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Clustering with Mobile Sink in WSN

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Abstract:-In today's scenario, the energy conservation is the main paradigm for prolonging the network lifetime. In the wireless sensor network, the cluster head selection is the main issue, which can enhance the whole network lifetime and improve their scalability. The low energy adaptive clustering hierarchy (LEACH) is an effective algorithm where all the nodes within the cluster send their respective data to the local cluster head. Here, the mobile sink(MS) is used to reduce the energy consumption and also the cluster head selection is done by using the neural network(NN)[1] approach in the area of 150*150, 200*200 and 250*250 which provides greater functionality in the homogeneous WSNs.

Keywords: Wireless sensor network, cluster head, clustering, mobile sink, neural network.

1. INTRODUCTION

Recent development in the field of micro-electronic mechanical systems (MEMS) results in WSNs technology. WSNs composed of large volume of sensors and each sensor node has disposable battery, due to this limitation energy saving, minimizing computational complexity and storage space are major issues that needs to be focused in order to increase the lifetime of sensor.[2]

1.1 Sensors

In WSNs, sensor node consists of four basic components: a sensing unit, a processing unit, a communication unit and a power unit. The sensing unit consist of one or more sensors (which senses the environmental parameters and generates analog signals) and ADC (Analog to Digital convertor), which receives the analog signals generated by the sensors and converts these signals to digital form and send them to processing unit[3]. The processing unit consists of a micro-controller or micro-processor with memory which process the signal and is responsible for sensor node control. The communication unit contains short range radio used to transmit and receive data over radio channels. The power unit consists of battery supply GPS unit can also be added to identify the sensor node location.[4] The general architecture of WSN is shown in the Fig.1.

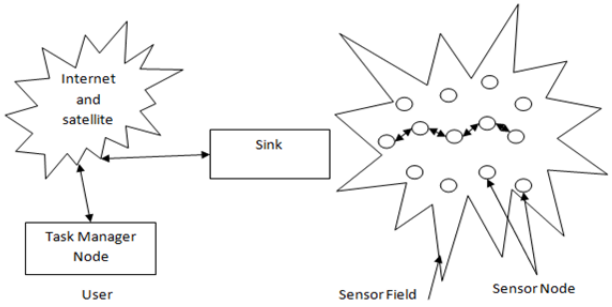

Fig 1.1: WSN communication architecture

1.2 WSNs

The WSN consists of large number of sensor nodes and a sink or base station located in sampling environment. The base station having major functions in WSN as sink send queries to nodes, [5]while nodes sense the asked queries and send the sensed information in a joint way reverse back to base station. Base Station also serves as an entrance for outer surface i.e. Internet so the collection of information and transmission of only relevant data to customer via internet is done by base station.[6]

1.3 TRANSMISSION BETWEEN NODE AND SINK

In single-hop transmission, each sensor node can send data to the sink through a single-hop i.e. by long distance transmission. But the limitation of this transmission is that it is not optimal in terms of energy consumption. In order to overcome this drawback, we need to decrease the distance thus can increase energy efficiency and prolong the network lifetime and this can be achieved by Multi-hop. In multi-hop transmission each node routes it data through other nodes and these nodes send the data to sink, thus it decreases the transmission distance and energy consumption when other node act as routers. Limitation of this method is that the energy of node located near the sink will drop quickly.[7] So in order to overcome the limitation found in Multi-hop transmission, another solution to decrease energy consumption is clustering method.

2. CLUSTERING TECHNIQUE

2.1 LOW ENERGY ADAPTIVE CLUSTERING HIERARCHY (LEACH)

LEACH (Low Energy Adaptive Clustering Hierarchy), the proposed algorithm is split into two stages: Setup Stage and Steady State Stage. The setup phase consists of 3 stages: Task Ordination (TO), Cluster Setup, and Scheduling. In Task Ordination Stage: each node is assumed to be a NN (Normal Node).[8] A node decides to become a CH based on the percentage of existing CHs (between 5% to 10%), the number of times that the node has been selected as CH and its level of energy. If the energy level of node is more than or equal to the average energy of all nodes, then that node can participate in CH selection. If the node does not have the required energy (means less energy) then it will cause a delay of 1/p (where p is the desired CH %) in rounds. The node then generates a random number between 0 and 1. If the number is < T (n), the node will become CH and CH label is attached to it.[9]

