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IMPROVED Q-LEACH

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Abstract: Sensor nodes are exceedingly energy compelled gadgets since they are battery worked gadgets and because of brutal environment sending it is difficult to change or revive their battery. Energy protection and dragging out the system life are two noteworthy difficulties in a sensor system. Communication devours the substantial part of WSN energy. This paper researches the related works identified with a few conventions that have been proposed to acknowledge power-productive communication in a wireless sensor system. We likewise talked about the issues in view of directing in a wireless sensor network challenges when contrasted with the conventional systems because of sensors smaller memory, less handling control and obliged energy supply. It has been shown that in the previous couple of years numerous new routing protocols have been contrived for wireless sensor Network. LEACH is suitable for small size networks because it assumes that all sensor nodes are capable of communicating with each other and are able to reach sink, which is not always true for large size network. Hence, coverage is a problem which we attempt to resolve. The main focus in WSNs is to increase network life-time as much as possible, so that resources can be utilized efficiently and optimally. Different approaches based on clustering are presented for optimum functioning. Life-time of the network is always related with energy of sensor nodes implanted at remote areas for constant and fault tolerant observation.

Key words-Coverage, network lifetime, Q-LEACH, flexible cluster head selection.

I. INTRODUCTION

Advancements in technologies related to micro-electro-mechanical systems (MEMS) technology, wireless communications, and digital electronics in recent times have yielded in development of low-cost, low-power; multifunctional sensor nodes that have small size and communicate over short ranges. [5] These tiny sensor nodes have capability of sensing physical parameters, processing the data gathered and communicating over network to monitoring station either through other nodes or directly. [4]

A sensor network is made up of a large number of sensor nodes that are densely deployed in application specific domain. The position of sensor nodes is not required to be pre-determined. This allows random deployment in inaccessible terrains or during relief operations in disaster prone areas. On the other hand, this also means that sensor network protocols and self-organizing capabilities must be possessed by the algorithms. One more special characteristic of sensor networks is the cooperative working of sensor nodes. Sensor nodes are attached with an on-board processor. Instead of transmitting the raw data to the nodes responsible for the aggregation, sensor nodes utilize their processing abilities to locally carry out simple computations and send only the required and partially processed data. WSNs are utilized for the mixed bag of purposes like military reconnaissance, living space observing, woodland fire discoveries, and avalanche location.

LEACH (Low Energy Adaptive Clustering Hierarchy) protocol is appropriate for networks of small size because it works over assumption that all nodes can communicate with each other and are capable of reaching the base station. This is not always correct for large size network. Hence, coverage is a problem which we attempt to resolve. The utmost focus in WSNs is to extend the network's life-time as much as possible so that resources can be utilized efficiently and optimally. Different approaches based on clustering are proposed for optimum functionality. Network life-time is always related with energy of sensor nodes that are implanted at distant areas for constant and fault tolerant monitoring. [3, 11]

II. RELATED WORK

The protocol Assisted LEACH (A-LEACH) achieves lessened and uniform distribution of dissipated energy by separating the tasks of data aggregation and routing. It introduces the concept of helper nodes which assists cluster heads for multi-hop routing. To facilitate energy efficient multi-hop route setup for helper nodes to reach base station a new algorithm has been formulated. The proposed protocol yields extension in the lifetime of the network, reduces overall energy dissipation in the network. Their theoretical analysis has shown that network lifetime reduces when both the tasks i.e. data aggregation and routing are performed by Cluster Heads alone. This burden on CH can be eliminated by usage of Helper Nodes for routing and Cluster Heads for Data Aggregation. The overhead for route formulation to base station is reduced by electing next hop at each Helper Node using the beckon signal's Received Signal Strength values from base station. This beckon signal is already available at helper nodes during Helper Node Selection phase. Our concept of Helper Nodes in Assisted LEACH (A-LEACH) protocol has enhanced the lifetime of the network by distributing the reduced energy dissipation throughout the nodes. This is substantiated by simulation results. [1]

Another approach was proposed to make an attempt to overcome the assumption of LEACH, which supposes that any node in the network can transmit their directly to the sink, and this is not possible especially in networks deployed in large areas. LEATCH is a (Low Energy Adaptive Tier Clustering Hierarchy) tier clustering hierarchy that manipulates two hops inter-cluster communication. This

