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Research Article

Performance Evaluation of Cluster Head Selection using ANFIS

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Abstract

Wireless sensor network are emerging in various fields like environmental monitoring, mining, surveillance system, medical monitoring. Wireless sensor networks consist of thousands of tiny nodes having the capability of sensing, computation and wireless Communications. Leach protocol is used as low energy consumption routing protocol. Communication between clustered data and Base station is done via Cluster head only so cluster head selection is one of challenging issue in wireless communication. In this paper we have introduced proposed approach for cluster head selection using neurofuzzy algorithm. Comparative analysis of proposed leach is done with leach, leach c, leach cc .Simulation results conclude that our proposed leach can improve life time of network and save more energy as compare to other leach protocols.

Keywords *Wireless sensor network, Leach, Leach C, Leach CC, Cluster Head Selection, Network life time.*

1. Introduction

Wireless Sensor Networks (WSNs) are usually self-organized wireless ad hoc networks comprising of a large number of resource constrained sensor nodes. One of the most important tasks of these sensor nodes is systematic collection of data and transmits gathered data to a distant base station (BS). With its wide application in military reconnaissance, medical aid, logistics management, environmental monitoring, agriculture and other commercial areas, WSN has become the furthermost technology in the field of communication and computer research (J. Anand *et al*,2012). Wireless Sensor Network (F.Alotaibi *et al*, 2007) generates a large amount of data that has to be aggregated at various levels. A multidimensional aggregation approach is considered for exhibiting the node parameters for each network. Bandwidth, memory, signal strength, time, battery power etc. have been utilized to examine the performance of a sensor network.

Hence network life- time becomes an important parameter for efficient design of data gathering schemes for sensor networks. Energy management is a key issue in the deployment of sensor networks, because sensors only reply on the battery for the power which cannot be recharged or replaced. The available energy is considered a major factor when designing protocols in a sensor network. The lifetime of the battery operated nodes may be extended in some way by adopting appropriate energy conservation mechanism for efficient communication. Low-Energy Adaptive Clustering Hierarchy (LEACH) is a classical clustering routing in wireless sensor networks (H. Ando *et al* ,2010). However the cluster-head selection in LEACH protocol is lack of balancing the whole network energy consumption, with the result that low energy nodes run out of energy prematurely and decline the network life. This paper analyses the effectiveness of LEACH protocol in cluster-head selection, and proposes an improved energy balanced clustering algorithm.

2. Introduction to Leach Protocol

W. R Heinzelman proposed LEACH protocol, which focused around group structure and progressive technology. With respect to the customary protocols, LEACH could spare a more noteworthy level of vitality. For most sensor nodes, the short-separate correspondence spared more vitality, in LEACH, the more correspondence was constrained in clusters, just a couple Next Node spoke with base stations long separation. It utilized versatile innovation and Next node pivot technology, LEACH was more proficient than the first class system structure; the entire WSN was more adjusted on burden appropriation, and could broaden the WSN lifetime extraordinarily. Moreover, each one cluster could compute by regional standards and uproot repetitive information, lessen the corresponding trouble of Next Node. As the vitality utilization of the count was substantially short of what the vitality utilization of correspondence, so LEACH could spare vitality incredibly. In any case there were still issues in LEACH: Firstly, the node utilized force control when sending information, the vitality utilization of node was not same. At the point when the Next Node decision, it was viewed as that the quantity of Next Node previously, without the vitality distinction between the remained nodes, prompting uneven dispersion of vitality utilization.

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Also, LEACH chose Next Node haphazardly, the quantity of Next Node shut to the ideal worth couldn't be ensured.

1 Operation: LEACH operation is broken into rounds, with each round having a set-up stage and a steady state stage.

Setup stage: Each node chooses whether or not to be a cluster head focused around its remaining vitality and a universally known sought rate of Next Nodes. Every node choosing itself as a group head shows a commercial message proclaiming its expectation. Non-cluster head node get perhaps a few ads and pick one group to join focused around the sign quality of the commercial got from the comparing cluster head.

