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Implementation of DEEC Protocol Using Optimization Technique in Wireless Sensor Technology

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Abstract:-Wireless sensor networks are employed in several applications like military, medical, household and environmental. In these applications energy factor is the determining factor in the performance of wireless sensor networks. In wireless sensor network, clustering is used as an effective technique to achieve scalability, self-organization, power saving, channel access, routing etc. Lifetime of sensor nodes determines the lifetime of the network and is crucial for the sensing capability. Clustering is the key technique used to extend the lifetime of a sensor network and also reduce energy consumption etc,. Energy-efficient clustering protocols should be designed for the characteristic of heterogeneous wireless sensor networks[1].

DEEC which is named as distributed energy efficient clustering protocol is selected as clustering protocol[1]. In DEEC, 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. Since in DEEC, the lifetime of sensors as well as network degrades very quickly. Hence in order to increase the network lifetime a new algorithm is proposed. This technique balances the cluster by using some backup nodes. The backup high energy and high processing power nodes replace the cluster head after the cluster reaches to its threshold limit. This approach will increase the network lifetime and will provide high throughput.

***Key words**: - DEEC, WSN, CH, CM*

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I. Introduction

Recent technological advances in hardware have enabled the deployment of tiny, low-power sensors with limited on-board signal processing and wireless communication capacities. Wireless sensor networks (WSN) become increasingly useful in variety critical applications, such as environmental monitoring, smart offices, battlefield surveillance, and transportation traffic monitoring. In order to achieve high quality and fault-tolerant capability, a sensor network can be composed of hundreds or thousands of unattended sensor nodes, which are often randomly deployed inside the interested area or very close to it. Since WSN is usually exposed to atrocious and dynamic environments, it is possible for the loss of connectivity of individual nodes. Conventional centralized algorithms need to operate with global knowledge of the whole network, and an error in transmission or a failure of a critical node will potentially cause a serious protocol failure. On the contrary, distributed algorithms are only executed locally within partial nodes, thus can prevent the failure caused by a single node. It is realized that localized algorithms are more scalable and robust than centralized algorithms [2]. As each sensor node is tightly power-constrained and one-off, the lifetime of WSN is limited. In order to prolong the network lifetime, energy-efficient protocols should be designed for the characteristic of WSN. 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 use to perform data aggregation, 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 [3]. 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. Cluster-heads will help to broadcast messages and collect interested data within their own clusters.

