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Quadrature Distributed Energy Efficient Clustering Technique for Energy Conservation in Wireless Sensor Network

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ABSTRACT:- *Now days with progression in the electronics field, small battery powered sensor nodes have started to make an impact on the communication with the physical world. These battery-powered devices can be deployed in a wide geographical area to monitor physical conditions. Wireless sensor networks are battery constrained. Due to limited power-supply in inaccessible areas, main research is in designing network in power saving way. Presently, there are various energy efficient communication models and protocols that are designed for specific applications. QDEEC is routing protocol proposed for heterogeneous networks. Pre-Deployment of network proposed in QDEEC perform better coverage of area and obtain global knowledge continuously. QDEEC enhance network lifetime, efficiency, reliability. The work has been compared with existing protocols LEACH, SEP and DEEC and results shows that QDEEC is 36.15% better than LEACH, 25.82% than SEP and 15.67% than DEEC in terms of network lifetime.*

Keywords**:** *WSNs, Heterogeneous, Efficiency, Network lifetime, Routing*

I. INTRODUCTION AND BACKGROUND

Out of certain Ad-hoc protocols, Wireless Sensor Networks become more attractive in recent years. Self-organization is one of the important characteristics of wireless sensor networks. WSNs have become increasingly useful in monitoring the environment, smart offices and transportation traffic, temperature, humidity, vibrations, seismic events and so on. WSNs used in many applications such as in medicine and healthcare, military and agriculture because of their low cost. WSN operate in those environments where it is impossible for human to reach and gather the required information. Sensors in WSN broadcast sensed data to multiple sensor nodes. In the dense sensor deployment, the constraints of sensors cause intense problems such as redundancy, scalability, and radio channel contention. To recharge the battery is very difficult task because sensor nodes are placed in the area where human cannot reach like forests.

Sensor node is a micro electronic device that comprises three basic components: a sensing system for data acquisition from the physical surrounding, a processing subsystem for local data processing and storage, and a wireless communication subsystem for data transmission. Sensor node have restricted battery power, which limit the lifetime of WSNs. Sensor node transmits sensed data to Base Station (BS) but it needs high energy consumption of each node and sensor nodes die frequently and there is need arise to recharge the battery which is difficult, because nodes may be deployed in a hostile or unpractical environment. So network must be designed in a way that energy consumption must be low [1]. Improving the routing of WSN can improve the power consumption. In hierarchical routing [2], sensor nodes are grouped into clusters. Each cluster is assigned with a leader, which is also called the cluster head (CH) and usually performs the unique tasks like data aggregation, processing and transmitting data to base station through radio communications. Every node belonging to cluster (cluster means group of nodes) transmits their data to Cluster Head, where, Cluster Head performs the data aggregation and transmit their aggregated data to base station. The CHs compress the data before sending it to the BS [4]. It has been shown that clustering is an efficient and scalable way to organize WSNs [2].

The clustering is a two-level hierarchical process where the CH nodes make the higher level and the member nodes make the lower level. The sensor nodes at regular intervals(rounds) send their data to the corresponding CH nodes(called epoch). Sensor nodes sense data and send to CH, where CH node act as leader node and aggregate the data and then transmit to the base station (BS) directly or through the midway communication with other CH nodes. Due to the CH nodes transmit all the time data to large distances than the member nodes; they obviously spend energy at large rates. A general explanation in order to balance the energy consumption amongst all the sensor nodes is to regularly re-elect new CHs in each cluster. It doesn't require any infrastructure for communication and these are self-organizing networks.

Types of Wireless Sensor Network

According the properties of sensor nodes deployed in the wireless sensor network, WSN can be of two types [2]:

I. **Homogeneous**: When all the sensor nodes are identical in terms of battery energy, processing, storage and hardware complexity network is called homogeneous network.

II. **Heterogeneous**: When network have two or more nodes with different energy and functionality then network is called heterogeneous network.

Heterogeneous networks are close to real time applications. These networks have different topologies which make them a very complex in nature. The routing protocol selected for network must exploit their heterogeneity on the WSN so that protocol can match with real time application areas.

Hierarchical Routing Protocols [2][3]:

Literature shows that instead of implementing direct transmission or multi-hop routing, clustering can significantly improve the total energy dissipation and lifetime of a WSN. Network on which routing is performed can be homogeneous or heterogeneous. Clustering algorithms applied on homogeneous networks are like the Low-Energy Adaptive Clustering Hierarchy (LEACH)[4], Power-Efficient Gathering in Sensor Information Systems (PEGASIS)[6] and various variants of LEACH are also proposed be researchers [9]. But under the conditions of network heterogeneity this protocol will not be efficient and gives poor performance. Secondly, the clustering algorithms applied in heterogeneous networks are like the Stable Election Protocol (SEP)[5], Distributed Energy Efficient Clustering (DEEC)[7] and variants of DEEC[8].

LEACH [4]is first clustering based routing protocol for WSNs. LEACH protocol can provide a significant amount of energy saving when compared to direct transmission or multi-hop routing. On the other hand, in LEACH, topology changes at every transmission round due to the randomized cluster formation structure. Forming new clusters and selecting new CHs for every round induce more energy consumption and bring extra network costs. The same problem is also observed in other LEACH based protocols. LEACH was initially invented for homogeneous network and while concept of heterogeneity come in research then same concept is applied for heterogeneity networks. where it is able to provide longer lifetime but not reliable. As protocol is not able to use nodes according to their properties and treat all the nodes same. Another clustering based protocol is Stable Election protocol (SEP).SEP is specially proposed for heterogeneous type of networks. This protocol is enhancement in LEACH protocol. But, according to LEACH each node have equal chance to be cluster head and high energy nodes are not properly utilized. SEP proposed a method that high energy nodes must be chosen more often as cluster head as compared to normal nodes. SEP protocol is proposed for reliable networks. This technique prolongs network life through increasing stability period(time till all the nodes in network are alive).

