Particle Swarm Optimization Technique using Efficacious Neural Network in WSN

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Abstract:- The LEACH routing protocol consist of Rendezvous nodes (RZ) and mobile sink which is used to enhance the energy efficiency. In this paper the swarm intelligence optimization technique called particle swarm optimization is used for selecting the best optimal path and Hopfield neural network which is used to select the best cluster head. By using the HNNPSORZLEACH technique the results are better in terms of energy and network lifetime. By evaluating the performance of RZ LEACH with the proposed system, results depicts that it is more efficacious.

Keywords: LEACH, Rendezvous nodes, swarm intelligence, PSO, Network lifetime.

I. INTRODUCTION

A wireless sensor network [1,2]is a wireless network consisting of spatially distributed autonomous devices using sensors to monitor physical or environmental conditions. The sensor nodes are typically scattered in sensor field sensor nodes has the capabilities to gather information and route information back to the sink and also the end users. A wireless sensor network (WSN) contains of lots of too many thousand low-power multi-functional detector nodes, responsibility include in unattended setting, and have sense, computation and communication capability. The basic aspects of a node definitely square measure a detector unit, AN ADC (Analog to Digital Converter), (Central processing unit), an work unit alongside a communication unit. detector nodes square measure micro-electro-mechanical systems (MEMS) that produce derived reaction to a modification of some wholeness like hotness and heaviness. Detector sense or live the physical information with the realm to become monitored. The repetitive Analog signal detected through the sensors is digitized by a digitizer and delivered to controllers for more process. detector nodes square measure of smaller size, use very low energy, square measure operated in high volumetrically densities, that modify it to be freelance and reconciling towards setting.

The spatial density of detector nodes inside the sector may well be the maximum amount as twenty nodes/ m^3. As wireless detector nodes square measure usually smaller electronic gadgets they might solely be ready having a restricted power supply. Every detector node carries a precise a part of exposure for the aim. It could and properly report the exacting quantity that it should be sensitive. A few reasons for power utilization in sensors are: (a) signal variety and exchange of physical signals to electrical ones; (b) signal gaining and (c) analog-to-digital conversion.In idle mode, the nodes consume virtually an equivalent quantity of power as in active mode, where as in snooze mode, the nodes ending the radio to avoid wasting the energy. The subsequent steps will be taken to avoid wasting power cause by announcement in wireless device networks.

a) To list the state of the nodes (i.e. transmittal, receiving or sleep).
b) Changing the transmission vary among the sensing nodes.
c) Using skillful routing and information grouping ways.
d) Avoiding the behavior of unwanted information as within the case of overhearing.

In WSNs the sole supply of life for the nodes is that the battery and communication with alternative nodes or sensing activities consumes lots of energy in process the information and transmittal the Collected data to the sink.

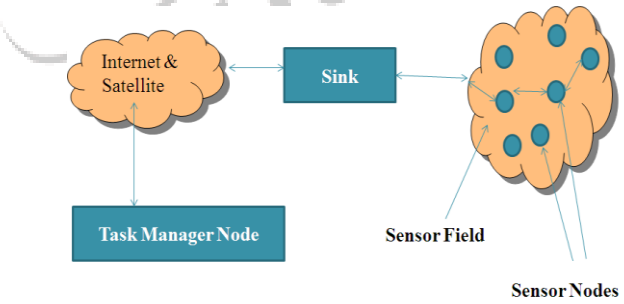

Fig 1. WSN basic structure

II. CLUSTERING

The key intention of graded routing or cluster primarily based routing is to apply maintain the energy usage of device nodes by connecting them in multi-hop communication among an exacting cluster. Cluster construction[7] is often supported the energy reserve of sensors and sensors closeness to the Cluster Head (CHs). Agglomeration plays a key role for power save in WSNs. Energy consumption, period of the network and

quantifiability will be increased. Since solely cluster head node per cluster is crucial to perform routing task and therefore the former device nodes simply forward their knowledge to cluster head. Agglomeration has main applications in high-density device networks, as a result of its greatly easier to manage cluster of cluster representatives (cluster head) from every group than to manage complete device nodes. In WSNs the device nodes square measure resource controlled which suggests they need restricted energy, transmit power, memory, and process capabilities. Energy consumed by the device nodes for human activity knowledge ranging from device nodes to the bottom station are that the central reason behind energy exhaustion in device nodes

a) Open house will give community members with larger recreation areas and build a way of openness that a lot of individuals need.

b) Open house will profit the surroundings by providing environment for life[8,11], naturally filtering storm water, reducing storm water runoff from moth-resistant surfaces, and protective the natural options of a web site.

c) Linking the open house of many conservation style subdivisions will facilitate develop larger and simpler "environmental corridors" among and between communities.

d) Developers could profit as a result of these styles sometimes cut back the prices of web site development and increase the value of individual plots compared with ancient subdivisions. These styles will profit rural areas by reinforcing the policy of maintaining the native rural character that's enclosed in several comprehensive land use plans.