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work presents a two level hierarchical approach. The first level is selection of Super Cluster Head (SCH) which is similar to the process of cluster head selection in LEACH. The second level corresponds to construction of mini cluster by selecting some mini cluster head (MCH) in super cluster. This significantly reduces the energy burden of cluster heads to transmit data to sink nodes that are at longer distances. [7]

LEACH protocol suffers from the problems of fast death of nodes as well as the short duration of the network lifetime. In the work presented by this paper, an improvement is added to the original LEACH protocol by using the SPIN protocol idea. That result a new protocol called S-LEACH. The SPIN protocol in which the nodes transmit metadata (which is very minute in size) to the resource manager whose task is similar to CH. If the information in the metadata is not similar to the data packets that belong to other nodes, the resource manager asks the node to transmit full packet; otherwise there is no requirement of that packet. All nodes transmit metadata to the CH, and CH is determined neighbouring nodes. The neighbouring nodes send the same data thus no need for more than one node to transmit the same data packet. The neighbouring nodes are forced to be in sleep mode until the death of the first node. By incorporating the idea of SPIN in LEACH good results are obtained. There is noticeable increase in the number of rounds, delay in the first node's death and network lifetime is prolonged. [6]

This protocol presented a new version of LEACH in which a Vice cluster head is introduced. In the conventional LEACH, the CH is always on gathering data from cluster members, aggregate these data and then transmit it to the BS that might be located at larger distance from it. Because of its additional operations of receiving, transmitting and over-hearing the CH will die earlier than the other nodes. When the CH die, the cluster will become useless because the data transmitted by cluster nodes will never reach the base station. In V-LEACH protocol, other than a CH in the cluster, there is also a vice-CH that takes the role of the CH immediately when the current CH dies. This significantly enhances the overall network life time since no need to elect a new CH each time the CH dies. But in case of Vice Cluster Head Dies the network dies completely. This problem is resolved in an improved version, i.e., when the cluster head dies, its responsibilities are taken by Vice Cluster Head and another Vice Cluster Head will be chosen at the same time. The proposed system will increase the network life and total transmission within the network. [8]

However, the basic idea of our research comes from work proposed in Q-LEACH. In this work, it is considered that sensor networks are deployed for long term monitoring of fields and are desired to continue working without any fluctuations. Also, it is also desired to obtain global knowledge without break i.e., better coverage of area should be obtained. Here, Quadrature-LEACH (Q-LEACH) for homogenous networks is proposed. In order to acquire better clustering, the network is partitioned into four quadrants. Doing such sort of partitioning better coverage of the whole network is achieved. Partitioning of network into quadrants result in efficient energy consumption of sensor nodes. Because of this division, optimum positions of CHs are defined. Moreover, transmission load on other transmitting member nodes is also decreased. In typical LEACH, cluster are arbitrary in size and several cluster members are located far away from their respective CH. Due to this dynamic cluster creation the nodes that are far away from the BS suffers high energy drainage and thus, network performance decreases. Whereas, in Q-LEACH network is partitioned into four quadrants and hence, clusters created within these quadrants are more deterministic in nature. Therefore, nodes are evenly distributed in a specific cluster i.e. uniform cluster sizes and results in efficient energy drainage. Q-LEACH significantly improved network parameters such as stability period, network life-time and throughput [2].

III. METHODOLOGY

According to this approach it is considered that sensor nodes are deployed in areas. In order to achieve better clustering the network is partitioned into four quadrants. Doing such kind of partitions result in better coverage of the whole network. In addition to this, distribution of nodes in field is also well defined. Fig. 3.3 describes an optimal method of load assignment among sensor nodes. It also presents an idea of efficient clustering mechanism which results in better coverage of whole network. Here, nodes are randomly deployed in a 100m×100m filed. Depending upon location information, network is partitioned into four equal parts i.e., (cluster 1, cluster 2, cluster 3, and cluster 4). Overall network area is defined as below:

$$A=cluster1+cluster2+cluster3+cluster4 \quad (1)$$

$$cluster_n = cluster(x_m, y_m) \quad (2)$$

Where, n = 4 and m = 100. Hence, overall field is distributed as follows:

$$\lim_{\substack{Ym=0:50 \\ Xm=0:50}} an + \lim_{\substack{Ym=0:50 \\ Xm=51:100}} an + \lim_{\substack{Ym=51:100 \\ Xm=0:50}} an + \lim_{\substack{Ym=51:100 \\ Xm=51:100}} an \quad (3)$$

Where, a=cluster.

