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EE-LEACH ALGORITHM USING WIRELESS SENSOR NODE LOCALIZATION

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Abstract: Wireless sensor networks are employed in several applications, including military, Submarine, medical, environmental and household. In all these applications, energy usage is the determining factor in the performance of wireless sensor networks. Consequently, methods of data routing and transferring to the base station are very important because the sensor nodes run on battery power and the energy available for sensors is limited. One of the nodes should be selected as head to receive all members' data and to transmit. Residue energy is calculated for electing head. To ensure this process, node localization algorithms like multiple algorithms are introduced like LEACH (Low Energy Adaptive Clustering Hierarchy) EELEACH, (Energy Efficient Low Energy Adaptive Clustering Hierarchy).

Index Terms – Wireless Sensor Network, LEACH Algorithm, EELEACH Algorithm

INTRODUCTION

Wireless sensor networks are composed of small sensor nodes, computation, and wireless communication capabilities. Many routing protocols have now been specifically made for WSNs where energy responsiveness is a significant strategy concern. Wireless sensor network (WSN) consists of hundreds and even thousands of small tiny devices called sensor nodes distributed autonomously to monitor physical or environmental conditions, such as temperature, sound, vibration, pressure and motion at different locations.

Energy plays an important role in wireless sensor networks because nodes are battery operated. Consequently, many protocols have been proposed in order to minimize the energy consumption of these nodes. Each node in a sensor network is typically equipped with one or more sensors, a radio transceiver or other wireless communications device, a small microcontroller, and an energy source, since in most Wireless sensor network applications the energy source is a battery, energy plays an important role in wireless sensor network, and preserving the consumed energy of each node is an important goal that must be considered when developing a routing protocol for wireless sensor networks. Many routing protocols have been proposed in the literature such as LEACH, PAMAS. Leach is considered as the most popular routing protocol that use cluster based routing in order to minimize the energy consumption; in this paper we propose an improvement on the Leach Protocol that further enhance the Power consumption, simulation results bring out that our protocol outperforms Leach protocol in term of energy consumption and overall throughput. In figure1.1 the configuration of the WSNs is described, where a sensor network is shown in a cloud that contained the many sensor nodes. These nodes transmit the data to the beds base station or sink node. Sink node aggregates the data from sensor nodes and transmit to the internet. The consumer receives data through internet from sink node.

Wireless Sensor Networks (WSNs) are almost same as mobile ad-hoc networks (MANET) with some extra features and restraint like limited energy capacity, non-rechargeable battery life and low memory capacity. The configuration of wireless sensor Network is shown in Fig. 1.