The threshold is set up as: $$T(n) = \begin{cases} \frac{p}{1-p*(r \bmod \frac{1}{p})} & , n \in G \\ 0, & otherwise \end{cases}$$

Where p=desired CH % (e.g. p=5%)
r= current round
G=set of nodes that have not been CHs in last 1/p rounds.
In Cluster Setup phase: After CHs are selected, each broadcasts an advertisement message to NNs (Normal Nodes). The NNs must keep their receivers 'ON' during this phase to hear advertisements from all the CHs. The CHs uses CSMA (Carrier Sense Multiple Access) to broadcast message. Each node senses the signal strength and attach to nearest CH having greater signal strength i.e. decision is based on the distance between NNs and CHs (the nearest CH produce largest signal). In Scheduling phase: After cluster formation, each CH creates a schedule based on TDMA (Time Division Multiple Access) protocol. The CHs broadcasts a message to inform each node when it will transmit data. This leads to decrease in energy consumption in the nodes as each node knows when to transmit so that nodes turn off their radios. Nodes put their receiver 'ON' only during the transmission time slot.[10]
In Data transmission stage: After clusters formation and establishment of schedule next phase starts called data transmission. During this phase, the data will transmit to a CH during each node's allocated time slot and NN radio will be ON only during its transmission time slot which leads to minimize energy consumption. However all CHs and RNs must keep their receiver ON during Data Transmission stage. When all data has been collected, CH begins to aggregate the data received and transmit it to the MS or to the nearest RN.[2]
LEACH reduces communication energy by as much as 8*compared with direct transmission and multi-hop transmission. However LEACH has certain limitations as: no guaranteeing that the cluster head nodes are well distributed through the network and is based on assumption that Base Station is fixed. As CH is chooses based in probability or randomly so there are chances that the node with very low energy gets selected as a CH. Moreover LEACH forms in general one-hop intra-cluster and inter-cluster topology where each node should transmit directly to CHs and thereafter to the BS thus is not effective in case of large regions network.

3. MOBILE SINK (MS)

To improve energy efficiency or decrease to decrease energy consumption a new concept called Mobile Sink has been introduced. In LEACH, BS is fixed. But by adding the concept of moving sink to LEACH, decreases the transmission distance thus increases the lifetime of network. Sink movement may be controlled or un-controlled. In controlled MS, the MS trajectory is predefined while in uncontrolled MS, the sink moves randomly in a pre-determined environment.[11]

4. NEURAL NETWORK

Neural network consist of parallel or distributed processing components called neurons which are connected in the form of graph topology. All these neurons are connected via weighted connections which are called synapses. These weighted vectors called synapses connect the network input layer to the output layer. The knowledge of neural network is stored on the weights of its connections so that's why the neural network does not need any data storage.

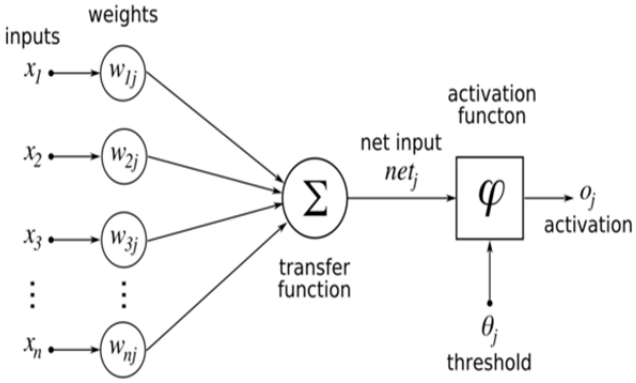

Fig 4.1. Structure of Neural network

Neural networkare the arithmetic algorithms which learns the complicated mapping between the input and the output according to supervised training and also classify the input data in a unsupervised manner. One of the problems occurring while using NN is topology. The different type of training rules especially inspired from biology science determines the way of NN to learn. In NN, the training is totally based on learning by example. A set of correct data of input and output is given to the network, and the network change the weights values and produce the new correct output, we called it as learning. One of the major property of NN is to find the affected data by noise and remove variations after learning. The capability of neural network is depend upon its structure, dynamics and training rules.[12] The main application of neural network is prediction, classification and identification.

4.1 Advantages of the Algorithm

- Used to perform nonlinear statistical modeling.
- Requiring less formal statistical training.
- Ability to implicitly detect complex nonlinear relationships between dependent and independent variables.
- Ability to detect all possible interactions between predictor variables, and the availability of multiple training algorithms.