Steady state stage: Each cluster head holds up to get information from all nodes in its group and afterward sends the accumulated or layered come about over to a BS. The cluster head selection in each cluster during the setup phase ensures the data transmission in steady state phase when there is need to transmit data, first they will send data to Ch. during idle slot canned in TDMA schedule table. Cluster heads should maintain communication status at all times and it will help to receive data from different sensor nodes. After receiving all the data sent by their members, CHs will aggregate them firstly and then send them to BS. When some sensor nodes may detect similar data them data reduce unwanted bandwidth cost, energy consumption is less. To overcome the problem of Cluster head dies early, a new round starts and new clusters formation will be done in the sensor network.

3. Simulation Results

3.1 Overview of Anfis Structure

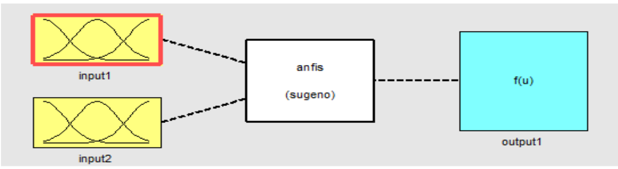

Figure 1 Structure of ANFIS

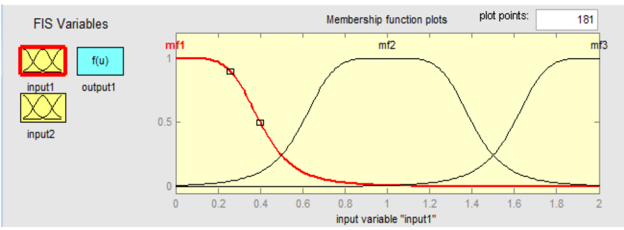

Figure 2 Membership function of input 1

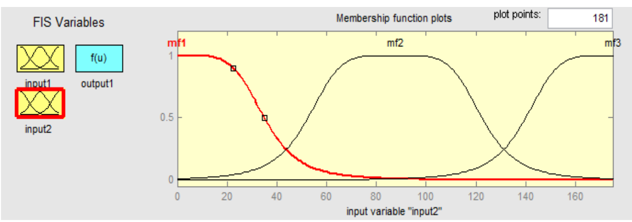

Figure 3 Membership function of input 2

As shown in above figure 1. We have used two inputs for train anfis i.e. input 1 and input 2 and there is only one output. Fig 2 shows the membership function of input 1 i.e. energy ranges between 0 -2 joules. Figure shows the membership function for input 2 i.e. Distance to Base Station .Ranges between 0 -175 k.m.

3.2 ANFIS Training and Error Values

We have loaded training and testing data set for anfis modeling .Training data is shown by 'o' and FIS output is shown by '*' As shown in fig 5.7 ,After 40 epochs average testing error for training data is observed is 0.07503.And after testing data set average testing error is found is 0.327. As shown in fig 5.8 ,checking data is shown by 'blue dot ' and Fis output is shown by red '*'