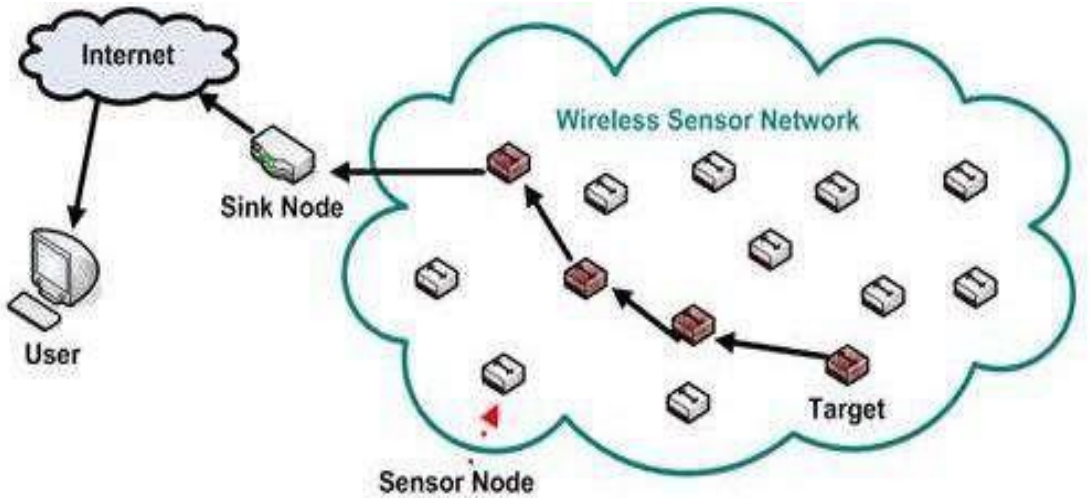


Fig.1: Configuration of Wireless Sensor Network

Thus, wireless sensor network originated as a battlefield surveillance application. Previously, the routing protocols did not require point to point communication. Nowadays, the field has been rising with new prospective in health, industrial and other monitoring applications and so it is required to make routing protocols more efficient. As memory is limited and more power is consumed, programmers need to consider these two challenges while designing wireless sensor networks. WSNs are application specific and nodes are responsible to sense, collect and aggregate data and send it further towards the destination. So, in WSN routing protocol should be design in a way to fulfill these tasks. The main concentration for designing a good routing protocol is: awareness of energy, scalability in energy constrained and bandwidth constrained environment, adaptability in limited memory environment. Due to limited energy resource, clustering routing protocols are more important. They are scalable and more energy efficient and easy to manage than direct communication and flat routing protocols.

This paper contribute five sections, in first section give the brief introduction of wireless sensor Network see above section, Literature Survey and Existing LEACH Algorithm explanation see in section two and three, section four and five give the Proposed EELEACH Algorithm and results discussion and finally see the conclusion in section six.

LITERATURE SURVEY

Various approaches for reducing the energy expenditure have been presented in literature; several papers minimize the transmitter power (a significant energy drain for WSN nodes) while maintaining connectivity by aggregation techniques [1,2], by using mobility of sinks [3,4]. Several routing protocols [5,6] showed significant improvements in the network lifetime for ad hoc networks (MANETs) and WSN by choosing routes that avoid nodes with low battery and by balancing the traffic load. Approaches at the medium access control (MAC) layer are geared towards reducing idle listening power and decreasing the number of collisions [7,8]. Application- layer approaches show dramatic energy savings for several classes of applications. The works in [9] deal with the target coverage problem where the purpose is to cover all the targets. The authors proposed an LP-based algorithm, which extends network lifetime by organizing the sensors to subsets, which are activated successively and only the active sensors are responsible for monitoring the targets. The works in [10,11] deal with area coverage problem where the main objective is to cover an area. Approaches to this problem are to divide sensors into disjoint or non-disjoint sets, such that each set can monitor every point in the surveillance area and all sets are activated successively so as to increase network life-time.

In 2013, Zhao et al. [15] proposed a cross-layer routing method called Topology and Link Quality aware Geographic Routing (TLG) that combines features of physical and routing layers. The function includes distance, energy and quality of the link as the relay has node selection parameters.

In 2015, Heimfarth et al. [4] proposed a joint MAC and routing layer method called AGA-MAC in which the source node searches for a receiver and selects the node which the minimum distance to the sink as the relay node.

In 2010, Haibo et al. [14] proposed a routing scheme called Energy-Efficient Beaconless Geographic Routing in which the source node determines the relay search region by calculating a point as the optimal relay position. The closest node to the optimal point is selected as the relay node through a handshake mechanism.

In 2014, Petrioli et al. [8] proposed a cross-layer routing method called ALBA-R which integrates MAC, routing and sleep/awake schedule for relay node selection. Queue Priority Index (QPI) and Geographic Priority Index (GPI) are major factors which are considered for relay selection in this method. Considering QPI and GPI for relay selection reduced congestion by balancing traffic among different nodes. Vuran et al. [11] proposed a new cross layer routing called XLP which uses receiver-based contention and considers thresholds for potential relays to ensure reliable communication. In this method a four conditional function is used for determining the nodes which participate in the relay node selection process. The nearest node with respect to the sink is selected as the relay node. In methods proposed previously, nodes queue statuses are not considered. This leads to congestion and packet dropping. Because of ignorance of important parameters ineffective transmission occurs in the above-mentioned methods.

