Fuzzy Logic Based Zone Head Selection Algorithmfor WirelessSensor Networks

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Abstract:*Hot-spots is a problem that comes in the cluster based routing protocol that employ the multi-hop communication due to this problem the energy among the sensor nodes are not balanced.Hot-spots issue requires high overhead and is prone to a connectivity issues in the sensor network this can be only possible because of unequal clustering.In this method we have to active all the nodes of the sensor network for communication. This process consumes high system energy if the numbers of nodes are very high. To offer guaranteed connectivity, decrease high usage and complexity, a fuzzy logic based zone divisional method has been proposed in this paper. Use a fuzzy logic to create clusters and assign nodes to them to decrease the consumption of energy, and the age of the network prolongation. The simulation and results section shows the outperformance of the proposed protocol, where the (LEACH) low-energy adaptive clustering hierarchy, (EAUCF) energy-aware unequal clustering fuzzy,(EAMMH) energy-aware multi-hop multi-path hierarchical, and (TTDFP) two-tier distributed fuzzy logic-based protocol for efficient data aggregation in multi-hop wireless sensor networks algorithms.Proposed algorithm has better results in terms ofenergy consumption minimization, and prolongation of the network lifetime.*

Keywords:Wireless sensor networks, clustering, fuzzy logic,multi-hop, hot-spots, energy consumption, network lifetime.

1. INTRODUCTION

Wireless sensor Networks (WSNs) serves as a broader area of research nowadays. These networks are composed of multiple autonomous, low cost, power efficient and tiny sensor nodes. The information is collected by the sensor nodes and transfer to base station for processing. A wide range of application areas of sensor node include medical, military, research, weather forecasting etc. Sensor networks monitor the physical attributes like moisture, temperature, pressure, noise, vibration etc.and also a wide range of sensor nodes are organized in an area for detecting the sure event is monitored by wireless sensor network applications[1], [2].The sensor nodes consume a very large amount of energy. The WSNs is separated into a group of clusters, each of which has a coordinator called the cluster head (CH). The sensing data collected by cluster member (CM) nodes sends directly to corresponding CH, but not directly sent to BS. The tasks of the CHs are aggregating data from CMs and forwarding it to BS [3].In wireless sensor networks extending network lifetime plays an energetic role if the distance is high, it needs extra energy and reduction of energy consumption.Clustering in sensor nodes is very essential in order to solve many problems like energy, scalability and lifetime issues of sensor networks and having some objectives like Allows aggregation, Limits data transmission, Cluster heads and gateway nodes can

form a virtual backbone for inter-cluster routing, Improve network lifetime, Minimize network traffic.The clusters can be either an equal or an unequal sized cluster. The data resemblance aware node clustering is an unequal sized clustering method mentioning in a spatial and temporal relationship[4], [5], [6].The multi-hop routing protocol and the CH located far from the BS needs to send data through the CH that is located near to the BS. Therefore, sensor nodes closer to the BS consume more energy due to heavier data forwarding jobs. Hence, the issue of energy hole is likely to happen. To solve problem of hot spot, unequal clustering algorithms are typically introduced in which the network is separated into clusters with unequal sizes [7].Single hop consumes more energy for transmission of data to far distance so multi hop communication is used. In multi hop communication through intermediate relay nodes source node transfers data to base station [8].Fuzzy Logic is based on human reasoning and heuristic knowledge, is one of the best problem-solving allowing a time-consuming latency and extends lifespan of the network.In this cluster formation each non-CH nodes calculates a chance value for being linked to each CH by applying FL, using residual energy and closeness to CH as fuzzy inputs[9].Fuzzy Logic is one such computational intelligence used for selecting CH nodes in the WSN. FL particularly consists of four giant components. It includes a Fuzzifier, a Rule Base, an Inference Engine and a Defuzzifier. The input values are usually crisp which again are converted into fuzzy linguistic variables. The fuzzified values are sending to Fuzzy Decision Block (FDB). FDB is composed of Inference Engine and Rule Base. It presents fuzzy output primarily based mostly on the fuzzy rules. Then the fuzzy output is transformed into crisp output by means of defuzzification [10].

The rest of the paper is organized as follows: Section 2 reviews the related work, Section 3 describes the proposed protocol method in the detail and Section 4 discusses the simulation results. Section 5 concludes the paper.