4.2 Disadvantages of the algorithm

- Its "black box" nature.
- Greater computational burden.
- Proneness to over fitting.
- Empirical nature of model development.

5. SIMULATION RESULT

In this simulation environment, the 100 sensor nodes are deployed in the area of (150,150),(200,200),(250,250). The MATLAB simulator is used for the given experiment. The parameters are listed below in the given table[13]. The metrics used for the simulation are:-

- Remaining Energy
- Dead nodes

Table1:- Simulation Parameters

Parameters	Value
Area(x, y)	(150,150),(200,200),(250,250)
Base Station(x,y)	X(sink)=0,Y(sink)=y_m/2.
Number of nodes	100
Probability	0.1
Initial Energy	0.3J
Transmitter Energy	50 nJ/bit
Receiver Energy	50nJ/bit
Free space Energy(amplifier)	1.0nJ/bit/m^2
Multipath Energy	0.0013nJ/bit/m^2
Number of rounds	10,000

6. SIMULATION SCENARIO

This is the environment where area is 150*150 meter. Here, the environment of simulation is at the mid, where all the green circles are nodes and Red circle nodes are dead and diamond shaped is the base station which is moving on y axis because the x axis of sink is zero.[14]

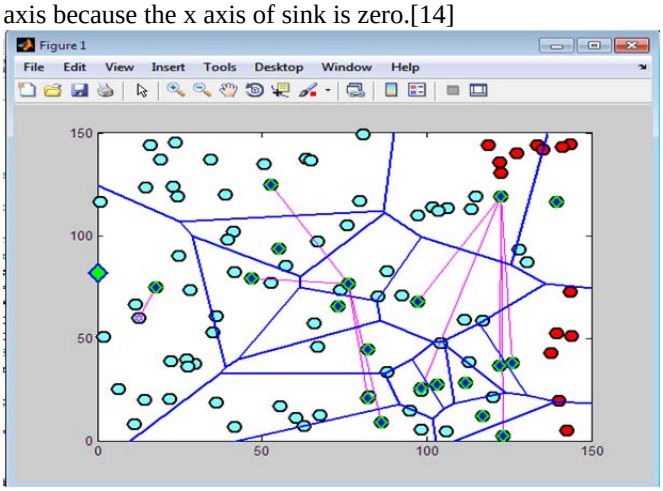

Fig 6.1. Simulation Enviornment

Here, the graph shows the simulation when all the nodes are dead. So all the nodes are in the red circle shape and again diamond shaped is the base station which is moving. From the above graph, we can see that the position of base station is moving along y axis.

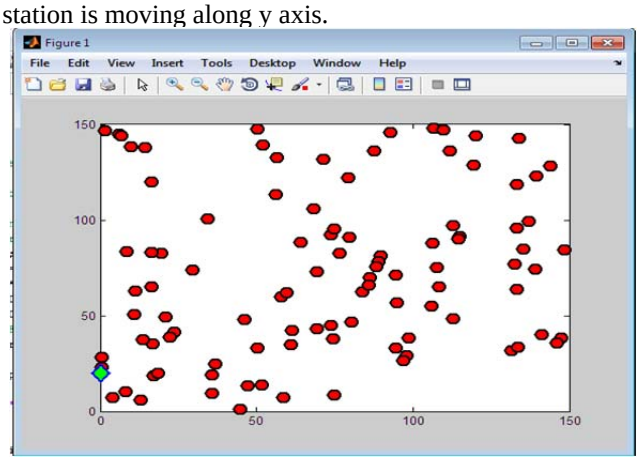

Fig 6.2. Simulation Enviornment at the end

Remaining Energy:-

This is the graph of remaining energy, which shows how much energy is left after the simulation. X axis shows the number of rounds .Here we have implemented the RZLEACH and NN RZ LEACH. In the case of RZLEACH the energy ends at the 1100 rounds and on the other hand, in NNRZ LEACH the energy dies at 1600 rounds. So NN RZ LEACH is more effective than the RZLEACH.[15]