In 2017, Zahra et. al [7] proposed a cross-layer routing method called Geographic Cross-Layer Routing adapted for disaster relief operations in WSN (GCRAD) which overcomes the above-mentioned problems by concurrently affecting all the relay node selection criteria. They introduced a new criteria called potential relay number (PRN) for relay node selection. This method considers the average of QPI and GPI for the relay node selection process. This protocol showed significant performance compared to the previously existing cross-layer protocols like ALBA-R, IRIS, etc.

In 2010, Adel et al. [2] proposed an energy efficient data forwarding protocol called Energy Aware Geographic Routing protocol (EAGRP) which is more suitable for multi-hop wireless sensor networks. This protocol is based on two parameters: location and energy left in the nodes. The performance of EAGRP has been significantly better compared to previously existing protocols.

In 2013, Wenget. al [13] has proposed an energy efficient routing algorithm called RIDSR (Relative Identification and direction for Wireless Sensor Networks) which divides the sensing area into sectors. Each sector consists of a manager node which transfers the data to the base station. In this protocol, the Base Station provides unique ID to all the nodes present in a sector based on quadrant name and distance from the base station. The simulation results have shown that energy consumption and throughput have been significantly increased in this protocol.

In 2014, Deganet. al [14] have proposed a energy balanced routing method called FAF-EBRM in which the next hop is determined based on the link's capacity and forward energy density. The experimental results show that this protocol balances energy consumption and guarantees high QoS of WSN. Wang et al. [12] has proposed a pair-wise geographical routing (PWDGR) for dense wireless sensor networks (WSN) to reduce the energy consumption and maintain a balance between energy consumption and delay in communication between two nodes. They have shown that this protocol prolongs the network life by 70% compared with similar protocols. Horacio et al. [1] have proposed an enhanced greedy forward algorithm in which data packets are forwarded to the node that is closer to the sink. This protocol makes use of only Received Signal Strength Indicator (RSSI) of exchanged packets. The experimental results show that this method has better performance and packet delivery ratio without the need for position information.

EXISTING LEACH ALGORITHM

Low Energy Adaptive Clustering Hierarchy: In this algorithm cluster heads are selected randomly among the nodes in the network. Each node in the network generates a random number between 0 and 1. The cluster head is calculated by using formula:

$$T(n)=\begin{cases}\dfrac{T}{1-p\left(r \bmod \dfrac{1}{p}\right)} & \text{if } n \in G \\ 0 & \text{Otherwise}\end{cases}$$

Here, p is the desired percentage of CH, r denotes the count of present round, and G is the group of sensor nodes that are not CHs in the previous 1/p rounds. The node will appoint itself as a cluster head. A node once selected as a cluster head. In LEACH protocol use the following clustering model: some of the node selects them as a cluster head. These cluster head collect the data from other nodes which are near to the cluster head and finally these cluster head sends the data to the base station. Cluster head changed at every round so it provides the balance energy consumption for all nodes and increase the lifetime of the network. This paper proposes a modification of LEACH's cluster head selection on the bases of remaining energy of nodes and distance from base station [4] to reduce energy consumption. For a micro sensor network, we make the following assumptions [5]:

1.The base station (BS) is located far from the sensors or may be in the center.

2.All nodes are homogeneous and have limited energy.

3.All nodes are able to reach BS

4.Symmetric propagation channel

5.Cluster-heads perform data compression.

