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Energy Efficient Super Node Operated Data Aggregation Approach in WSN

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Abstract: With the advancements in the technology, the communication networks also shifted to wireless networks from wired networks. Wireless networks are named as WSN (Wireless Sensor Networks) and this technology is rising day by day. WSNs are has been proved cost effective networks since they saved a lot of energy which indirectly reduced the maintenance cost by enhancing the lifetime of the network. In order to make energy efficient network, various energy efficient mechanisms has been developed within last few years. This work also introduced a novel energy efficient CH selection approach by enhancing the traditional (LEACH) Lower Energy Adaptive Cluster Heads protocol. These enhancements are done by improving the list of parameters by introducing the distance between Cluster Head (CH) and Base Station (BS). And the fuzzy inference system is applied for performing the SCH (Super Cluster Head) selection. The results proves that the proposed fuzzy based LEACH mechanism is proficient than the traditional LEACH protocol in terms of network lifetime, dead nodes and alive node.

Keywords: Energy Efficient Wireless Sensor Network, LEACH, Fuzzy Inference System, Network Lifetime, Dead Node, Alive Nodes.

I. Introduction

Wireless Sensor Networks (WSN)are gradually reckoned by the technical society with the prospectus of environmental observations. The concept of automating the grouping of environmental data to monitor the surrounding is not a new concept [1]. But the WSB has a feature that allows the real time based processing at a minimum cost. Its ability of spontaneous deployment of the nodes within a network makes it easier to expand and maintain. These sensor nodes perform operation of data transmission by utilizing the allotted energy.

In past few years the use of WSNs have been increased and simultaneously the problems related to the energy constrained also raised because we have limited amount of energy stored in the battery. As the working of nodes totally dependent on the amount of energy therefore it is not an easy task to recharge and replace the battery unit. If any node in the network stop operating then it leads to failure of the whole network. To overcome the problem of extra energy consumption, the concept of clustering was introduced. This is a systematic process which gathers the nodes of similar nature in a group and thus creates multiple small groups of nodes in a network. The main purpose of the clustering is to reduce the energy consumption of the nodes by creating CH corresponding to each cluster which is responsible to transmit the data from nodes to sink node or base station [2]. The clustering has been proved quite successful for reducing the energy consumption of the nodes. Then different energy efficient clustering protocols was introduced which are specifically considered for the purpose of energy efficient CH (Cluster Head) selection. These protocols are LEACH (Low Energy Efficient Cluster Head), HEED (Hybrid Energy-Efficient Distributed Clustering), DEEC (distributed energy efficient clustering), TEEN (Threshold sensitive Energy Efficient sensor Network), PEGASIS (Power-Efficient Gathering in Sensor Information System), etc [3].

Within last few decades, various authors has been conducted their research in the domain of the energy efficient network generation. But still there are some issues which need to be resolved. Traditionally, the CH selection was done by applying energy efficient CH selection protocols and also considered some factors that highly affects the performance of the network, these factors are like energy, distance between node and Ch, mobility of the nodes, centrality of the nodes etc. But most of the researchers focused on energy, mobility and centrality as a major factor and somewhere avoids the distance. This study has been organized with an objective to develop and energy efficient network by introducing an enhanced version of traditional LEACH protocols. The enhancements are performed in the terms of list of parameters that selects the CH, as distance between CH and BS (Base Station) is added as a major factor. The proposed work performs the CH selection by using Fuzzy Inference System.

II. Problem Formulation

From the literature survey, it has been studied that several protocols have been defined followed the clustering criterion. However, these algorithms have been suffering from several issues such as cluster heads are selected on the random basis. The random selection of cluster heads sometimes selects the same node as cluster head more than once. This can leads to the early depletion of the energy of such nodes. Thus if the Ch depletes energy at early stage then the data transmission also gets effected. Another issue was that the super cluster head selection was done on the basis of centrality, mobility and energy parameters. The traditional work did not considered the distance as a factor. The super cluster heads are responsible to transmit the data to the sink node. It is possible sometimes that base station gets far away from the SCH since it follows the concept of random walk. Thus it is mandatory to consider the distance as a part of the major factors also. Therefore, the existing algorithms consume high energy and reduces lifetime of the network.