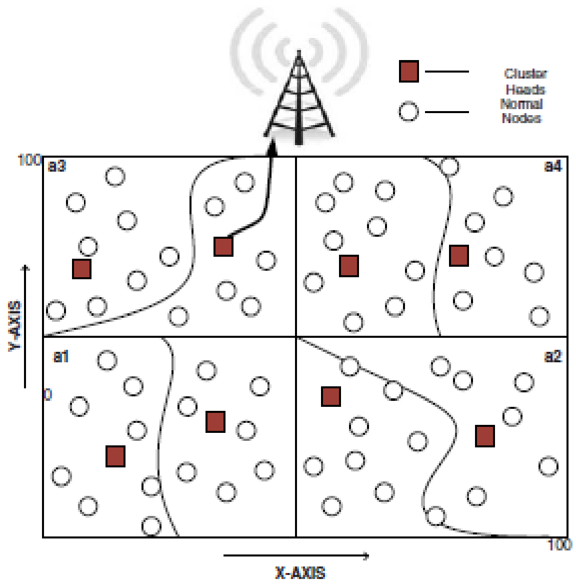

Fig. 1. Network Topology.

Partitioning of network into quadrants result in efficient energy consumption of sensor nodes. Because of this division, optimum positions of CHs are defined. In addition to this, transmission load on other transmitting member nodes is also decreased. In typical LEACH, cluster are arbitrary in size and several cluster members are located far away from their respective CH. Due to this dynamic cluster creation the nodes that are far away from the BS suffers high energy drainage and thus, network performance decreases. Whereas, in Q-LEACH network is partitioned into four quadrants and hence, clusters created within these quadrants are more deterministic in nature. Therefore, nodes are evenly distributed in a specific cluster i.e. uniform cluster sizes and results in efficient energy drainage.

However, partitioning of area into quadrants does not ensure optimum number of cluster heads in each quadrant. Because of random distribution of nodes, large number of cluster head may selected in proportion to the nodes. Optimum number of cluster head is important because the CH performs extra task and drains faster. Selection of larger number of CH effects lifetime of the network. This paper proposes an algorithm to overcome this problem.

A. Algorithm

Step 1: Distribute nodes randomly in the defined area.
Step 2: Perform partitioning of area into four quadrants according to their location.
Step 3: Select cluster heads depending upon probability p and limit the number of cluster heads according to an optimum fraction. This will result in formation of cluster heads according to the presence of randomly distributed nodes in each quadrant.
Step 4: Clusters are formed according to CH's received signal strength.
Step 5: Nodes send their data to CHs, CHs forward this data to BS.

B. System parameters

TABLE I. SYSTEM PARAMETERS

Area(M)	100*100 meters
Location of Base Station	(50,110)
Number of Nodes(N)	100
Cluster Head Probability(p)	0.05
E(elec)	50 nJ/bit
E(amp)	100pJ/bit/m^2
Packet Size(K)	2000
Initial Energy	0.5J
Limit for maximum number of CH(k)	4