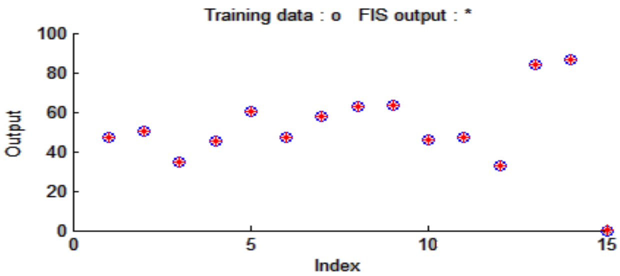

Figure 4 Training data set output

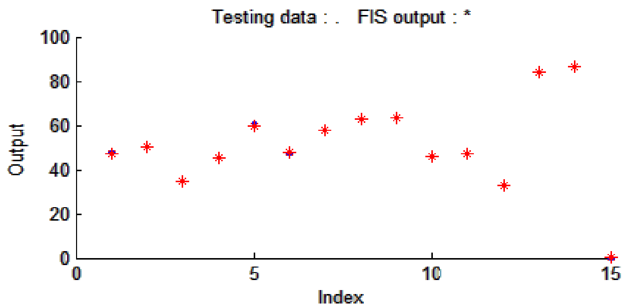

Figure 5 Testing data set output

As we know for ANFIS, we need data sets for training. Data sets are the combination of inputs and outputs. When the training process initiated epochs are set ,then after every epoch error is minimized .We have used 40 epochs for error minimization. The error minimization is shown in the Figure 5.7. After 40 epochs the error is minimized to 0.639981. Figure 5.9 Shows the testing error after training, testing data set. After 40 epochs testing error is minimized to 0.07503.

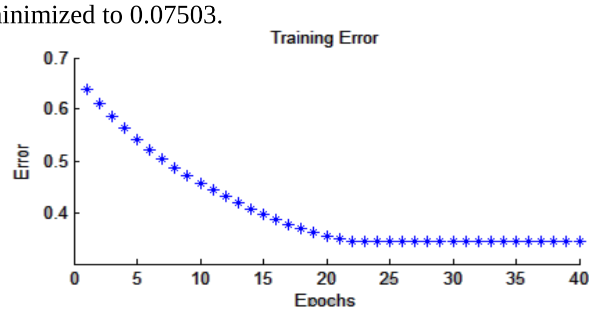

Figure 6 Minimum training error

Table 1 Minimum training values

S.No.	Error	Value
1	Training error	0.639981
2	Testing error	0.349269

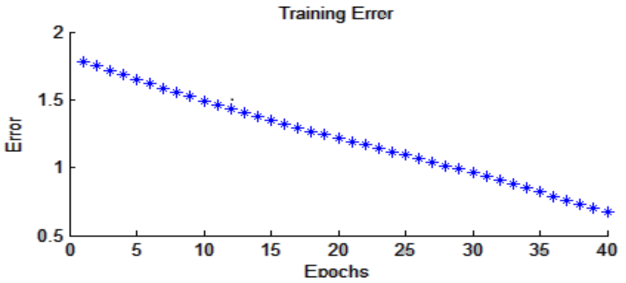

Figure 7 Minimum testing error

3.3 FIS Rules and Simulation Parameters

We have made 3^2 =9 anfis rules .Fig 8 shows the 9 anfis rules .Fig 9 shows the chance to become clusterhead inacordance with the variation of input 1 and input 2 .Fig 10 shows the surface diagram of input 1 and input 2 and chance output 1.

Figure 11 shows the shows the generated ANFIS structure using MATLAB. The two inputs that we considered are the Energy and Distance to Base Station are shown in layer one. Both inputs are represented by black dots. Layer 2 represents the input memberships of energy and distance to the Base Station.