III. Proposed Work

On the basis of the review study, it is extracted that in traditional work the cluster head selection was performed on random basis. This increases the probability of selecting a node as a CH more than once. Thus the energy of such CH nodes gets depleted earlier which can results to the interruption in the process of data transmission. Furthermore, it was also notices that the number of parameters which were considered for SCH selection was not relevant enough to generate energy economic network. Thus in this study a novel approach is proposed by using Fuzzy Inference System to achieve an energy efficient network.

In proposed work, the CH selection is performed on the basis of the residual energy of the nodes. It means the node with the higher residual energy has highest probability of becoming a Ch. Another enhancement is done in proposed work is that the distance within the SCH and sink node is also considered along with the energy, centrality, mobility of the nodes. The methodology of proposed work is as below:

1. Start
2. Initialize the network by initializing the different network parameters. The network initialization is done on the basis of network area, number of nodes in a network, initial energy of the nodes etc.
3. Perform cluster formation on the basis of the minimum distance. The near located nodes or more adjacent nodes will comes under same cluster.
4. After creating the cluster, next step is to select the cluster heads on the basis of the energy. It means the node with the higher amount residual energy is selected as a cluster head for that particular cluster.
5. After selecting the CH, this step initializes the proposed fuzzy inference system for selecting the super cluster head. This is done by using four input membership functions i.e. Energy, Centrality, Mobility and Distance.
6. By applying the proposed fuzzy rule set the SCH is selected.
7. Next step is to perform data transmission and evaluation of network performance parameters.
8. Stop

The figure 1 shows the flow of proposed work in a pictorial representation.

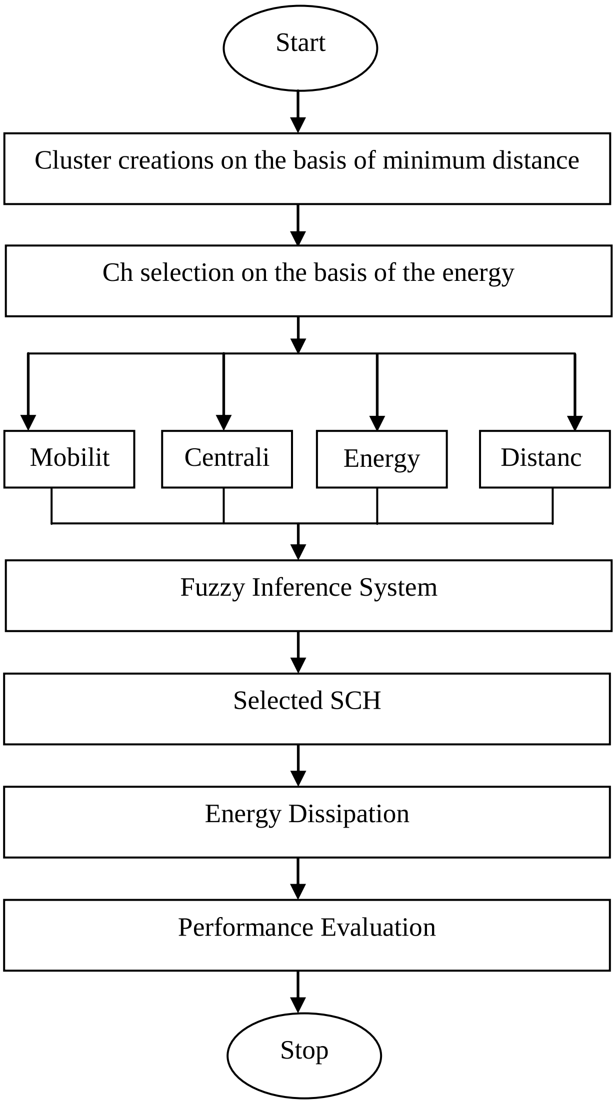
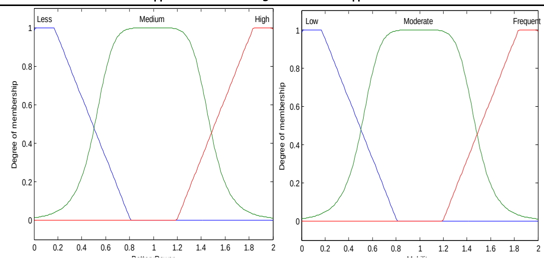