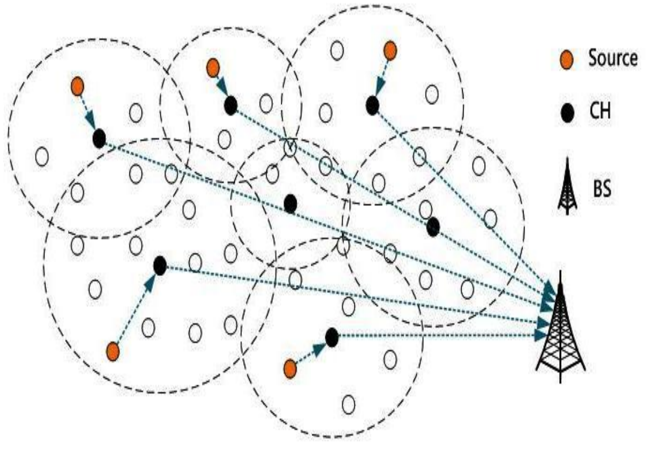

Figure 1 Wireless Sensor Network

II. Literature survey

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. It could be the result of reenergizing the sensor networks in order to extend the network lifetime. The new nodes added to the networks will own more energy than the old ones. Even though the nodes are equipped with the same energy at the beginning, the networks cannot evolve equably for each node in expending energy, due to the radio communication characteristics, random events such as short-term link failures or morphological characteristics of the field. Therefore, WSN are more possibly heterogeneous networks than homogeneous ones. The protocols should be fit for the characteristic of heterogeneous wireless sensor networks. Currently, most of the clustering algorithms, such as LEACH, PEGASIS, and HEED, all assume the sensor networks are homogeneous networks[4]. These algorithms perform poorly in heterogeneous environments. The low-energy nodes will die more quickly than the high-energy ones, because these clustering algorithms are unable to treat each node discriminatorily in term of the energy discrepancy. In, SEP scheme is proposed for the two-level heterogeneous wireless sensor networks, which is composed of two types of nodes according to the initial energy. The advance nodes are equipped with more energy than the normal nodes at the beginning. SEP prolongs the stability period, which is defined as the time interval before the death of the first node[5]. However, it is not fit for the widely used multi-level heterogeneous wireless sensor networks, which include more than two types of nodes. In this paper, we propose and evaluate a new distributed energy-efficient clustering scheme for heterogeneous wireless sensor networks, which is called DEEC. Following the thoughts of LEACH, DEEC lets each node expend energy uniformly by rotating the cluster-head role among all nodes[6][7][8]. In DEEC, 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. The round number of the rotating epoch for each node is different according to its initial and residual energy, i.e., DEEC adapt the rotating epoch of each node to its energy. The nodes with high initial and residual energy will have more chances to be the cluster-heads than the low-energy nodes. Thus DEEC can prolong the network lifetime, especially the stability period, by heterogeneous-aware clustering algorithm. Simulations show that DEEC achieves longer network lifetime and more effective messages than other classical clustering algorithms in two-level heterogeneous environments. Moreover, DEEC is also fit for the multilevel heterogeneous networks and performs well, while SEP only operates under the two-level heterogeneous networks.

III. Distributed Energy Efficient Clustering Protocol

DEEC is one among those protocols. DEEC is called as distributive energy efficient clustering protocol. DEEC uses the initial and residual energy level of the nodes to select the cluster-heads. Cluster-heads are elected by a probability based on the ratio between residual energy of each node and the average energy of the network. The epochs of being cluster-heads for nodes are different according to their initial and residual energy. Nodes with high initial and residual energy will have more chances to be the cluster-heads than the nodes with low energy. DEEC achieves longer lifetime and more effective messages than current important clustering protocols in heterogeneous environments[4].

There are two phases in DEEC protocol:

i) Setup phase
ii) Steady phase.

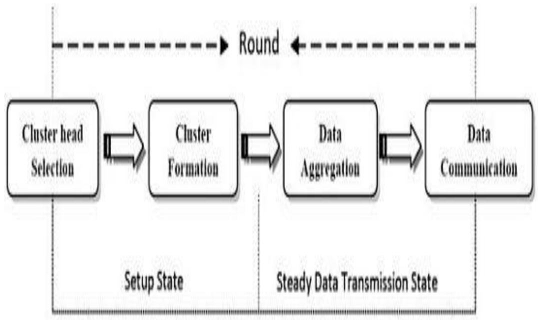

Figure 2 Steps involved in DEEC protocol

In the setup phase the clusters are formed and the cluster-heads are selected. In the steady-state phase, the data from non-cluster heads are transmitted to the sink. The sensor nodes communicate to the cluster-heads using TDMA schedule. The nodes communicate to the cluster-head only in their allotted slots. It avoids collision. The cluster-heads are selected randomly for every round. Each round starts with the setup phase when the clusters are organized followed by steady phase.

In order to avoid the problem, that each node needs to know the global knowledge of the networks, DEEC estimates the ideal value of network life-time, which is used to compute the reference energy that each node should expend during a round[4]..

