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Efficient Energy Consumption of Cluster Head in Wireless Sensor Network

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ABSTRACT

Advancement in technology, WSN of sensor nodes in the network is the structure which is small in size and has low battery to communicate with other nodes. It contains memory and processors for sensing the data from the surroundings. Routing is much complicated in this form of network as compared to other wireless networks and there are different routing protocols are used to deploy the communication among the nodes. Energy consumption is one of the major issues in this network to maintain the lifetime of the network. Entire network life span is depending on proficient energy exploitation in sensor network. To improve the energy consumption, performed the clustering among the nodes which is one of the techniques to utilize the energy of network efficiently. In the existing work, performed the deployment of cluster head randomly on the basis of distance and residual energy. But it is not efficient method which overcome by applying another technique in proposed work. MATLAB simulator is used in this paper work which shows proposed technique.

Keywords—Wireless Sensor Network, Energy, Base Station, Clustering, Cluster Head, Fuzzy logic.

I. INTRODUCTION

WSN is different from other popular wireless networks like cellular networks, wireless LAN and Bluetooth in many ways. WNS are proposed for variety of monitoring applications. In these networks (Fig.1) large number of nodes periodically takes measurements of environmental data and transmits them to a central data sink. The fundamental step of functioning of WSN:

Sensing -> Computation -> Communication -> Data aggregation at sink node -> various applications.

With the development in wireless technology and embedded device technology, the capacity of the sensors is quite improved while their cost is lower. A WSN is a group of hundreds to thousands of sensor nodes with greatly little distance between neighboring nodes and small application data rate. WSN has additional chances to be installed in real environments. WSN becomes hopeful area in widespread collection in current years of applications like forecasting system, health observing applications, ecological surveillance, battlefield surveillance, robotic exploration, monitoring of human physiological data etc. The sensors can be installed at a variety of places with dissimilar usages and each have dissimilar potential to sense dissimilar attributes such as temperature, moisture, pressure humidity etc. The batteries are usually irreplaceable. Accordingly, there lifetime will relies upon separate batteries of sensors. So the life time of WSN can be drawn out by utilizing compelling vitality adjusting techniques [1].

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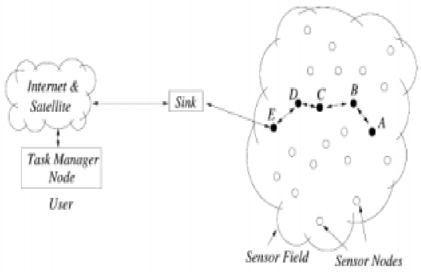

Fig.1 WSN

II. CLUSTERING

The gathering of sensor nodes into groups has been broadly sought after by the examination group with a specific end goal to accomplish the system adaptability objective. Each cluster would have a leader, regularly known as the cluster head (CH). Although many clustering algorithms have been proposed in the writing for ad hoc systems, the goal was principally to create stable bunches in conditions with mobile nodes. Many of such actions care frequently about node reachability and route stability, without much worry about serious design goals of WSNs such as network longevity and coverage. As of late, various clustering algorithms have been particularly intended for WSNs.

These proposed clustering methods generally vary depending upon the node arrangement and bootstrapping plans, the sought network planning, the qualities of the CH nodes and the network operation display. A CH might be chosen by the sensors in a group or pre-alloted by the system planner. A CH may equally be only one of the sensors or a node that is resources wealthier. The enrollment of cluster might be settled or variable. CHs may shape a moment level system or may simply deliver the information to invested individuals, e.g. a base-station or a command center.

III. CLUSTERING ALGORITHMS

A. Single-Level Clustering Algorithm

In the network, every sensor becomes a CH with probability p and proclaims itself as a CH to the sensors within its radio range. We call these cluster heads the volunteer cluster heads. This announcement is sent to every one of the sensors that are close to k hopes far from the CH. Any sensor that gets such notices and is not itself a CH connects the group of the nearest CH. Any sensor that is neither a CH nor has joined any cluster itself revolves into a CH; we call these CHs the limits CHs. Since we have restricted the announcement sending to k hops, if a sensor does not get a CH announcement inside time period t (where t units is the time required for information to come to the CH from any sensor k hops away) it can gather that it is not inside k hops of any volunteer CH and consequently turn into a constrained CH.