C. Flowchart

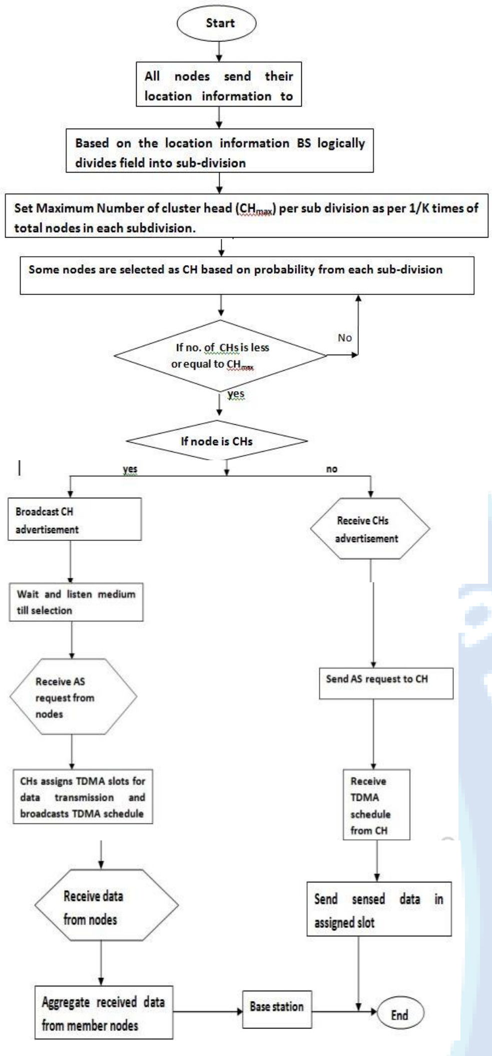

Fig. 2: Working Principle of Improved Q-LEACH.

IV. RESULT AND DISCUSSION

We have discussed a WSN energy saving approach for the developed Q-LEACH model with flexible number of cluster heads in each quadrant. The WSN considered here is assumed to be scattered in an area of 100x100 m^2 field with 100 nodes randomly distributed in this area as shown in fig 3.

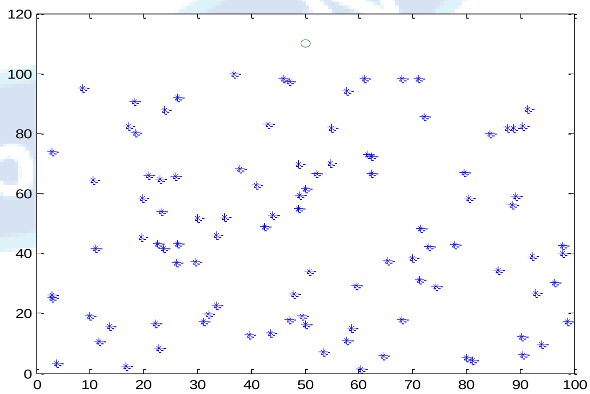

Fig. 3: WSN network with 100x100 m^2 area with randomly distributed 100 nodes.

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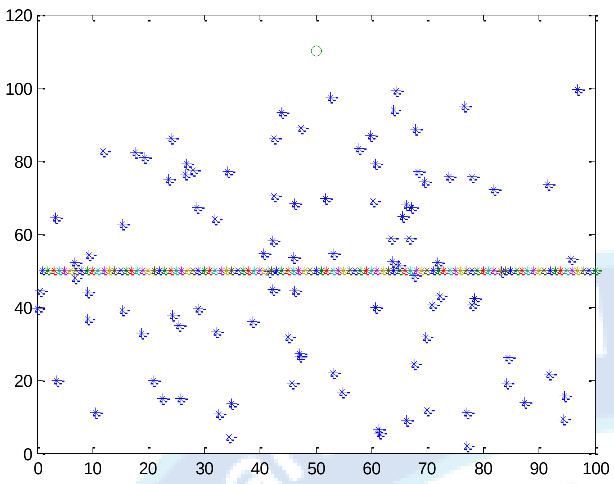

Fig. 4. Partition the area in upper and lower half.

In fig 3 the base station is located in the position x=50, y=110 in the middle top of the area and shown as 'o' circle and sensor nodes are shown as blue '*' asterisk markers. We have considered a strategy named as Improved Q-LEACH. We have developed MATLAB programming based WSN network characteristics and working development of proposed scheme for efficient performance. This paper presents key concept of proposed algorithm layout and results for WSN network model. In order to extent of some features such as clustering process, stability period and network life-time for optimized performance of WSNs we present this model. According to this approach sensor nodes are deployed in the territory. In order to acquire better clustering the partition of the network is done into four quadrants. Doing such sort of partitioning better coverage of the whole network is acquired. In addition, it also defines the exact distribution of nodes in field.