DEEC is designed to cope with nodes of heterogeneous WSNs. For CH selection, DEEC uses initial and residual vitality of nodes. Let ni denote how many rounds to be a CH for node si. PoptN is the optimum quantity of CHs in our network during each round. CH selection criteria in DEEC are based on vitality of nodes. As in homogenous network, when nodes have same amount of energy during each epoch then choosing pi = popt assures that $p_{opt}N$ CHs during each round. In WSNs, nodes with high energy are more probable to become CH than nodes with low energy but the net value of CHs during each round is add up to $p_{opt}N$. Pi is the probability for every node si to become CH, so, node with high energy has larger value of pi as set alongside the popt) denote s average energy of network during round. In DEEC, the election of cluster-heads is performed by way of a probability based on the ratio between residual energy of every node and the average energy of the network[4]. The DEEC protocol is more efficient in terms of energy and other parameters compared to the EELEACH scheme. The epochs to be cluster-heads for nodes are different according with their initial and residual energy. The nodes with maximum initial and residual energy can have greater chances to be the cluster-heads compared to nodes with minimum energy. To avoid that each and every node needs to know the global familiarity with the networks, DEEC estimates the ideal value of network life-time, which can be used to compute the reference energy that each and every node should expend during a round[4]. It consists two phases

1. An energy aware passive clustering approach that reduces clustering overheads and assures uniform energy distribution.
2. A node association approach based on residual energy and communication cost of a CH.

The proposed work makes the following assumptions before designing the energy efficient protocol.

- Topology is static
- All nodes are aware of their location
- All the cluster members can reach CH in one hop
- CH can reach the base station in one hop or multiple hops

Proposed DEEC:-In order improve the performance of DEEC protocol , Clustering can be used for balancing the load in the wireless sensor networks. In a cluster based technique, the maximum transmission power of the nodes is used to become the cluster member. Cluster membership depends on the communication cost. The proposed approach does not consider the backup recovery. This technique uses comprehensive weight value composed of distance between the head and the member and the residual energy to improve cluster member choice. It also uses optimization threshold value to avoid load imbalance. The algorithm considers load equalization for creating balanced cluster. A multi-hop clustering algorithm for load balancing in wireless sensor networks, uses layered approach for intra cluster and inter cluster communication. The algorithm consider homogeneous network. Reconfiguration of cluster head for load balancing in wireless sensor networks, increases the network lifetime by fairly distributing the cluster heads. Reconfiguration of the cluster is done based of the number of general nodes in the cluster & the number of cluster heads within the cluster head's transmission range. The algorithm provides effective data aggregation.

Algorithm:-The proposed approach assumes heterogeneous network with the sensor nodes having different energy levels and processing power. Some high computing nodes are deployed nearby each other. All the nodes with high initial energy level and processing power are selected. Some nodes from the set are selected as cluster head (CH) according to their location [4]. Each CH defines its communication range in terms of power level to form cluster. Some nodes with comparable energy and processing power in the CH range are asked to go to sleep and information about those nodes is maintained with the CH. Each CH sends a hello request message to all the nodes within its communication range to become the cluster member. This process will be repeated for all the CH. All the cluster members will send the sensed data to the CH. The CH will send the aggregated data to the Base Station directly or by using some intermediate CH. When the energy level of the CH will reach to the threshold value TL, the CH will activate one of the sleeping nodes and will make it CH. This information about the new CH will be sent to the entire cluster member and other CH also. The old CH will become the general sensor node.

The algorithm is divided into four phases

1. Initialization Phase

1.1 Select the CH according to the capabilities of the nodes.
1.2 Select the desired number of CH according to their location.
1.3 Define the range of CH.
1.4 CH sends membership request message to all the nodes in its range and request to reply with their current energy status.
1.5 The nodes with high residual energy and processing power will be identified and they are made to sleep. They become the backup nodes.
1.6 The nodes which are not in the range of cluster head, will try to join the cluster by sending the message to the nearest cluster member.

2. Steady State Phase

2.1 The cluster members sends the sensed data to the CH in the allotted time using TDMA schedule.
2.2 The non-cluster members will send the sensed data to the cluster head through the intermediate cluster member.