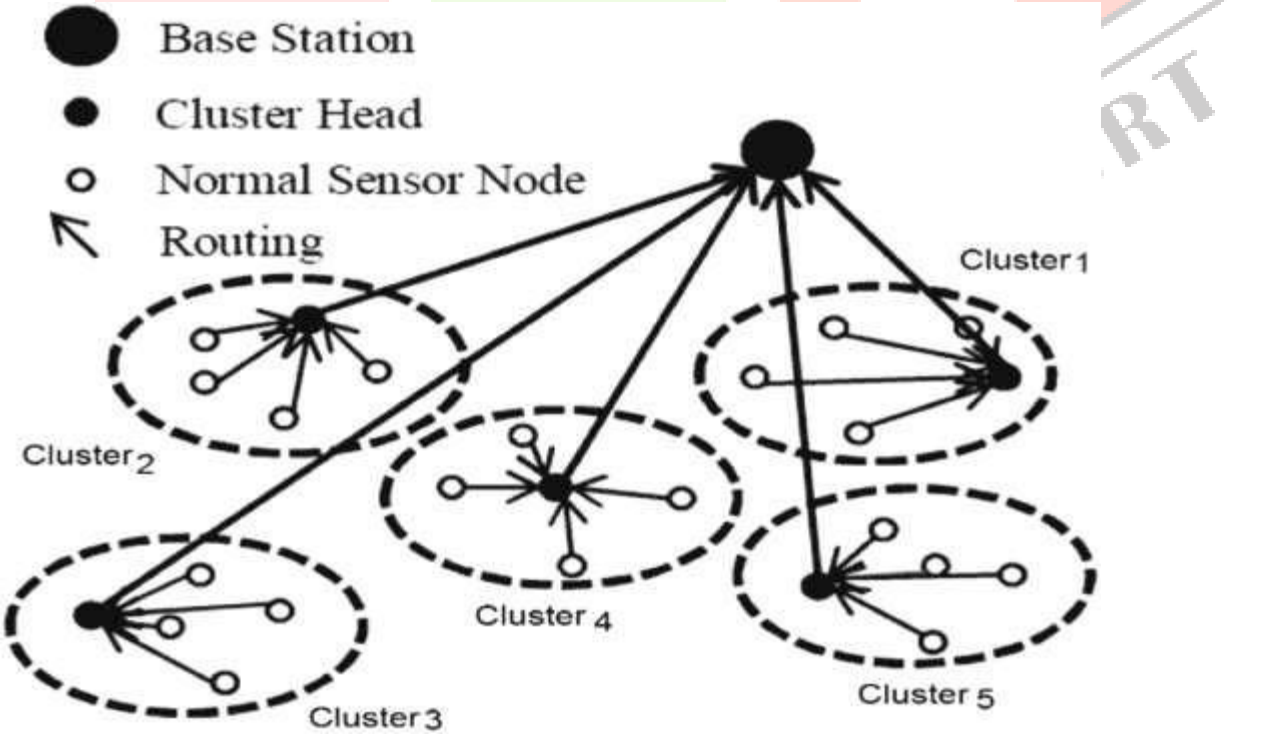


Fig. 2 Existing LEACH Clustering

Existing LEACH clustering is shown in Fig. 2. Cluster-heads collect n k-bit messages from cluster nodes and compress the data to cnkbit messages which are sent to the base station, with c ≤1 as the compression coefficient. The operation of LEACH has lots of rounds, where each round is separated into two phases, first is the set-up phase and second is steady-state phase. In the setup phase the clusters are organized, while in the steady-state phase data is delivered to the base station. During the set-up phase, each node decides whether or

not to become a cluster head for the current round. This paper presents an improvement of LEACH's cluster-head selection and the formation of clusters.

Low-Energy Adaptive Clustering Hierarchy (LEACH) is a self-organizing and adaptive clustering protocol proposed by Heinzelman [4] [5] [6] [7]. The operation of LEACH is divided into rounds, where each round begins with a setup phase for cluster formation, followed by a steady-state phase, when data transfers to the sink node occur. Though LEACH uses random election of cluster heads to achieve load balancing among the sensor nodes.