2. RELATED WORK

Siqing et al. [11]propose a clustering protocol based on fuzzy logic for Multi-hop WSNs to extend the lifespan of wireless sensor networks and decrease energy consumption of the entire sensor network.The technique of multi-hop transmission between clusters in a Fibonacci sequence avoids extreme transfer of data by a cluster head and prolongs lifespan of the network. The simulation results display the outperformance of FLCMN algorithm, where the LEACH, EAMMH and DFLC algorithms in terms of network's survival time and energy consumption.Lee and Teng[12]proposed improved low-energy adaptive clustering hierarchy protocol to prolong the network lifetime and also reduce the packet loss by using fuzzy inference systems. The simulation results show that the proposed LEACH-MF approach performs better than other existing approaches in terms of enhancement in the network lifespan, energy consumption, packet delivery ratio, and cluster deviation.Balaji et al. [13]proposed a multi-hop transmission, where the data packets are transmit from one hop to another hop. Lastly these data packets are sending to the base station. Type 1 fuzzy logic algorithm has been used to select the cluster head that is best in data forwarding also the fuzzy logic analyse the network nodes, which is having high trust rate, and as near as to the base station.The simulation show that the proposed EET2FL protocol has better results compared to LEACH, PEGASIS and EEUC protocols in terms energy consumption minimization, load balancing and prolongation of network lifetime.Mirzaie and Mazinani [14]presented an adaptive multi-clustering algorithm based on fuzzy logic for saving energy of wireless sensor network nodes. This proposed algorithm for clustering nodes in different rounds using different clustering algorithms and without selecting new cluster heads by trusting previous cluster heads leading to a reduction in the number of messages and lessen energy consumption of wireless sensor network nodes. Simulation results show that Adaptive MCFL approach performs better than other existing approaches in terms the reduction of energy consumption and saving more energy within the network.Bagci and Yazici [15]proposed an energy-aware fuzzy unequal clustering algorithm to solve hot spots issue. In this work fuzzy logic approach was used to process the competition range

andthis proposed protocol increases the network duration and solves the energy holes issue. The simulation results show that proposed approach EAUCF has a better performance compared to LEACH, CHEF and EEUC algorithms.Sert et al. [16]proposed Two-Tier Distributed Fuzzy Logic-Based Protocol for improving the data aggregation efficiency in the two-tier sensor networks. Selection of cluster head occur on the bases of available sensor nodes connectivity and saved energy has resolved and avoids the energy consumption in the network.The simulation graphs shows that TTDFP performance better than various methods under the same network area that is assuming metrics which is used for energy-efficiency comparison and network life time of the methods.Assari et al. [17] proposed an Energy-efficient Multi-hop routing with Unequal Clustering approach to save and to balance the energy usage between all network nodes. In thisthe nodes compete to be CHs based on a probabilistic model and the remaining energy of nodes. The minimum transmission energy algorithm is implemented to calculate the optimal path between the CH and its member nodes. The simulation results show that proposed EMUC algorithm has better results than LEACH and EEUC algorithms. EMUC balances consumption of energy between sensor nodes, lessens the hotspots problem, saves more energy and prolongs the network lifespan.Salam and Hossen [18]present clustering as a method to defeat the difficulties of energy efficiency and provide a brief analysis of homogeneous LEACH and EAMMH routing methods. EAMMH has a cross-section routing procedure that will help to keep the network alive for long periods of time. Due to multi-path and hierarchical routing mechanisms, EAMMH approach can have better energy efficiency than LEACH where there are large numbers of nodes in the sensor network.Most of the above protocols are proposed for cluster head selection algorithms. Moreover,some protocols are proposed for multi-hop transmission and some for clustering which are based on fuzzy logic approach. In this cluster head selection we have to active all the nodes of the sensor network for communication. This process consumes high system energy if the numbers of nodes are very high for reducing this complexitydevelop an algorithm based on fuzzy logic zone divisional method for energy consumption minimization, load is balanced, andprolongation of network lifetime.

3. METHODOLOGY

This methodology is applied to achieve the objectives of the study.This method is about zone divisional algorithm that is based on unequal clustering with multi-hop routing protocol using fuzzy logic approach. In this paper the algorithm improves cluster header selection method. In this section the proposed methodology is given below in the detail.

1. Select an area. That covers the whole area in which all the communication will happen in a well monitored fashion.
2. Deploy sensor nodes in that area, in a random method. Every time code will run, this deployment is meant to change to keep the system dynamic.
3. There will be a base station which will manage all the transfer of information from source to the receiver. Every route will be configured on the basis of base station.
4. The whole area is divided into zones like 9 in our case. Zones are very important and each zone will have its own head coordinator.
5. There will be some nodes available in each zone.
6. Our task is to select the zone header which will coordinate all the information transfer from/to that specific zone.
7. We use fuzzy logic to create clusters and assign nodes to them.
8. This process consumes high system energy and is very complex for the system architecture if the numbers of nodes are very high. We have to decrease this high usage and complexity for efficient data flow.

9. Therefore, our method will select the zone header but we will be more concerned on saving system energy and reducing the complexity.
10. This will be easy to deploy for sensor networks with large number of nodes as that would be case where most of the system energy will be used.
11. By using MATLAB the whole system will be simulated.