DEEC protocol is enhanced version of SEP. Cluster head selection is improved in order to save the network energy and make a reliable network. In SEP cluster head selection is proposed on the basis of initial energy of sensor nodes. But problem arise when network evolves as high energy nodes are punished to be cluster head always, so DEEC algorithm proposed that selection of cluster head must be based on residual energy of sensor nodes.

2. QUADRATURE DISTRIBUTED ENERGY EFFICIENT CLUSTERING(QDEEC)

The proposed QDEEC is enhancement of DEEC because it saves more energy as compared to DEEC. QDEEC is protocol proposed in extension to DEEC protocol According to this approach sensor node are deployed in the territory. In order to acquire better clustering we divide the network into four quadrants/Areas. Doing such sort of partitioning better coverage of the whole network is achieved and distance to transmit the data to base station decreases and the network lifetime increases. Additionally, exact distribution of nodes in field is also well defined.Network is partitioned into sub-sectors and hence, clusters formed within these sub-sectors are more deterministic in nature. Therefore, nodes are well distributed within cluster and this results in efficient energy drainage. Concept of randomized clustering as given in DEEC for optimized energy drainage is applied in each sector.

3. SIMULATION AND RESULTS

Simulations of the network is conducted using MATLAB (R2010a) and to get precise plots, confidence interval is taken. Simulations show that QDEEC performs better in terms of network lifetime and remaining energy of the network. QDEEC improves efficiency and performs best amongst all. In the results LEACH, SEP, DEEC and QDEEC are compared.
Network created have some assumptions like:

- The base station or the sink node is located at the fixed position at location (50,50).
- 100 sensor nodes are deployed randomly over the network.
- These sensor nodes and base station are placed in a fixed size of the network. The size of the network is 100×100.
- The size of the data packet is L= 4000 bits.
- Energy heterogeneity is used in the purposed protocols. m fraction of the sensor nodes has additional energy given to them. Initial energy of the nodes is given as 0.5 Joules where m=0.1 and fraction of additional energy, $\alpha = 3$

- These nodes sense the data continuously and send the sensed data to their cluster heads. After aggregation, cluster heads transfer the whole data to the base station.
- Initial Energy of normal nodes is Eo=0.5J and advanced nodes id $Eo(1+\alpha)$
- Optimal probability used is P_{opt} =0.1
- Energy used from transmission/reception of data is 50nJ/bit
- Energy used in free space is E_{fs} = 10pj/bit/m^2
- Energy used in multipath routing is E_{mp} = 0.0013pJ/bit/m^4
- Energy used for data aggregation E_{DA} =5nJ/bit

The performance of the network with QDEEC routing is measured with the performance metrics as Network lifetime: Number of alive nodes in the network and Number of dead nodes in the network with each round.

Number of Dead Sensor Nodes: For a reliable network, all the sensor nodes must remain alive as long as possible. QDEEC have proposed better deployment that helps in saving energy of sensor nodes as cluster heads are not at longer distance than a quadrature. Figure 6.1 shows that dead node of network with QDEEC, DEEC, LEACH and SEP protocol. Dead nodes are those which have consumed their total initial energy. Results show that QDEEC perform better than other protocols. As graph shows that when in QDEEC sensor nodes start dying later as compared to other protocols.

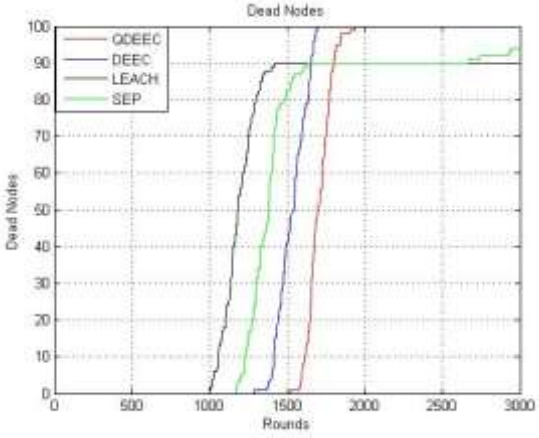

Fig. 1 No of Dead Nodes in Network

If all the nodes of network remain alive for long time, then network is considered reliable network. Graph shows that QDEEC scheme provide a reliable solution for the network.
Results in Table 1 shows the comparison in first dead node (stability period) of LEACH, SEP, DEEC and QDEEC. To check the variations in results are calculated with 5 simulations where the nodes are deployed in each simulation.
Combined results of simulations in Fig. 1 and Table 1 show that QDEEC provide more reliable network as compared to other protocols and Stability period of QDEEC is 36.15% better than LEACH, 25.82% than SEP and 15.67% than DEEC protocol.

Table 1: Comparison of Stability period (time till all the nodes are alive or when first node is dead in network) with 5 simulations (in terms of rounds) when m=0.1 and α=3

	LEACH	**SEP**	**DEEC**	**Q-DEEC**
Simulation 1	998	1089	1298	1538
Simulation 2	975	1183	1284	1524
Simulation 3	998	1173	1287	1592
Simulation 4	989	1141	1342	1524
Simulation 5	965	1136	1293	1537

4. CONCLUSION AND FUTURE WORK

This paper has evaluated and compares the well-known heterogeneous WSNs energy efficient protocols i.e. DEEC and LEACH.LEACH works in one epoch that is at a time only one CH is selected but in DEEC more than one CHs are formed at a

time. QDEEC is better than both LEACH and DEEC protocols because area is divided into quadrants and distance becomes less and energy dissipation is less as compared to DEEC and another protocols and network lifetime increases.

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