Figure 2 Block Diagram of Proposed Work

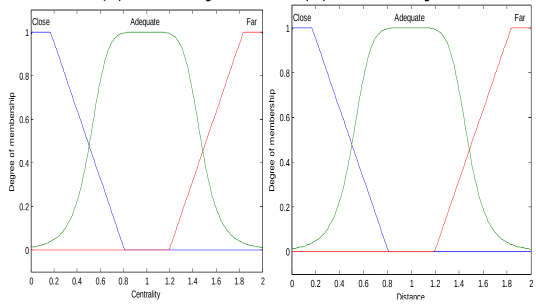
IV. Results

This section provides an overview to the results that are obtained after implementing the proposed work in MATLAB. The figure in 2 represents the membership functions that are used for proposed work. The input membership functions are as follows:

1. Battery power: This input membership function is used for defining the battery power or energy of the nodes in the network.
2. Mobility: It is an input parameter which is used for defining the movement or mobility of the nodes in the network.
3. Centrality: This input parameter elucidates the central location of the selected CH.
4. Distance: distance is considered as an input parameter to measure the difference between CH and sink node.
5. Chance or Probability: It is an output parameter that defines the chance of a node of getting s4elected as n cluster head.



(a). Battery Power (b). Mobility



(c). Centrality (d). Distance

Figure 2 Input membership functions

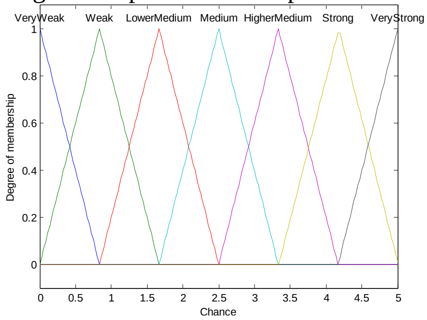


Figure 3 Output membership functions (a). Chance

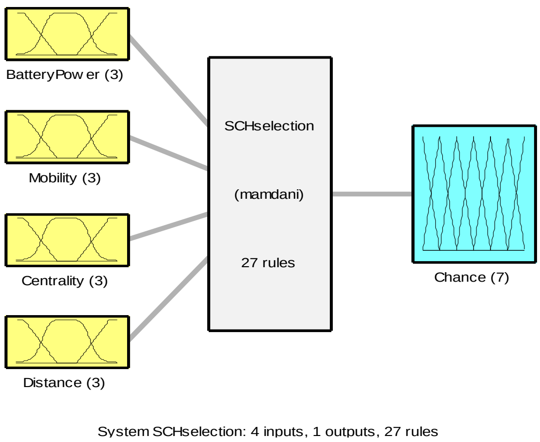


Figure 4 Proposed Fuzzy Systems

The image in figure 4 shows the proposed fuzzy network. It is comprised of 4 input parameters that are defined in above section. Then CH selection is performed by applying 27 different rules on these input parameters. The Mamdani fuzzy system is used for the purpose of implementation. Then the output is generated in the form of probability of the nodes for selecting as a CH.

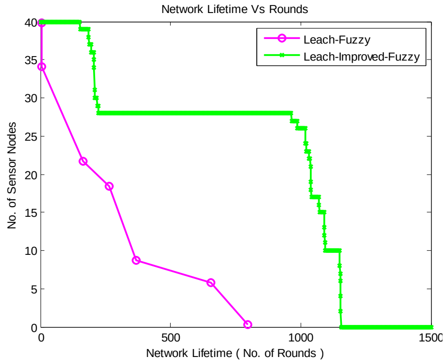


Figure 5 Comparison of Network Lifetime

The figure in 5 portrays a comparison of LEACH fuzzy and proposed work in the terms of network lifetime. The analysis of network lifetime is done on the basis of number of communication rounds. The curve in green color shows the network lifetime of proposed work and curve in magenta color represents the lifetime of traditional network. On the basis of the graph it is concluded that the lifetime of the proposed work is higher in comparison to the traditional work.

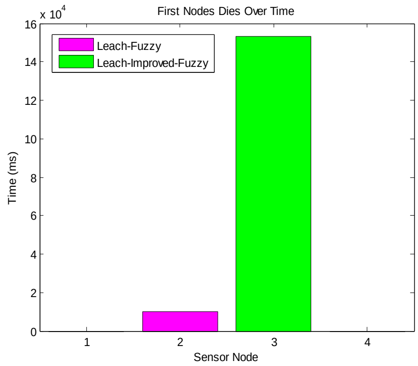


Figure 6 First Dead Nodes

The graph in figure 6 depicts the comparison of proposed and traditional work in the terms of the first dead node in the network. The x axis in the graph shows the number of sensor nodes in traditional and proposed network. The y axis calibrates the time in ms for evaluating the first dead node in the network. The graph proves that in traditional work the first node dies earlier than the proposed work.