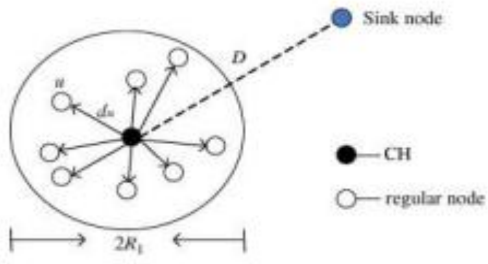

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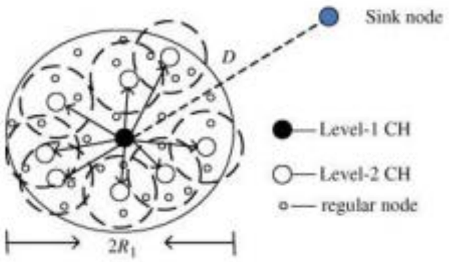
Fig. 2 A level-1 cluster with radius R1 and number of nodes N1. In the clustering scheme, CH locates in the center of this cluster. D is the distance between CH and sink node.

B. Hierarchical Clustering Algorithm

This algorithm allows more than one level of clustering. Expect that there are h levels in the clustering chain with level 1 being the most minimal level and level h being the most noteworthy. In this clustered condition, the sensors impart the accumulated information to level-1 CHs. The level-1 CHs total this information and impart the aggregated information or collected information to level-2 CHs and so on. At long last, the level-h CHs impart the totaled information or accumulated information to the processing center.



The cost of communicating the information from the sensors to the processing center is the energy spent by the sensors to communicate the information to level-1 CHs, plus the energy depleted by the level-1 CHs to communicate the aggregated data to level-2 CHs, …, plus the energy exhausted by the level-h CHs to communicate the aggregated data to the information processing center.

Fig. 3. A level-1 cluster with radius R1. Each level-2 cluster is estimated as the circle-shaped area, and CH places in the center of that cluster. D is the distance between level-1 CH and sink node. In this level-1 cluster, the amount of level-2 CHs is indicated as NCH2.

C. Low Energy Adaptive Clustering Hierarchy (LEACH)

LEACH diminishes energy dissipation in sensor networks due to developing clusters. This protocol does not believe node's remaining energy in the clustering process. LEACH process is done in two stages, setup stage and steady state stage. In the setup stage, a random number has chosen by sensor node between 0 and 1. If this quantity is not greater than the threshold T(n), the node becomes a CH. T(n) is calculated as:

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

D. Hybrid Energy Efficient Distributed Clustering [HEED]

In this approach, each regular node chooses the least communication cost CH in order to connect it. On the other hand, the aggregated data send by CHs to BS in a multi hop fashion. HEED periodically picks CHs according to a hybrid of their left behind energy and secondary parameter, such as node proximity to its neighbors or node degree. HEED does not build any hypothesis about the allotment or density of nodes, or about node capabilities, e.g., location-awareness. The clustering procedure terminates in O (1) iterations which does not rely on the topology of network or use. The protocol incurs low overhead in terms of processing cycles and messages exchanged. It also attains literally uniform CH distribution across the network [2].

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IV. RELATED WORK

The huge amount of works has been done to minimize the inefficient power consumption in the sensor network field. LEACH [7] is one of them that are mostly used. This is basic protocol for all protocols concerned with clustering. Concise introduction is given below.