- More quantifiability
- Data Aggregation/Fusion
- Less Energy Consumption
- More strength
- Quality of Service

III. Radio Energy Consumption Model

Radio energy model is used to calculate the amount of energy consumed by sensor node while transmitting and receiving the data. The two different channel models used by this model is depend upon the distance between the transmitter and receiver i.e. free space model (Efs) and another is multipath fading model (Eamp). If the distance is shorter than the threshold value then free space model is used and if the distance is larger or equal than the threshold value then multi -path model is used. To transmit l-bit information to a distance d, the radio exhausts energy:

$$Etx(l, d) = l * Eelct + l * Efs * d2, \quad d < d0 \qquad (1)$$

$$Etx(l, d) = l * Eelct + l * Eamp * d4, \quad d \geq d0 \qquad (2)$$

Here threshold distance,

$$d0 = \sqrt{\left(\frac{E_{fs}}{E_{amp}}\right)} \qquad (3)$$

The radio energy consumed while receiving an l-bit data is as follows:

$$Erx(l) = l * Eelct \qquad (4)$$

Where l is the length of the message in bits, d is the distance between transmitter and receiver. Eelct is the energy dissipated per bit to run the transceiver or the receiver circuit, Efs is the energy spent by free space model, Eamp is the energy spent by a multi-path amplifier circuit and d0 is the threshold distance between multi-path fading model and the free space model. In addition to this the other assumptions which are made are as follows: The energy spent by the node for sensing is Es and the energy spent for data aggregation is Eda.

IV. LEACH Routing Protocol

Leach is low energy adaptive clustering hierarchy. It is the first hierarchical routing protocol. Leach[3] is one of the most popular clustering algorithm uses to increase the network lifetime and scalability. Leach supports only single-hop communication as it transmits data directly to the base station. Leach is based on data aggregation technique that aggregates the useful data, removes the redundant data and finally transmits it to the base station or sink. Due to the single hopping, Leach leads to hot-spot problem.

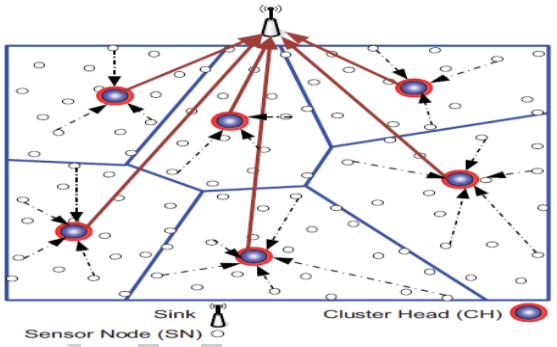

Fig 2: LEACH [1]

V. Mobile Sink

In WSN, with the help of mobile sink we can reduce the energy [5] consumption because due to sink mobility the sink is moving inside and outside the surroundings to gather the node data. Sink has two movements: controlled and uncontrolled. Controlled means the Mobile sink [4,6]trajectory is fixed or predefined. Whereas in uncontrolled it is not specified. Rotating sink closes to the normal nodes decrease the transmission distance. To increase the lifetime of wireless sensor network , the mobile sink is introduced. To count the total tour distances and the maximum distance between two consecutive movements , the mobile sink is introduced in the wireless sensor network.

VI. Rendezvous Node

The concept of MS introduced above has a drawback that it cannot be closed to collecting data from all the nodes. So, a new method called Rendezvous Node (RNs) or Rendezvous

Point (RPs) has been developed. RN is defined as a point closer to the area of MS. RNs collects data from CHs and transmits this data to MS as it comes closer to it. MS notify RNs of its arrival by sending a signal called beacons. The advantage of RZ node is that it helps in reducing consumption of energy.

To determine RZ node we need to find the distance of nodes from the trajectory of MS, which is as given below:

$$yw/2\ (1+Rx) <= yy <= yw/2\ (1-Rx) \quad (6.1)$$

Where yw is the sampling region width, yy be the node location in y-direction and Rx = constant related to the width of region <1.

