International Research Journal of Engineering and Technology (IRJET) e-ISSN: 2395-0056
Volume: 08 Issue: 02 | Feb 2021 www.irjet.net p-ISSN: 2395-0072

Energy Efficient Clustering in Wireless Sensor Network

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Abstract - *The primary challenges in defining and organizing the operation of wireless sensor networks are the enhancement of energy utilization and the life of the system. Clustering is a powerful approach to aligning the system to the associated order, adjusting the load and improving the life of the system. In a cluster-based network, the cluster head closer to the sink depletes its energy quickly resulting in hot spot problems. Numerous algorithms on unequal clustering are being considered to conquer this problem. The downside in these algorithms is that the nodes that join the same cluster head will overburden the cluster head. So in this paper, we propose an algorithm called fuzzy based unequal clustering to improve the execution of a cluster. The proposed study is tested using simulation. The proposed algorithm is compared to two algorithms, one with an identical clustering algorithm called LEACH and the other with an unequal clustering algorithm called EAUCF. The simulation results using MATLAB show that the proposed algorithm offers better performance compared to the other two algorithms.*

Key Words: **Cluster head Fuzzy logic Fuzzy inference system Residual energy Unequal clustering Wireless sensor network Hotspot Problem**

1.INTRODUCTION

Wireless Sensor Networks (WSNs) improved overall Consideration recently, particularly with the expansion of Innovation of micro-electro-mechanical systems (MEMS), Which has energized smart sensor enhancement. WSNs are used as part of a variety of applications. Examples: environmental monitoring, medical monitoring, And so on .

Sensor nodes spend their energy while collecting, processing and transmitting information. In the house, most of the cases are equipped with these sensor nodes with batteries that are not rechargeable. After that, the power of the sensor nodes is to be used productively to prolong the life of the network. Cluster-based design is one of the ways to deal with it. Save the energy of the sensor equipment. Clustering in the WSN. Ensures critical output with a large number of sensor nodes. It also improves scalability of the WSN. In a cluster-based architecture, the sensor nodes are increasingly clustered together in clusters. Each cluster has a cluster head (CH) that is allowed to communicate with a base station (BS) or a sink. Both sensor nodes forward their sensed information to the cluster head, which processes the information and sends it to a specific node called the sink. Much of the clustering convention uses two techniques for choosing cluster heads with more residual energy and regularly matching cluster heads with the energy consumption of sensor nodes across the network. But these algorithms do not understand the distance to the BS, which appears to die quickly because it is located relatively far from the base station. With the specific intention of avoiding this problem, some unequal clustering algorithms have been proposed in the literature. In unequal clustering, the network is divided into clusters of different sizes. Clusters near the base station are smaller in size than clusters further away from the base station. There are many unequal clustering algorithms in the literature. In this paper we propose an unequal clustering algorithm based on fuzzy logic called fuzzy based unequal clustering (FBUC), which is an improvement of fuzzy energy-conscious unequal clustering algorithm (EAUCF). Improvement is shown in this work by the implementation of one more variable called node degree in competitive radius computing where the competition radius determines the size of the cluster. In addition, ordinary nodes join the final cluster head to form the cluster using a fuzzy logic with two variables, namely the distance to the cluster head and the degree of the cluster head. In EAUCF, the competitive range of the attempted cluster heads is determined using fuzzy logic using residual energy and distance to the base station of the sensor nodes. The final cluster head is chosen on the basis of the residual energy of the nodes within the same competition range. In FBUC, for the computation of the competition range, three fuzzy variables, namely residual energy, distance to the base station and node degree, are used. It is very important to consider the degree of the node because it increases the efficiency of the algorithm, which in turn prolongs the existence of the network. After the final cluster heads are chosen, the non-cluster head nodes will be joined by the cluster head that is nearest to them in EAUCF. There are several other algorithms in which non-cluster header nodes merge with cluster heads based only on size. But in the unequal clustering, the cluster size near the base station is small, and the cluster size far from the base station is high. So if more nodes are close to the cluster near the base station, the energy of the cluster head will deplete very quickly when more nodes close to the cluster head join the cluster head. In order to resolve this problem, we propose a novel approach to joining non-cluster head nodes with the cluster head. In this work, once the final cluster head is

chosen, using fuzzy logic, the non-cluster head nodes will join the cluster head to form a cluster based on the distance between the cluster head and the cluster head. Here the cluster head degree is the ratio of the number of nodes to the total number of nodes within its competition range. The key advantages of the proposed system are the reduction of transmission latency, improved node life and reduced power usage consumption. The rest of this paper is structured as follows: the research work carried out on the proposed solution is briefly explained in the next section.

2. RELATED WORK

The most important problems for optimization in WSN are clustering and routing. Many of the clusters are centered in there have been experimented into routing strategies and a lot of memoranda were created. Digital Intelligence neural networking methods, reinforcement learning, the approaches to swarm intelligence, the evolutionary algorithms and fuzzy logic is used in WSN to answer many design problems including selection of CH, routing, protection, data aggregation, synchronizer. Fuzzy logic is supreme suitable in circumstances with high degree with ambiguity. Hein Zelman proposed a first approach to the clustering named LEACH (Low Energy Adaptive Clustering Hierarchy), the clustering most common and widely cited Technology. This is a distributing protocol in which the CHs are chosen at random in each round. The CH's get the data aggregate into a single packet from its cluster members, and in a single hop way forwards to BS. It is useful in critical times applications where nodes send information when sensed price reaches a predefined threshold. It does away with periodic transmission that in effect lowers the number data transmission and energy preservation is not technically useful in any case. When value of threshold is not reached, nodes do not transmit data and through sensing, the consumer does not notice the present scenario land. To remove TEEN's drawbacks, proposed a called APTEEN hybrid protocol was proposed. The Nodes in APTEEN are also going to submit data regularly in an energy-efficient way as they reacts to changes in the physical one immediately umbrella.

