energy of sensor nodes has been taken as 0.2J. Assumption is made that each sensor node sends one data packet per round to the sink node.

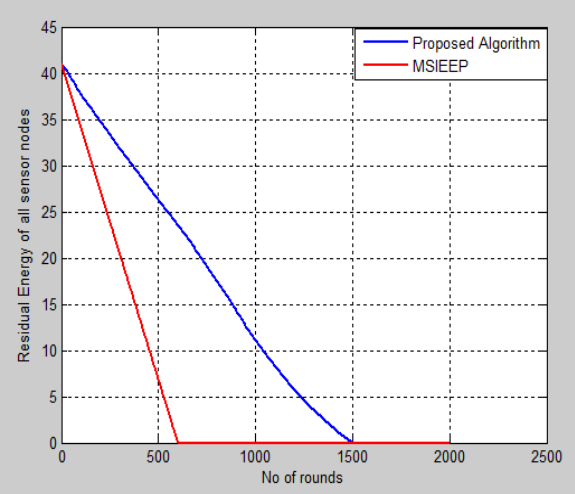

Figure 1 Residual energy contained in the network against number of rounds

Table 1: comparison data for stability period

Performance measure	MSIEEP	Proposed Algorithm	% age improvement in stability period
Number Of Rounds	584	665	13.87%

The simulation results are shown in the Figure 1. It shows the residual energy of the network with respect to number of rounds of packet transmission. After the performance of simulation as per proposed algorithm, mentioned in section III. The comparison data of the MSIEEP protocol and proposed algorithm is listed in the table 1. From the obtained results we can seen that the proposed algorithm improves the stability period by 81 rounds as compared to MSIEEP protocol. .

V. CONCLUSION

In this paper we proposed a algorithm which uses the APTEEN hybridization with mobile sink. We performed simulation with the help of MATLAB and the result data was analyzed. The result obtained from the proposed algorithm shows that it performs better than MSIEEP protocol and the residual energy contained in the network is more at every round as compared to that in MSIEEP protocol based network. Thus the network remains live for more number of rounds. In other words it improves the stability period by 13.87%.

VI. FUTURE WORK

The overall energy contained in the network is indication of stability of the network and it also shows how long the network can survive with a set rate of data transmission. A combination of APTEEN and mobile sink model of WSN has been used in this paper to increase the network's contained energy. Future work can be carried out for scheduling the mobile sink path in more efficient way using other algorithm with mobile sink for increasing the network's contained energy.

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