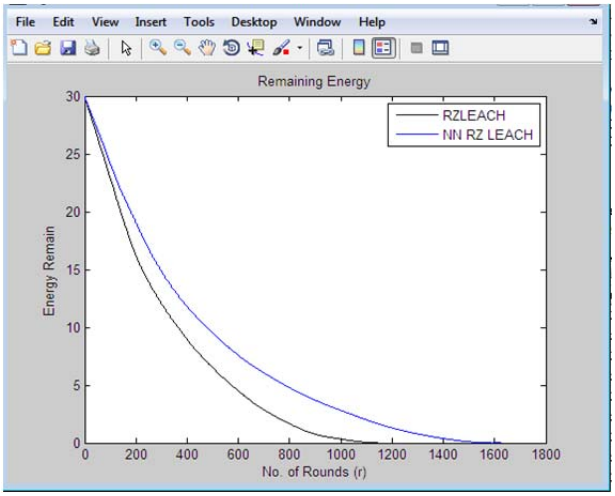

Fig 6.3. Remaining energy Vs Rounds

Dead Nodes:- This is the graph of dead nodes in RZLEACH and NNRZLEACH protocol.The network lifetime can be evaluated by using the number of dead nodes. It has been found that the number of nodes die earlier in RZLEACH protocol. Here, we can see from the graph that the nodes are die at the round of 1050 in case of RZLEACH and 1650 in case of NNRZLEACH.

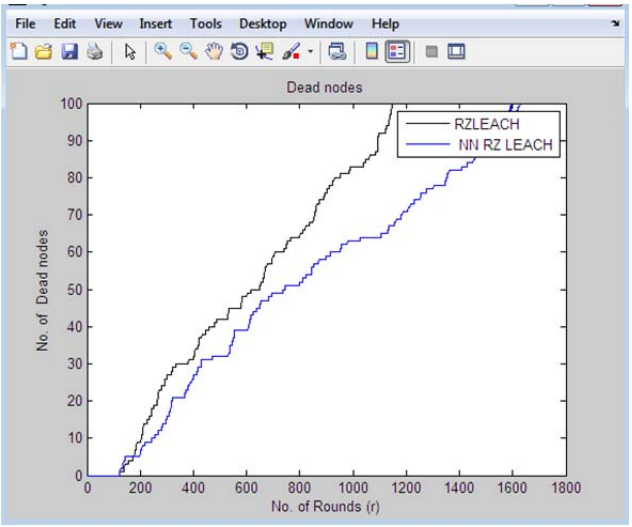

Fig 6.4. Dead nodes Vs Rounds

This is the results of area 150*150 meter of remaining Energywhich shows how much energy is left after the simulation. X axis shows the number of rounds . In the case of RZLEACH the energy ends at the 1190 rounds and on the other hand, in NNRZ LEACH the energy dies at 1600 rounds. So NN RZ LEACH is more effective than the RZLEACH.

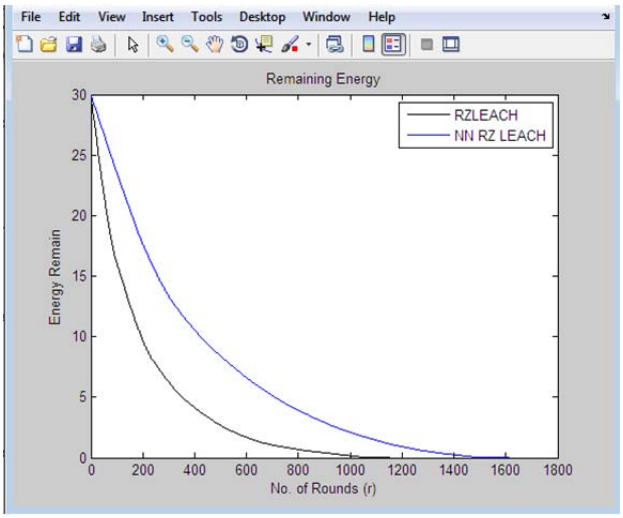

Fig 6.5. Remaining energy Vs Rounds

E. Dead Nodes:- This is the graph of dead nodes in RZLEACH and NNRZLEACH protocol.The network lifetime can be evaluated by using the number of dead nodes. It has been found that the number of nodes die earlier in RZLEACH protocol. Here, we can see from the graph that the nodes are die at the round of 1050 in case of RZLEACH and 1620 in case of NNRZLEACH. .