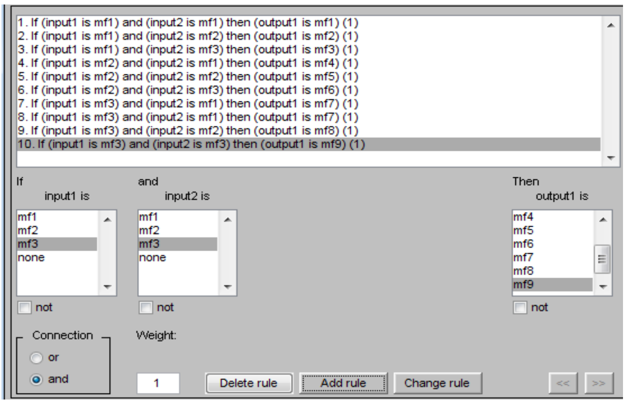

Figure 8 Rule editor window

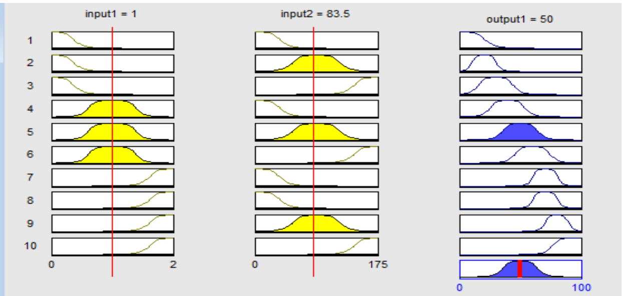

Figure 9 Rule viewer

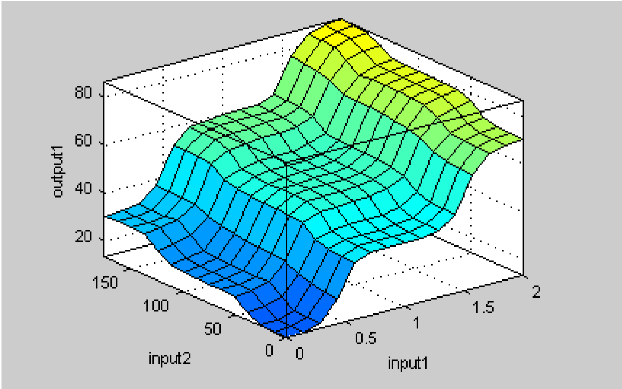

Figure 10 Surface diagram

The linguistic variable are ‘LOW’,‘MEDIUM’, ‘HIGH’ and ‘NEAR’, ‘MEDIUM’, ‘FAR’ respectively. Layer 3 represent the number of rules generated. We have used 9 rules which are shown by blue spot. Layer 4 represents an output membership function after training the input membership functions. Layer 5 shows the output. Final output is shown only by a single node. This layer represents the final output using black dot.

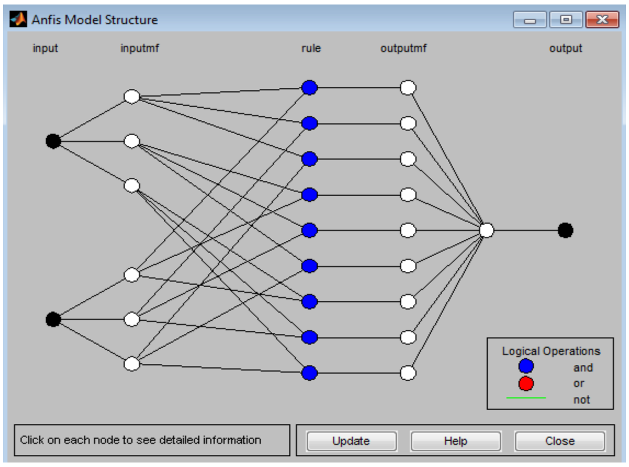

Figure 11 ANFIS Structure

3.4 Simulaion Parameters

Table 2 Simulation Parameters

S.No	Parameters	Value
1	No of Nodes	100
2	Network Size	(100 x 100) m^2
3	Initial Energy(Eo)	2J
4	Transmission Energy (ETX)	50nJ/bit
5	For Energy Reception (ERX)	50nJ/bit
6	Free Space Energy Loss (Efs)	10 pJ / bit /m2
7	Multi path Energy Loss (Emp)	0.0013pJ / bit /m^4
8	Maximum no. of Rounds (rmax)	700
9	Location of BS(Sink)	(50,175)
10	Adaptive Energy(E_{DA})	5n J/bit
11	Packet Length	4000 bits

4. Network Model

The network modelmake available the operating environment that consists of N nodes and one base station. Nodes are randomly deployed in an area of (100 x 100) m^2. The base station is fixed at a far distance from the sensor nodes. The sensor nodes periodically sense the environment and send data to base station. In this work, our model sensor network has following properties:

1. The Base station is immovable at far away from the sensor nodes
2. The sensor nodes are homogeneous and energy constrained with even energy.
3. The energy rate for transmitting a data packet depends on the distance of transmission.
4. The communication channel is symmetric.