LEACH uses special methodology to select the cluster head and to transfer data. This uses hierarchal protocol in WSN. This uses two phase to implement the protocol in each round as below:

- Set-up Phase
- Steady-state Phase

The setup phase is responsible for the formation of clusters. In this a random number is selected between zero and one by the nodes of sensor network. Leach uses distributed approach in the cluster formation, in this each and every node make decisions on the basis of non-centralized support. In the beginning of every round all nodes declared itself cluster head using the probability criterion of p(i) with number of k cluster head in the present round. While the steady-state plays vital role in transmitting data from non-header nodes to header-nodes and finally from header nodes to the base station. This process is repeated out till the last node is alive.

$$P_i(t) = \begin{cases} \frac{k}{N-k*(r \bmod N/k)} & : \quad C_i(t)=1 \\ 0 & : \quad C_i(t)=0 \end{cases}$$

V. LITERATURE SURVEY

Padmalaya Nayak, et al. [2017] In this paper, our propose a clustering algorithm on the basis of interval type-2 FL model, expecting to manage doubtful level choice superior than T1FL model. Lifetime improvement has always been a vital matter as the majority of the WSNs operate in unattended environment where human access and monitoring are practically infeasible. Clustering is one of the most influential techniques that can organize the system operation in associated manner to concentrate the network scalability, minimize energy utilization, and achieve prolonged network lifetime. To defeat this issue, current researchers have triggered the proposition of a lot of frequent clustering algorithms. On the other hand, a large amount of the proposed algorithms overstrain the CH during cluster development. To overcome this problem, many researchers have come up with the idea of fuzzy logic (FL), which is applied in WSN for decision making. These algorithms focus on the efficiency of CH, which could be adoptive, flexible, and intelligent enough to distribute the load among the sensor nodes that can boost the network lifetime. But regrettably, the majority of the algorithms use type-1 FL (T1FL) model [4].

Firoj Ahamad et al. [2016] this paper provides an approach to prolong the WSN lifetime using fuzzy logic based selection of cluster head that provides completely non probabilistic approach. This procedure uses two fuzzy variables: Base station distance and remaining energy of sensor nodes. In this process multi-hop communication is used. One CH has the right to communicate with the other CH and also with the BS. Simulation result verifies the proposed approach in prolonging the WSNs network lifetime [5].

Pichatorn Eak-Une et al. [2016] In this paper, our propose fuzzy based CH election algorithm (called FuzzCHE) to manage and preserve cluster size while balance remaining energy of sensors and extend the network lifetime. With FuzzCHE, each sensor can dynamically adjust probability that each sensor becomes CCH in each round by

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fuzzy logic. Comparing with existing cluster head election algorithm, results from simulations show that FuzzCHE can give more precise control of the average operated cluster size in the network to the deployed size required by the application [6].

Sanjoy Mondal, et al. [2016] In this paper, our propose an energy proficient load balanced data gathering protocol coined as RF-LEACH where division is done using rough fuzzy c means (RFCM) and CH selection is based on fuzzy logic. Matlab simulation results indicate RF-LEACH performs better than LEACH, Fuzzy LEACH and FCM LEACH in terms of extending network lifetime and throughput in a load balanced way. The results are shown to be statistically significant [8].

Suganya S et al. [2016] In this paper, to conserve energy and to maximize lifetime, FLC1 and FLC2 are used which dynamically regulates transmission power and sleep time. An IEEE 802.15.4 standard network is used. The main aim is to dynamically change transmission power and sleep time to maximize the battery life of the devices. And, finally by using fuzzy logic control FLC, we can calculate the lifetime by using RPS, STR and TTR. MATLAB simulations show that the lifetime of the device is increased by more than 30% when compared with fixed sleep time and fixed transmission power and by using fuzzy logic lifetime prediction, its lifetime is predicted [9].

Padmalaya Nayak et al. [2015] in this paper, WSN brings a new prototype of real time embedded systems with communication, memory, constrained computation and energy resources that are being used for huge range of applications where traditional infrastructure based network is mostly infeasible. The sensor nodes are densely deployed in a hostile environment to monitor, detect, and analyze the physical phenomenon and consume considerable amount of energy while transmitting the information. It is impractical and sometimes impossible to replace the battery and to maintain longer network life time. So, there is a limitation on the lifetime of the battery power and energy conservation is a challenging issue. Appropriate cluster head (CH) election is one such issue which can reduce the energy consumption dramatically. Fuzzy inference engine (Mamdani's rule) is used to choose the opportunity to be the SCH. The results have been resulting from NS-2 simulator and shows that the proposed protocol performs superior than LEACH protocol in terms of First node dies, half node alive, improved stability and enhanced lifetime [10].