LEACH is a routing protocol that organizes the cluster such that the energy is equally divided in all the sensor nodes in the network. In LEACH protocol several clusters are produced of sensor nodes and one node defined as cluster head and act as routing node for all the other nodes in the cluster.

As in routing protocols the cluster head is selected before the whole communication starts and the communication fails if there is any problem occurs in the cluster head and there is much chances that the battery dies earlier as compare to the other nodes in cluster as the fix cluster head is working his duties of routing for the whole cluster.

LEACH protocol apply randomization and cluster head is selected from the group of nodes so this selection of cluster head from several nodes on temporary basis make this protocol longer lasting as battery of a single node is not burdened for long.

Sensor nodes elect themselves as cluster head with some probability criteria defined by the protocol and announce this to other nodes. Flow chart Existing LEACH algorithm is shown in Fig. 3.

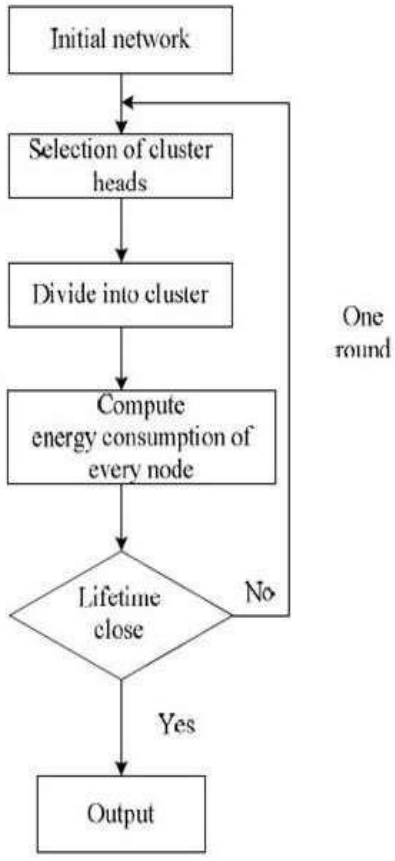


Fig. 3 Flow Chart of Existing LEACH Algorithm

LEACH still has some deficiencies which are listed as follows,

- In LEACH, a sensor node is elected as the cluster head according to a distributed probabilistic approach. Non cluster nodes decide which cluster to join based on the signal strength. This approach ensures lower message overhead, but cannot guarantee that cluster heads are distributed over the entire network uniformly and the entire network is partitioned into clusters of similar size, and the load imbalance over the cluster heads can result in the reduction of network lifetime.

- LEACH assumes that all nodes are isomorphic, and all nodes have the same amount of energy capacity in each election round which is based on the assumption that being a cluster head results in same energy consumption for every node. Such an assumption is impractical in most application scenarios. Hence, LEACH should be extended to account for node heterogeneity.
- LEACH requires source nodes to send data directly to cluster heads. However, if the cluster head is far away from the source nodes, they might expend excessive energy in communication. Furthermore, LEACH requires cluster heads to send their aggregated data to the sink over a single-hop link. However, single-hop transmission may be quite expensive when the sink is far away from the cluster heads. LEACH also makes an assumption that all sensors have enough power to reach the sink if needed which might be infeasible for energy constrained sensor nodes. To address the deficiencies listed above, a clustering based algorithm called ECHC (Energy and Node Concentration Hierarchical Clustering Algorithm) is proposed in this paper. In ECHC, node concentration and the residual energy of sensor nodes is considered in cluster-head election, and non-cluster node choose its cluster head according to the residual energy of the cluster head and the size of the cluster.