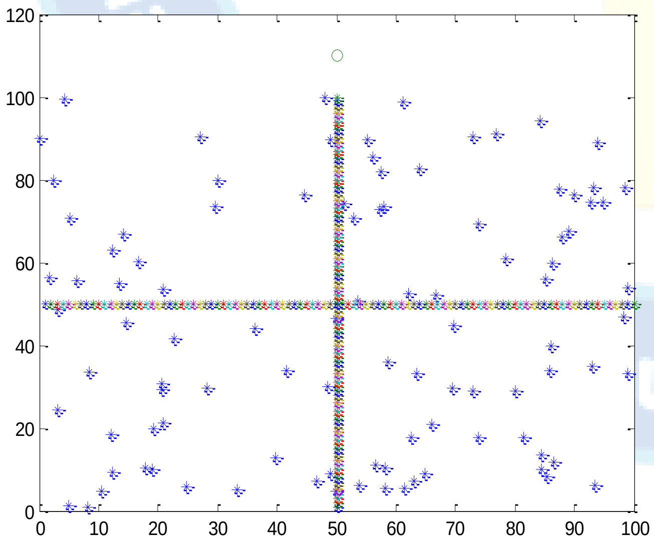

Fig. 5. Partition the area in right and left half.

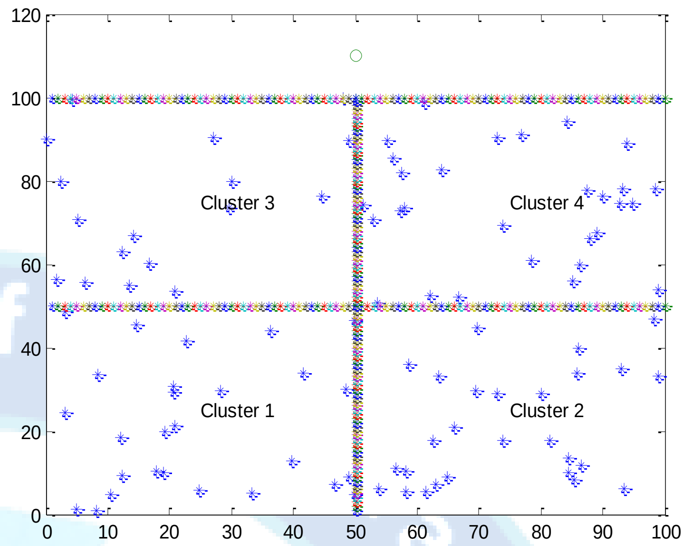

Fig. 6. All the quadrants label definition for developed WSN.

The algorithm is run for several times at different allowable of CH limit in each cluster the nodes which has residual energy less than zero are considered as dead nodes and remaining nodes are considered as alive in each round the number of alive and dead nodes is updated and plotted in fig 5 and 7.

Fig 8 and 9 shows that the proposed flexible cluster head population per cluster is capable of giving higher life time than conventional Q-LEACH approach. We get higher life time, stability period and more packets sending to the base station by the implemented algorithm of proposed scheme as shown in figure 9 to 12 for representing alive nodes, dead nodes, packets send to CH and packets send to base station with respect to no. of rounds.

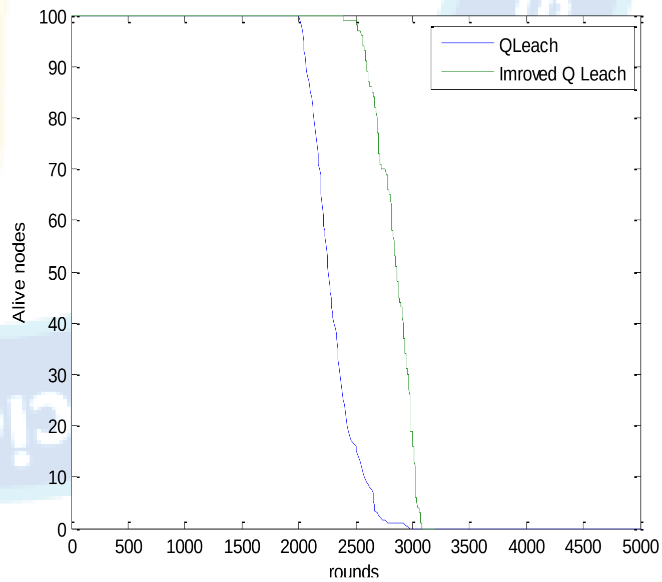

Fig. 7. Alive nodes by proposed (green) and previous Q-LEACH (blue) approach.