VII. Proposed One Hopfield Neural Network (HNN)

One-Hopfield Neural Network (HNN) is an area of Artificial Neural Networks (ANN). It is a Recurrent Neural Network that have synaptic connection pattern. Following are the steps to find cluster head using HNN

1. Initialize weights $T_{xy} = \sum_{c=0}^{M-1} i_x^c i_y^c$ x≠y Where i_x^c is element x of class c exemplar
2. Apply input on the outputs $z = i$
3. Iterate until the network converges $z_y^+ = f_h(\sum_{x=0}^{N-1} T_{xy} z_x^-$ where, f_h is hard limiter. The output converges to the best matching exemplar.
4. One-hop-field concept of neural network has been applied to learn the group of nodes that are eligible to become CH. Hop-field network are used for pattern recall. In it weights are assigned to each node and must take value of +1 or -1.

```
T = [ +1   +1   -1   +1;.....
      -1   +1   +1   -1;.....
      +1   +1   +1   +1;.....
      -1   -1   +1   +1  ]
```

The first parameter shows energy consumed (should be minimum), second parameter shows distance (minimum), third parameter indicates neighbors (maximum) and fourth parameter shows ratio of current energy by remaining energy (maximum). In best case we have value [-1 -1 +1 +1] and in worst case values are [+1 +1 -1 -1]. The nodes having best and average set of values are considered for CH selection.

VIII. PSO ROUTING

Particle swarm optimization is an optimization technique developed by Eberhart and Kennedy in 1995 inspired by the behavior of birds flocking and fish schooling. Many variants of PSO [9,10] exist and it may also grow very rapidly. Two types of variant exists basic variant and modification variant of PSO. In basic variants of PSO, we have velocity clamping, weight, constriction coefficient and synchronous Vs Asynchronous and in the modification of PSO, we have single solution of PSO, nitching with PSO, Discrete PSO.

In PSO, Every single solution is bird which may also called particles. Each particle has their fitness value which can be obtained by fitness function and have velocities which flying with the particles. In each iteration, each particle is updated by two best values called global best and local best. First of all, the best solution is achieved and fitness value is stored and this particular value is called the pbest. The value obtained so far by any of particle in the whole population is called global best gbest. When any particle takes part in their population, the best value obtained so far become the local best also called the lbest.

After finding these two values, the particle has to be update their velocity and position with the following equation.

```
vel[] = vel[] + c1 * ran() * (pbest[] - present[]) + c2 * ran() *
        (gbest[] -present[])                                    (6.1)

pre[] = per[] + vel[]

                                                                (8.1)
```

vel[] represents velocity of particle, per[] represents current particle, ran () represents random number ranges from 0 to 1 and c1, c2 represents learning factors which is equal to c1 = c2 = 2.

Pseudo code for PSO

Generate Initial Particle randomly
Repeat
For every particle i to the maximum iteration
Compute best fitness function
Upgrade velocity
Upgrade best position
Upgrade global position
Upgrade Position
End for
Until the final criterion is met

IX. Simulation Result

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

- Number of dead nodes

- Number of alive nodes
- Number of packets send to base station
- Remaining Energy

Table1:- Simulation Parameters

Parameters	Value
Area(x,y)	150,150
Base Station(x,y)	Moving
Number of nodes	100
Probability	0.1
Initial Energy	0.5J
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
Message Size	4000bits

Dead Nodes:- This is the graph of dead nodes in RZLEACH and HNNPSORZLEACH 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 all the nodes are die at the round of 2000 in case of RZLEACH and 2700 in case of HNNPSORZLEACH.

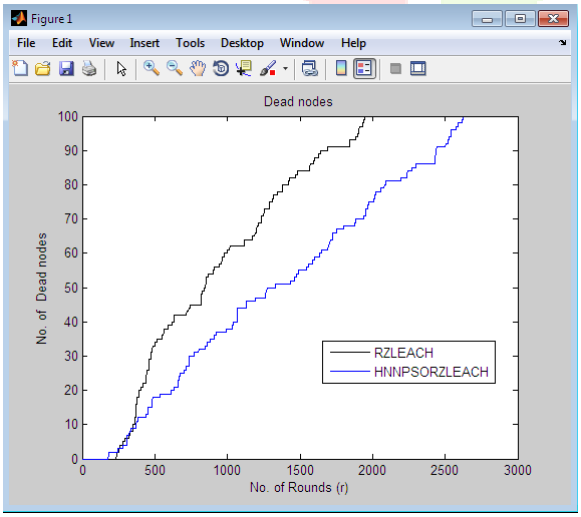

Fig 7.1 Dead nodes Vs Rounds

Alive Nodes:- This is the graph of alive nodes in RZLEACH and HNNPSORZLEACH protocol. It has been found that the number of nodes alive much more in HNNPSORZLEACH protocol. Here, we can see from the graph that the nodes are alive at the round of 2000 in case of RZLEACH and 2700 in case of HNNPSORZLEACH.