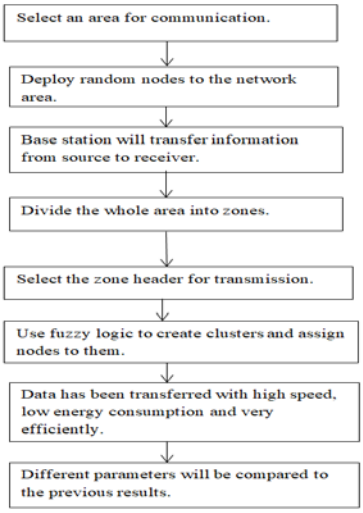

Fig. 1 Flow chart of methodology

4. SIMULATION RESULTS

The proposed algorithm has been evaluated by using MATLAB because its Fuzzy Toolbox observes all fuzzy membership functions;thereforeit is suitable for use. This proposed algorithm was simulated by using MATLAB. In thisscenario the implementation is done by taking One hundred sensor nodes in the selected area. The following are simulation results of the proposed method step by step implementation and results have been shown.

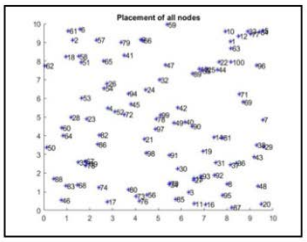

Fig. 2 Random placement of nodes in the network

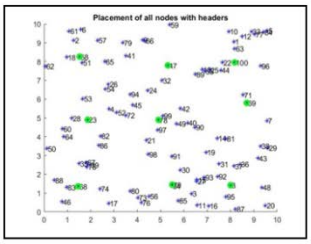

Fig. 3 Header nodes are selected from all the nodes

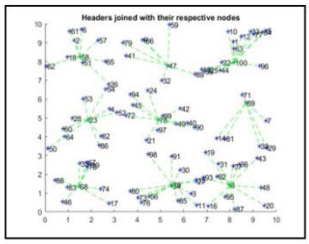

Fig. 4 All the nodes in a zone are connected to their respective header nodes

The fig. 2 shows the random placement of nodes in the network. Every time the code runs, a new set of coordinates are generated which are considered as the network nodes. Fig. 3 shows header nodes are selected from all the nodes using fuzzy logic systems. Fig.4 shows all the nodes in a zone are connected to their respective header nodes. The fig. 5 shows all the header nodes are also connected to each other for efficient communication. The sub nodes will transfer information to their respective header nodes and then header-to-header communication will start. Fig. 6 shows sender is selected and communication takes place from sender to receiver using the inter zonal network (comprising of head node and sub nodes) and inter header network (comprising of only header nodes).

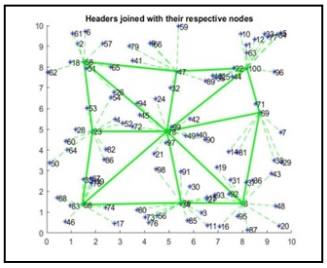

Fig. 5 All the header nodes are connected to each other for efficient communication

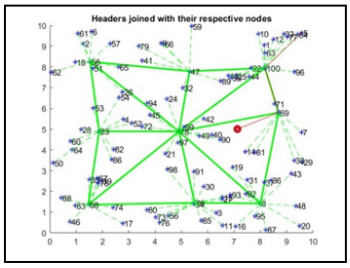

Fig. 6 Sender is selected and communication takes place from sender to receiver

This graph shows the final results of the energy consumption after every iteration.

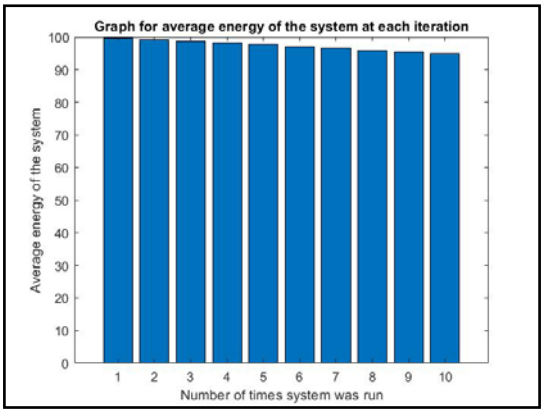

Fig. 7 Graph for average energy of the system at each iteration (average energy Vs no. of times system was run)

Table 1. Average energy of the system at each iteration

No. of times system was run	Average energy of the system
1	99.9
2	99
3	98
4	97.9
5	97
6	96.9
7	96
8	95.9
9	95.8
10	95.7

5. CONCLUSION

In this paper we proposed a fuzzy logic-based zone divisional protocol because it performs better than other comparing algorithms in terms of load balancing, decrease high usage of energy, minimize complexity of the sensor nodes and network lifetime prolongation. Unequal clustering has a high overhead and is prone to connectivity issues in the wireless sensor networks. The simulation and results section shows that the proposed algorithm is compare with the existing algorithms. Proposed algorithm has better results in terms of load balancing, energy consumption minimization, and prolongation of the network lifetime.

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