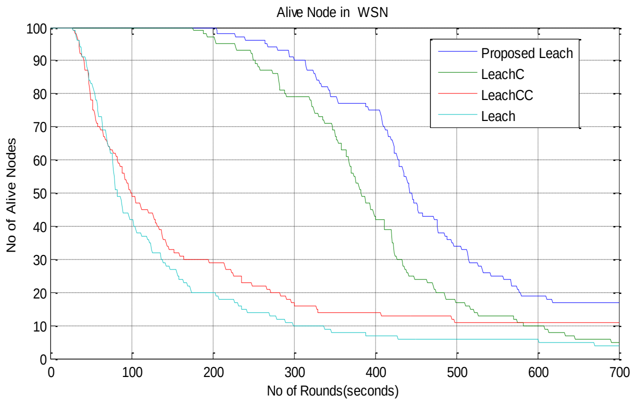

Figure 12 Comparative analysis Alive Nodes of Leach , Leach C,Leach CC and Proposed Leach

As we can be seen from the above fig 12 that life time of proposed leach is better as compare to Leach ,Leach c and Leach CC Protocols.Proposed leach improves the network life time by 84%.From the above figure 13 proposed leach transmit more data packets to base station as compare to other leach protocols. So communication over the network can be performed for more time.

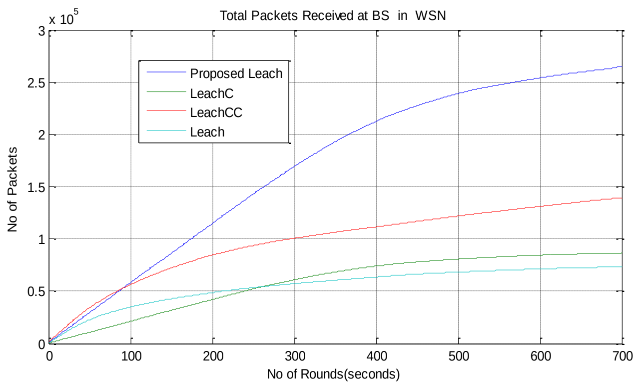

Figure 13 Comparative analysis of Total packets received at BS (Proposed ,leach c, leach cc ,leach)

Figure 14 shows that Proposed leach consumes less energy as compare to other leach protocols. So Proposed leach can save more energy and prolongs the network life time effectively.

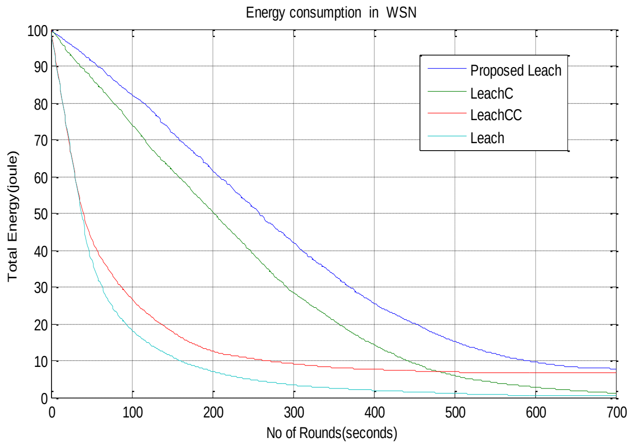

Figure 14 Energy consumption of Proposed leach ,leach C, Leach CC,leach.

Conclusion

This paper presents the improvement in LEACH CC and Comparison analysis of Leach ,leach c,LEACH CC.In LEACH CC cluster head is selected on bases of residual energy only.In our proposed approach we have used residual energy as well distance to base station for cluster head selection .Hence obtained results shows the significant improvement in longevity of network life and packets transmitted to base station. It shows that communication is better in proposed Leach . The proposed Leach has momentous improvement in the network life span and energy saving . The comparative analysis of proposed Leach is done with leach, leach c,leach cc.

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