PROPOSED ALGORITHM

EE-LEACH (Energy Efficient Low Energy Adaptive Clustering Hierarchy) employs the distributed clustering approach as compare to LEACH protocol. The total sensor field is divided into the equal sub-region. The choice of the cluster head (CH) from each sub-region is determined by the threshold approach as in LEACH protocol. Following is the algorithm for the EE-LEACH protocol. The sensor nodes in WSN are having with limited battery life so the main point of improvement of lifetime of wireless sensor networks directly focus on the factor of energy conservation. The networks based on clustering mainly divide the sensing area in the number of clusters and from each cluster one cluster head is selected. Other nodes in the cluster are called as cluster members. LEACH that is first energy efficient protocol used in WSN improves the life time of the network efficiently. This is a clustering-based approach. With the number of advantages LEACH protocol also comes with some disadvantages like while choosing cluster head this protocol does not take into account the residual energy of the sensor nodes and also the cluster head distribution is non-uniform. The EE-LEACH MIMO scheme provides an improvement over the LEACH protocol. In this scheme the network is divided into sectors of equal angles and the residual energy of sensor nodes also considered while choosing cluster head and cooperative nodes for MIMO system. The clustering is done only for one time. The network is divided into clusters by cutting it from center using an angle of $2\pi/K_{opt}$ Sink inform the nodes to join the cluster nearest to them. The value of is K opt is 5 for implementation of EE-LEACH MIMO scheme. All the operations are managed in rounds. For each round the selection of cluster head and cooperative nodes takes place.

Designed to cope with nodes of heterogeneous WSNs. For CH selection, EELEACH 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 EELEACH 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 poptNCHs 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 poptN. 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) denotes average energy of network during round r which may be given. In EELEACH, 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. 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, EELEACH 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. To maximise the EELEACH protocol performances, the EELEACH implemented a balanced and dynamic solution to distribute the spent energy more equitably between nodes. 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.

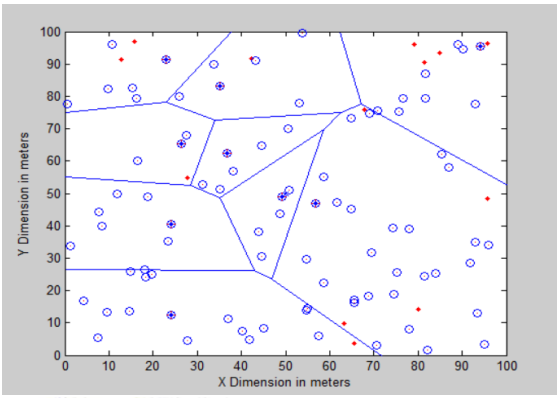
- Topology is static

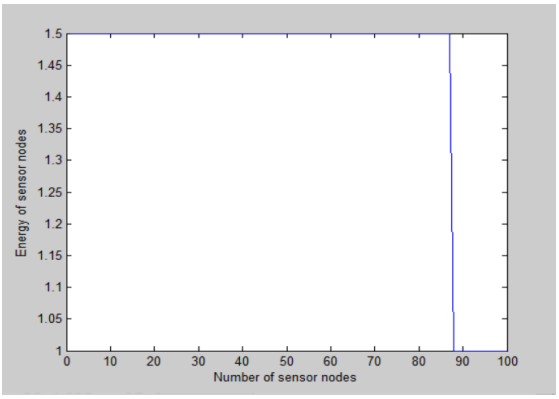
- All nodes are aware of their location
- All the cluster members can reach CH in one hop
- CH can reach the base station in one hop or multiple hops

The actual purpose of creating clusters is to reduce the energy consumption of the sensor nodes and the bandwidth requirement for the network. The clusters in the network are attributed by a single CH, connected to multiple sensor nodes nearby. The sensor nodes transmit their data to the cluster head, which aggregates the data and forwards it to the base station. This process moderates the energy expense of the nodes and decreases the probability of data collisions. In the proposed work, higher energy nodes are elected as CH to attain energy efficiency. To distribute the load uniformly among the nodes, node priority is consumption during clustering process, the passive clustering method has been proposed, where the proclamation delay is defined as the function of node's weight.