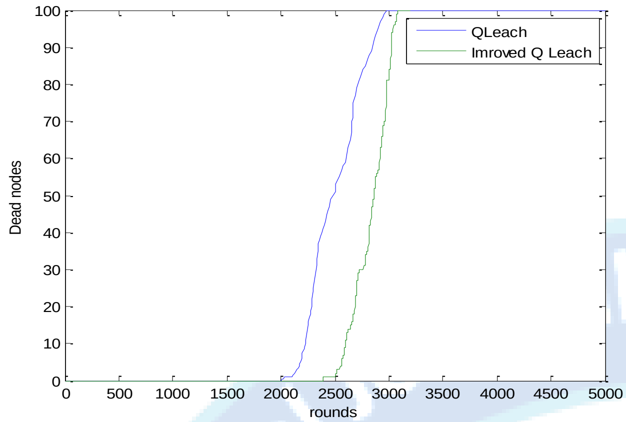

Fig. 8. Dead nodes by proposed (green) and previous Q-LEACH (blue) approach.

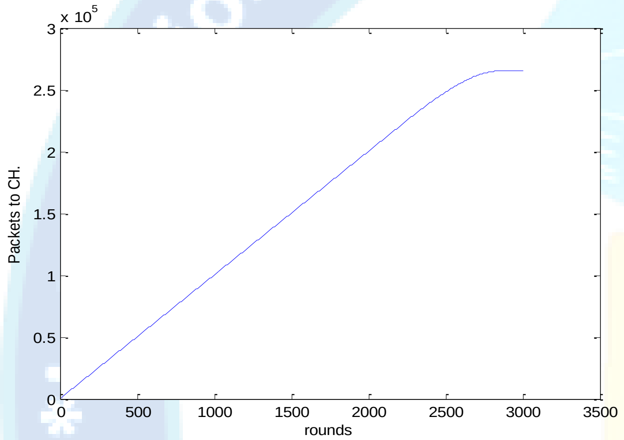

Fig. 9. Packets send to CH by sensor nodes by proposed (green) and previous Q-LEACH (blue) approach.

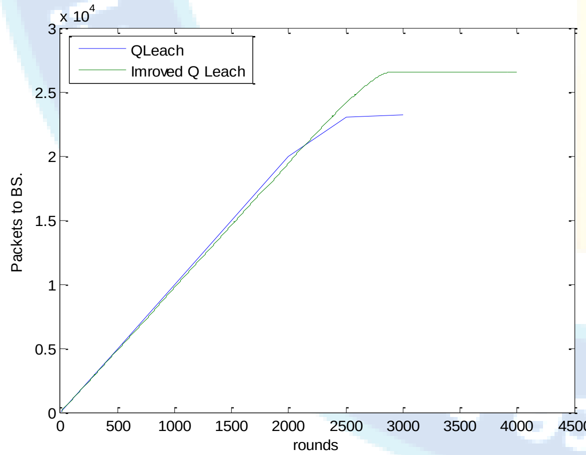

Fig. 10. Packets send to BS by CH nodes by proposed (green) and previous Q-LEACH (blue) approach.

TABLE II. COMPARISON TABLE BETWEEN Q-LEACH AND IMPROVE Q-LEACH

	Q-LEACH	Improved Q-LEACH
Stability Period	2000	2390
Network Life Time	2900	3085
Throughput	23296	24900

V. CONCLUSION

We developed our proposed strategy named as Improved Q-LEACH. According to this approach sensor nodes are implanted in the region. For achieving better clustering we partition the network into four areas or quadrants. Doing such type of partitioning causes better coverage of the entire network is achieved. It describes optimal approach of uniform load assignment among sensor nodes. Moreover, it also proposes an idea of efficient clustering mechanism which results in better coverage of entire network. In our improved Q-LEACH WSN the partitioning is in sub-sectors and clusters formed within the quadrants with more deterministic way. Load balancing in between WSN node is the key importance hence it strictly improves stability period and network life-time.

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