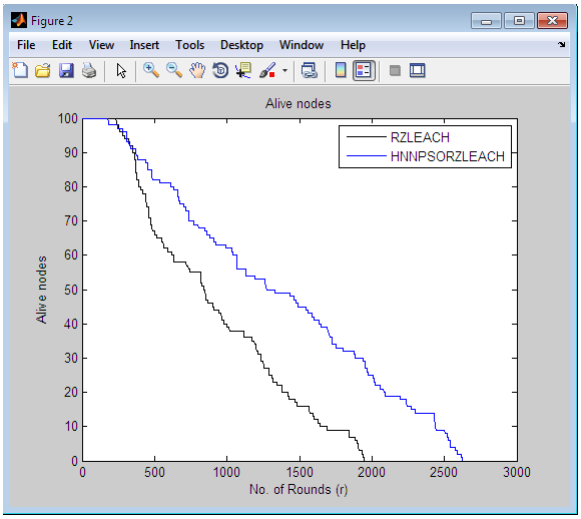

Fig 7.2 Alive nodes Vs Rounds

Packets Send to base station:-
This is the graph of Packet send to base station after simulation. This graph shows the total number of packets send to the base station by the sensor nodes. At the round of 2000, the total number of packets send to base station is 6050 in the case of RZLEACH protocol and in case of HNNPSORZLEACH ,the packets send to base station is 10500.

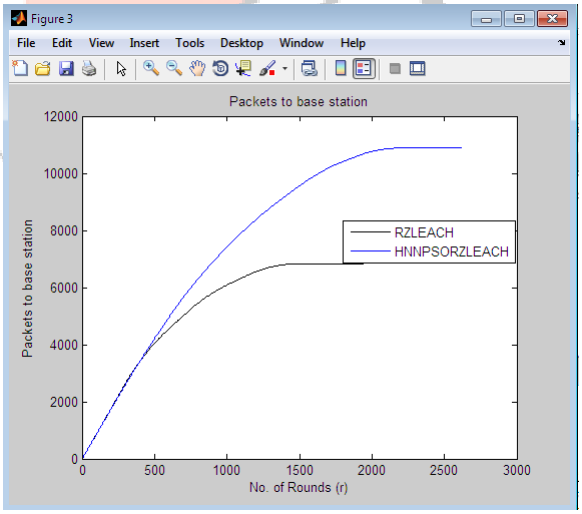

Fig 7.3 packet send to BS Vs Rounds

Remaining Energy:-
This is the graph of remaining energy, how much energy is left with the rounds. From the graph, we can see the remaining energy with RZLEACH goes to 2000 rounds, whereas in the case of HNNPSORZLEACH the remaining energy goes to 2500 rounds means more work can be done with HNNPSORZLEACH protocol.

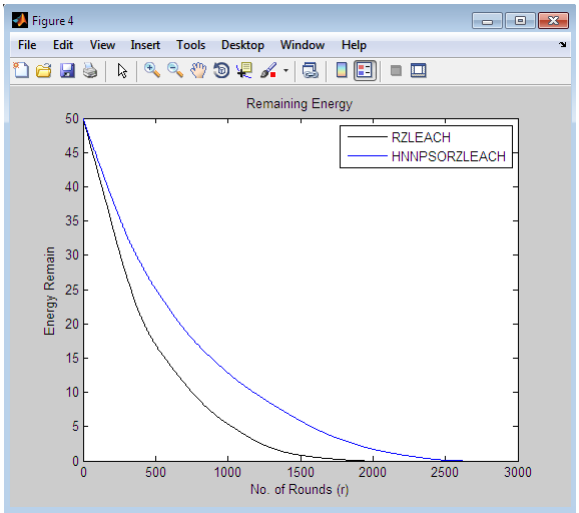

Fig 7.4 Remaining Energy Vs Rounds

X. CONCLUSION AND FUTURE SCOPE

In this paper, we have proposed the HNNPSORZLEACH which is an efficient technique. This protocol adopts the selection of path criteria using the PSO technique which outperforms RZLEACH. The proposed protocol shows the better improvement over existing protocol. But this work has not taken into account the utilization of 3D WSNs, which are becoming major area of research in these days. Therefore in near future work we will extend the planned technique for 3D WSNs environment.

XI. REFERENCES

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