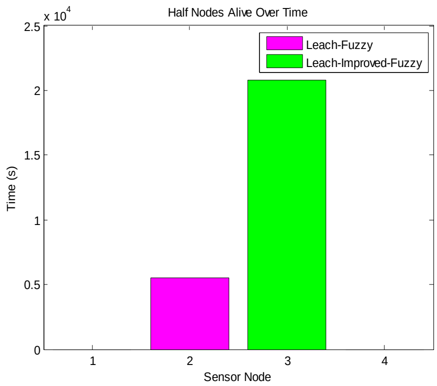


Figure 7 Half Nodes Alive

The graph 7 shows the half dead in case of proposed and traditional work. The half alive depicts the 50% nodes of the total available nodes. The half alive node is also evaluated on the basis of the time. The y axis in the graph shows the time in ms and x axis shows the half alive nodes corresponding to proposed and traditional work. The graph manifested that the proposed work is much better than traditional work in terms of respective parameter.

The graph in figure 8 shows the comparison of proposed and traditional work in terms of last dead node located in the network. The graph represents that in traditional work, last dead node is found earlier which results to the shortest network lifetime whereas for proposed work, the last dead node is found quite later in the network which ensures the enhanced lifetime of the network.

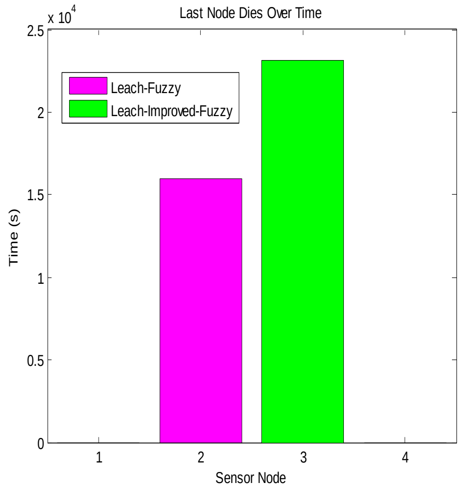


Figure 8 Comparison of Last Dead Node

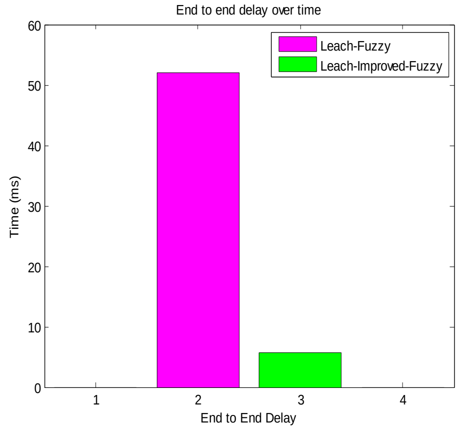


Figure 9 Comparison of End to End delay

The graph in figure 9 draws a contrast among proposed and traditional work on the basis of the end to end delay. The term end to end delay is used for measuring the time taken by the data packets to reach at receiver end. The end to end delay should be low. It is observed from the graph 5.12 that the proposed work has quite lower end to end delayed i.e. 5.77 ms approx in comparison to the LEACH-FUZZY.

V. Conclusion

Clustering algorithm is an approach to enhance the network lifetime. Based on foibles of original LEACH method, a technique (LEACH-Improved-Fuzzy) is developed in this study. The proposed algorithm is enhanced by adding distance among Super CH and base station as major parameter. The efficiency of the proposed work is evaluated on the basis of the results that are performed by using MATLAB simulation. The proposed work performs the super cluster head selection on the basis of the energy, centrality, mobility and distance. These parameters lead to produce an output in the terms of chances of a node for getting selected as CH. It is observed that the proposed work has proficiency over traditional work in the terms of network lifetime, end to end delay, number of dead nods and number of alive nodes in the network.

It has been noticed that number of authors have been worked on energy efficient networks to enhance network lifetime but data processing is a domain which is less entertained yet. Thus, further enhancements can be done on data processing in terms of securing the data, reducing packet size etc.

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