VI. PROPOSED WORK

In the existing work, cluster head election is based on fuzzy logic technique to enhance the life span of the wireless sensor network. Distance of base station and residual energy are two terms used as fuzzy variable for the selection of cluster head appropriately. There is multihop communication are achieved which offer the connectivity of the nodes. But they used fuzzy based technique for selection of cluster head and sometimes one or more cluster heads are formed in the grid. This increase the energy consumption of the nodes as nodes has to send data from multiple cluster heads.

In the proposed work, define the area for the deployment of sensor nodes in the network which are used to communication to each other. Grid are performed which convert the area into small region. Clustering performed in the network to divide it
into clusters in which select cluster head dynamically. This CH communicates until its energy decrease below the threshold value. If CH has not enough energy then elect CH again by calculating the distance and residual

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energy. In this paper provide 50% to each parameter and then calculate the value. The nodes with smallest value considered as a new CH for the further processing. Now aggregate the data from the cluster members at the cluster head and then forward the data to other CHs.

Proposed Algorithm:

Step:1 Start

Step:2 Define the area of network

Step:3 Split the network into tiny area identified as grid

Step:4 Deployed the sensor nodes in the network randomly

Step:5 Apply clustering technique for the formation of clusters

Step:6 Initially select the cluster head of each cluster dynamically

Step:7 If (energy of cluster head < 0.3)

Perform cluster head selection

Else

Continue

Step:8 Now compute the residual energy RE and distance D

Step:9 Evaluate Cluster Head Value

CHV=$\sqrt{RE + D}$

Step:10 If (CHV=min)

Choose it as cluster head

Else

Cluster member

Step:11 Aggregate the data from the cluster members

Step:12 Forward data to suitable cluster head until data reached towards base station

Step:13 Exit

VII. SIMULATION PARAMETERS

Parameter	Value
Size of Network	100m*100m
Location of Base station	50m,140m
Number of Sensor nodes	200
Initial Energy of each Node (E_0)	0.5J
Size of Packet	4000 bit
Transmission Energy (ETX)	50 nJ/bit
Receiving Energy (ERX)	50 nJ/bit
Efs	10pJ/bit/m2
Eamp	0.0013 pJ/bit/m4

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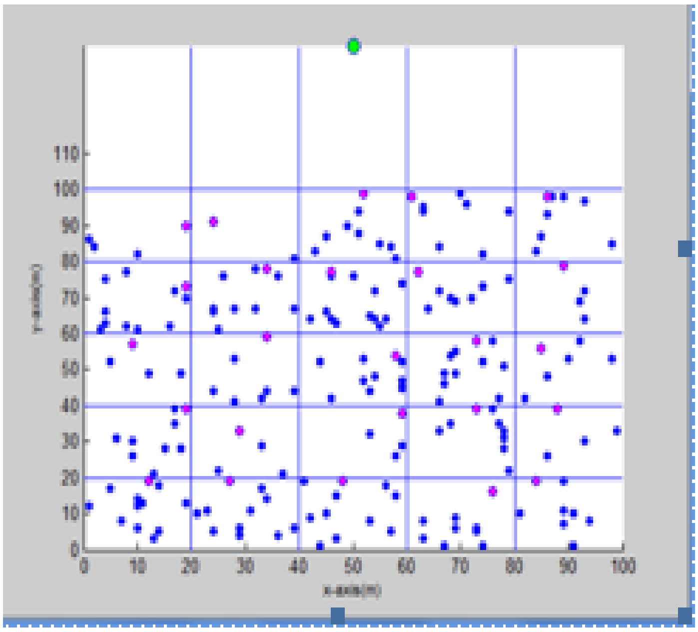
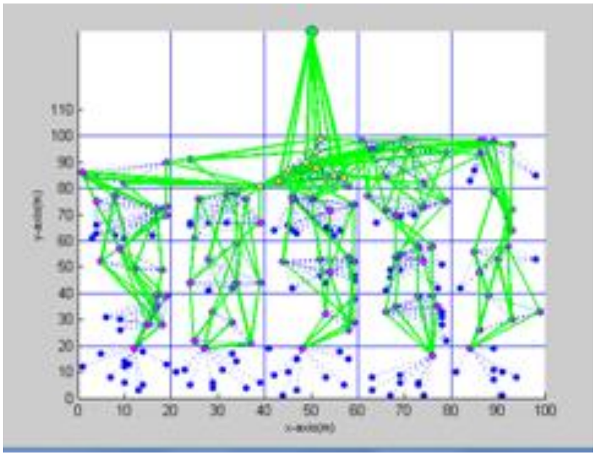
These following parameter are used in proposed work with MATLAB 2013.