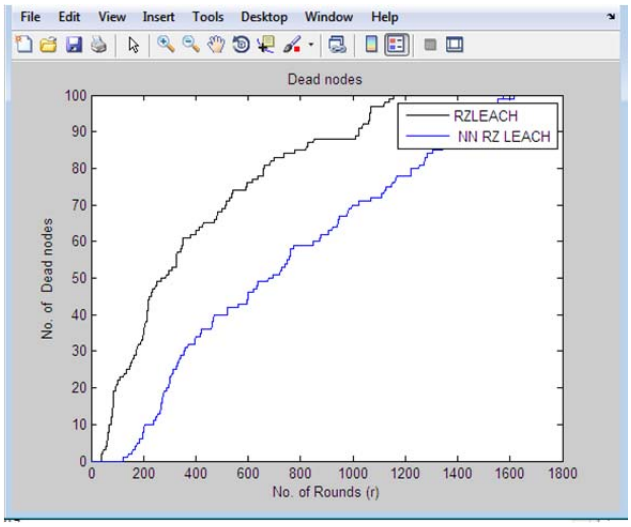

Fig 6.6. Dead nodes Vs Rounds

This is the results of area 250*250 meter of remaining Energy which shows how much energy is left after the simulation. X axis shows the number of rounds . In the case of RZLEACH the energy ends at the 950 rounds and on the other hand, in NNRZ LEACH the energy dies at 1450 rounds. So NN RZ LEACH is more effective than the RZLEACH.

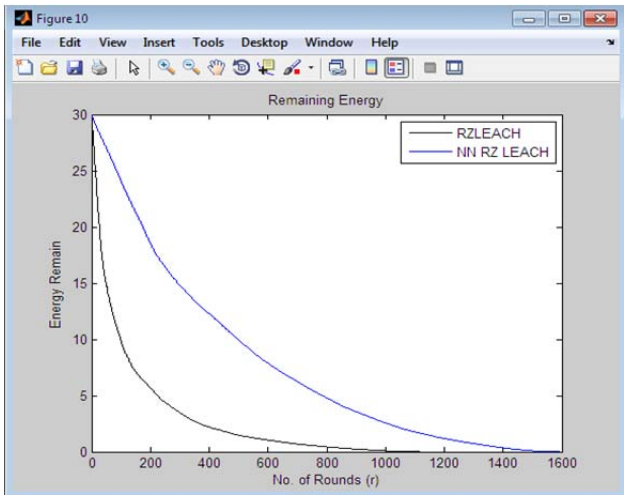

Fig 6.7 Remaining energy Vs Rounds

This is the graph of dead nodes in RZLEACH and NNRZLEACH protocol.The network lifetime can be evaluated by using the number of dead nodes. It has been found that the number of nodes die earlier in RZLEACH protocol. Here, we can see from the graph that the nodes are die at the round of 1020 in case of RZLEACH and 1600 in case of NNRZLEACH.

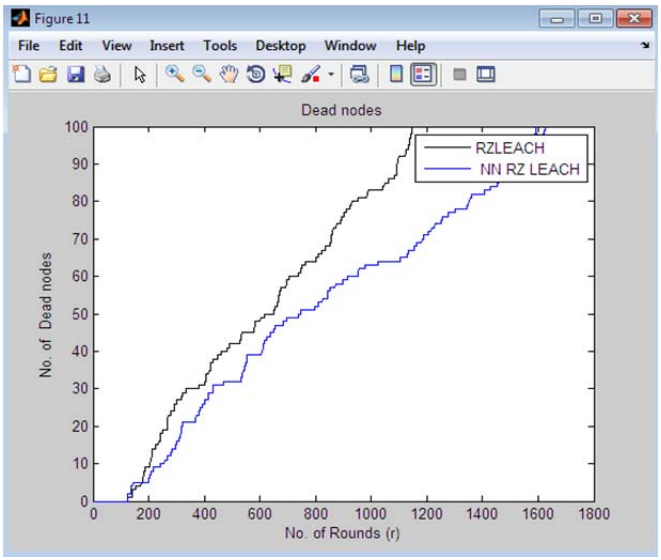

Fig 6.8 Dead nodes vs rounds

CONCLUSION

In this paper, we have proposed the NN RZ LEACH is an efficient technique.This protocol adopts the selection of cluster head using neural network approach which outperforms RZ LEACH. The proposed protocol shows the better improvement over existing protocol. In future work, we can implement some other optimization technique on cluster head selection and also work on WSN 3D environment.

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