3. Final Phase

3.1 CH will aggregate the data from all the nodes in its cluster.
3.2 CH will transmit the data to the base station.

4. Cluster Reconfiguration Phase

4.1 If the CH residual energy reaches to the threshold value, the CH will activate the backup node.

4.2 The CH will relegate its responsibility to the backup node and will make the node the cluster head.

4.3 The CH will transmit the new CH information to all other nodes in the cluster.

4.4 The CH will transmit the new CH information to all other CH also.

4.5 The old CH will become the general node.

Results:-

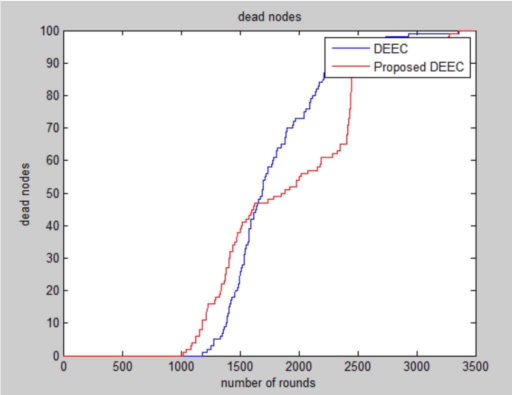

Fig 3:- dead nodes comparison in DEEC & L-DEEC

The lifetime of the proposed DEEC is very
High than DEEC from the figures 3 and 4

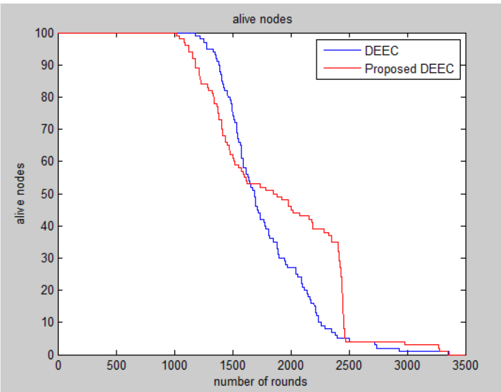

Fig 4:- alive nodes comparison in DEEC &Proposed –DEEC

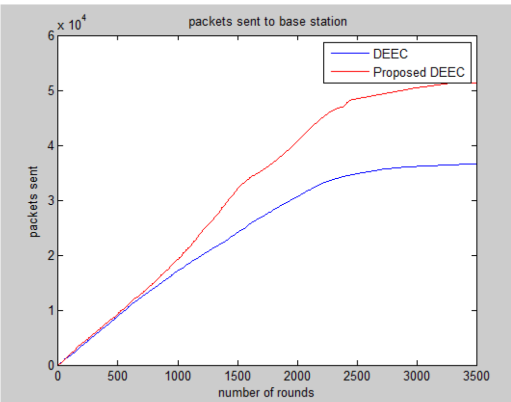

Fig 5:- Packets sent comparison in DEEC & Proposed -DEEC

Communication to base station is very
High compared to DEEC protocol as seen in fig 5 .

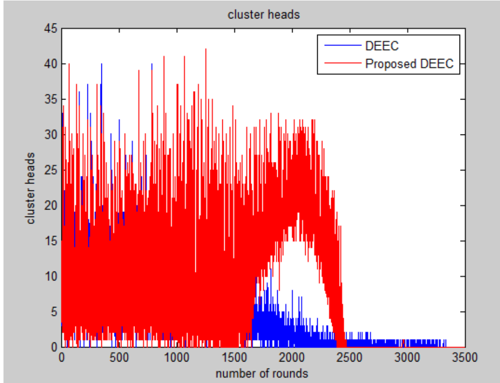

Fig 6:- Cluster head formation in DEEC & Proposed -DEEC

Probability of cluster head formation is large even after 1600 rounds as seen in fig 6.

IV. CONCLUSION

V. In WSNs sensor nodes react immediately to sudden and drastic changes in the value of a sensed attribute due to the occurrence of a certain event. The performance of the DEEC protocol is compared with the proposed DEEC approach with respect to the number of rounds and the dead nodes using the parameter like energy dissipation in each round per node. The result of simulations conducted indicates that the proposed approach is more energy efficient and scalable and hence effective in prolonging the network life time compared to other based algorithms. Hence from the simulation results the performance of the proposed DEEC scheme is effective in terms of energy consumption compared to other protocols.

In future, work has been planned to extend for parameters and scenarios like coverage, fault tolerance and mobility of nodes.

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