RESULTS AND DISCUSSION

LEACH (Low Energy Adaptive Clustering Hierarchy) Algorithm is a clustering technique which is used to reduce the power dissipation of the sensor nodes. In this the total region is divided into number of clusters and each cluster consists of one or more cluster heads. Cluster head is selected based on the residual energy. Cluster head is changed at every round so it provides the balance energy consumption for all nodes and increases the lifetime of the network. Clustering and deployment of sensor nodes is show in fig6.1. Variation between different sensor nodes based on energy they are cluster head, higher energy node i.e., less than the cluster head, normal sensor nodes are shown in Fig. 4. Fig. 5 shows the energy of the sensor nodes and number of living nodes. EE-LEACH (Energy Efficient Low Energy Adaptive Clustering Hierarchy) Algorithm is also a clustering technique it is more efficient than the LEACH. In EE-LEACH the total region is divided into sectors of angles which creates the number of clusters. The clusters division in EE-LEACH is depending upon the applied input angle based on that angle the clusters are divided. The clustering and deployment of sensor nodes in EE-LEACH is shown in Fig. 6,7, 8. The energy of the sensor nodes and number living nodes is shown in Fig. 9,10, 11.





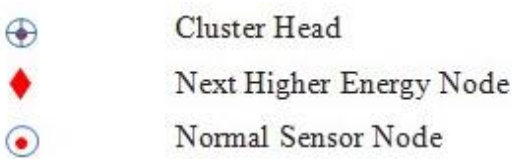


Fig. 4 Deployment of sensor nodes & Clustering, Fig. 5 Number of sensor nodes Vs Energy of sensor nodes

Angle-70°:

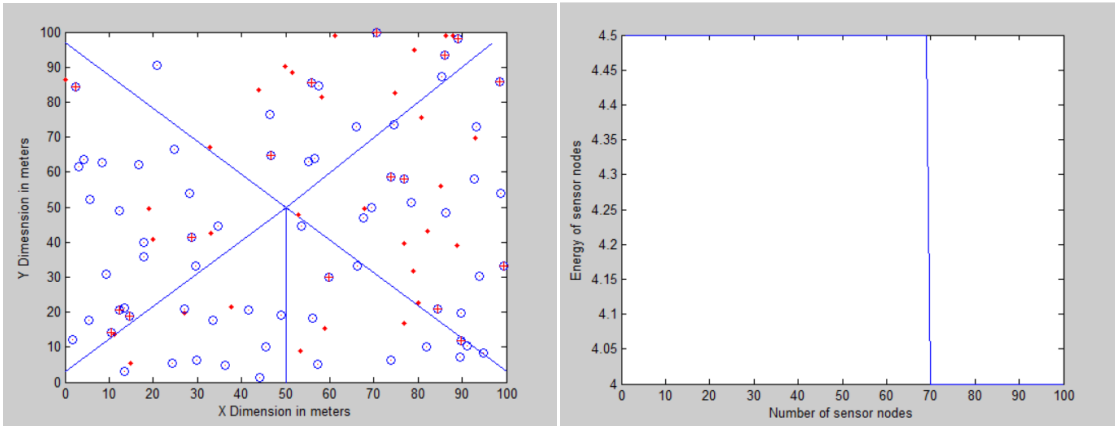


Fig. 6 Deployment of sensor nodes & Clustering, Fig. 7 Number of sensor nodes Vs Energy of sensor nodes,

Angle-45°:

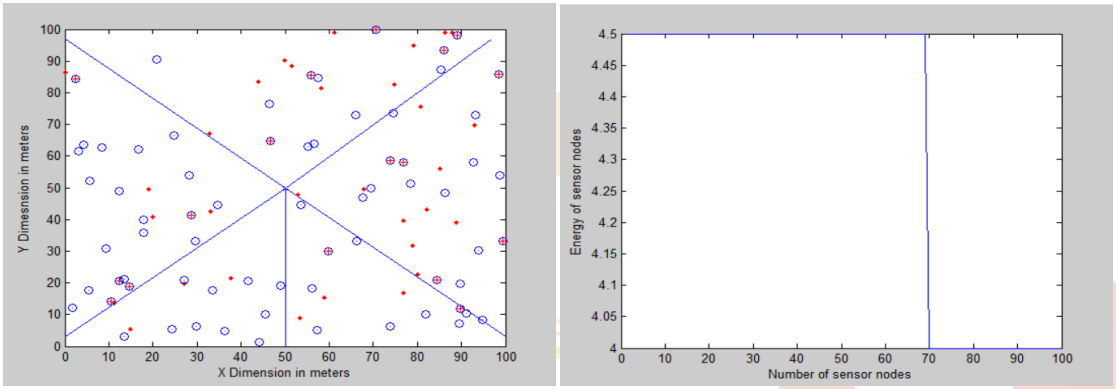


Fig. 8 Deployment of sensor nodes & Clustering,Fig. 9 Number of sensor nodes Vs Energy of sensor nodes,

Angle-15°:

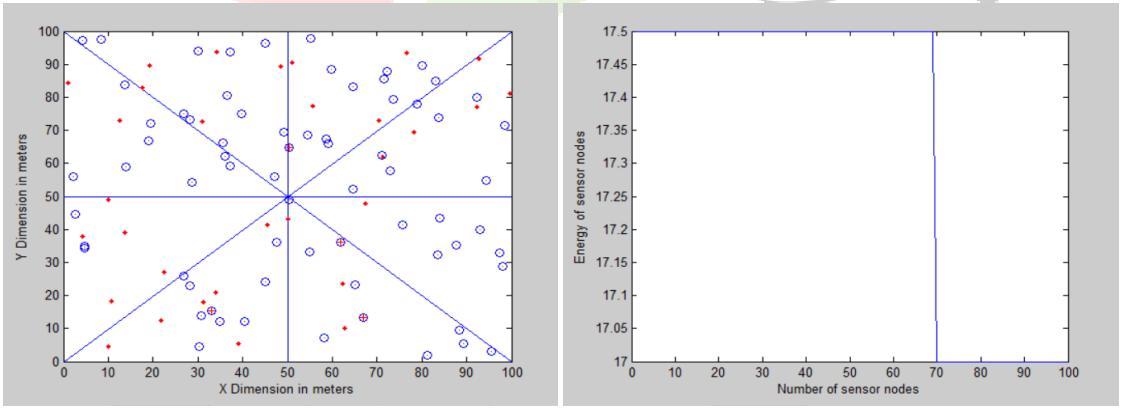


Fig. 10 Deployment of sensor nodes & Clustering, Fig. 11 Number of sensor nodes Vs Energy of sensor nodes

CONCLUSION

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 proposed algorithm ensures that the elected cluster-heads are uniformly distributed over the network. Hence, there is no possibility that all cluster cluster-heads will be concentrated in one part of the network. This paper has evaluated and compares the well-known heterogeneous WSNs energy efficient protocols like LEACH, EELEACH variants. The simulation results

shows that EELEACH protocol is very enhanced and efficient routing process for selecting cluster head. The result of simulations conducted indicates that the proposed clustering approach is more energy efficient and scalable and hence effective in prolonging the network life time compared to LEACH based algorithms.

Wireless sensor networks are used in different applications. In all the applications energy usage is the determining factor in the performance of wireless sensor networks. Because all the sensor nodes are mostly battery operated and energy available of the senor nodes is limited. Design of energy efficient algorithms for routing in wireless sensor networks is a rapidly growing area of research. Presented research work focuses on the design of energy efficient algorithms for generic applications of WSN. EE-LEACH (Energy Efficient Low Energy Adaptive Clustering Hierarchy) algorithm is an efficient algorithm to reduce the energy consumption of the sensor nodes and increases the life time of the network.

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