VIII. RESULT ANALYSIS



Network Area Model

whole area divided into small-small sub areas of equal size. And those sub areas have the individual heads, using this became able to overcome the range overlapping problem as well as cluster area selection problem.



The fig.shows the transmission of data through appropriate cluster head election from destination to base station.

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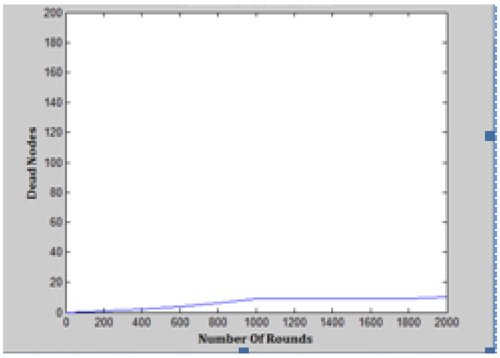
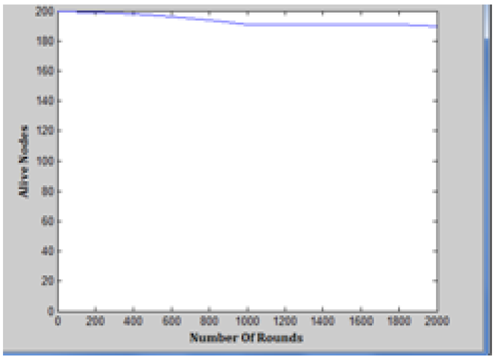


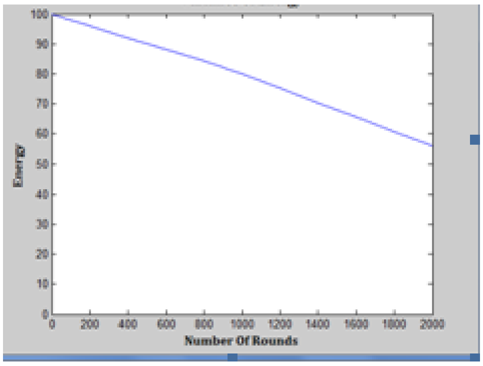
VARIANCE OF DEAD NODES

The number of dead nodes in RCAFL is represented in above graph. In the above graph, till 2000 rounds, there is improvement in no. of dead nodes.



VARIANCE OF ALIVE NODES

The number of alive nodes in RCAFL is corresponding in above graph. In the above graph, till 2000 rounds, no nodes alive in LEACH protocol but using proposed no. alive nodes is near about 8 node still alive.



VARIANCE OF ENERGY

IX. CONCLUSION

Sensor nodes are responsible to sense the data from the surroundings and collect it for various events. In this paper, improve the consumption of energy by selecting the cluster head efficiently. This deploy the cluster head dynamically which reduce the chance of more energy consumption. In WSN, we have to forward the data from one node to another by cluster head and pass it until it reaches the base station. This proposed method provides the better performance to the network and increase the efficiency. This work on the head selection on-demand rather that to select it in each and every round because it consumes more energy. There may be chance

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to use of the Artificial Intelligence in the head selection process. The no. of dead nodes reduces and residual energy also improve. The shortest path CH are chosen to send data from nodes to base station.

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