. In the design of the WSN, energy is the most important resource because the life of the sensor node is limited by its battery life. Cluster-based architecture is one of the ways to solve the energy savings of sensor systems. There are several clustering algorithms in literature. LEACH is the most significant and common protocol among the most well known clustering systems. It selects a cluster head based on a probability model. The network is divided into primary and secondary levels and selects the primary cluster heads at the nearest distance to the BS for transmission. It minimizes energy depletion in cluster heads by taking into account the transmission distance between cluster head nodes and BS. It also measures the number of cluster heads dynamically, as shown by the number of live nodes in the system. In using fuzzy logic to determine the probability of being clustered head, the algorithm prolongs the existence of the network. They used energy and local distance as a fuzzy package. In the case of cluster header collection, fuzzy logic is used to solve LEACH defects. In their work, three fuzzy variables, namely concentration, energy and centrality, are used for the selection of the cluster head. Normally, most clustering methods use cluster head selection with more residual energy.

3. SYSTEM MODEL

The basic device model of this work consists of sensor nodes that are deployed to track the environment. The assumptions made in our work are as follows:

1. WSN consists of homogeneous sensor nodes and
You have the same initial capacity.
2. Sensor nodes are arbitrarily deployed.
3. Both sensor nodes and base station are maintained
When stationary, they're deployed.
4. Nodes are energy constrained and left unattended.
After deployment, sir. In this way, the recharge of the battery is
It's unrealistic.
5. The distance between the nodes is determined on the basis of the
The signal strength obtained.
6. The base station is located within the WSN.The sensor nodes in the WSN are a cluster of different sizes. Each cluster has the header of the cluster. The information sensed by the sensor nodes is transmitted via the cluster head to the sink. Each sensor node can work in sensing or relay mode. The cluster header in the relay mode collects data from its cluster members, compresses and forwards the compressed data to the base station. Since most of the energy of the sensor nodes is lost in transmission, we have concentrated a lot on maximizing the energy of the sensor node. The energy model used in our work is close to the work discussed in [34, 35]. Moreover its action is based on the Eqs. (1) and (2) (2). Eelec, efs and emp are the energy of the circuitry and the energy of the amplifier in free space and multipath, respectively. The transmission energy required for the l-bit message is more than the separation d, as per the separation d, as follows:

$$E_T(l,d) = \begin{cases} l\,E_{elec} + l\varepsilon_{fs}d^2 & \text{for} \quad d < d_0 \\ l\,E_{elec} + l\varepsilon_{mp}d^4 & \text{for} \quad d \geq d_0 \end{cases}$$

4. UNEQUAL CLUSTERING USING FUZZY LOGIC

This section explains the unequal clustering algorithm that uses fuzzy logic. It is an improved version of a fuzzy energy-conscious unequal clustering algorithm (EAUCF)[7]. We have improved the efficiency of the EAUCF algorithm in three ways. Second, using the probabilistic threshold value instead of the predefined threshold value. Second, in selecting the

cluster header, we used three fuzzy variables instead of two variables. Third in the non-cluster head, nodes entering the cluster head nodes are also considered, and we used fuzzy logic with two variables. FBUC is a distributional unequal clustering algorithm. It acts like LEACH in rounds. The key flow of the algorithm is defined in the Algorithm 1. In each round, the initial preliminary cluster heads are selected by generating an arbitrary number for each node. If the arbitrary number generated is less than the probability value (TH) of the nodes given in the Eq. (3), then it becomes the head of the preliminary cluster.

Algorithm 1 Fuzzy based unequal clustering algorithm

Calculate TH for each round
TH – probability to become a tentative cluster head
Tentative_Cluster_head = False
For each node do
R = rand (0, 1)
NodeState = member
If R\ TH then
Tentative_Cluster_head = True
// Calculate Competition Radius using fuzzy if–then rules given in Table 1.
Comp_Radius = Fuzzy_Logic1(distance, residual energy, node degree)
End if
End for
Send CHMsg (ID, Comp_Radius, RE) to its neighbors
Each node M on receiving the CHMsg from node N
If N(residual energy)[M(residual energy) then
Tentative Cluster head = False
End if
If TentativeClusterhead = True then
Nodestate = ClusterHead
Add N to cluster member list
End if
If Nodestate = member then
CH = Fuzzy_Logic2 (distance, ClusterHead_degree)
Join with CH as a cluster member
End if

TH = P / (1 - P * (r mod 1/ P))

If r is the current round number, P is the desired percentage of the cluster head (e.g. P = 0.05). Like EAUCF, the fuzzy logic approach is used to measure the competition radius of each cluster head node. For the estimation of the competition radius, EAUCF uses two linguistic variables, namely the separation of the base station and the current energy level of the node. In this work, however, we used three linguistic variables, two such as EAUCF and the third variable attempt cluster head node degree. In EAUCF, they concentrated only on the energy of the node for the computation of the competition radius. However it is important to reduce the service area of the cluster head when the battery power is low and the number of neighbors is high. So in this work, we have used the degree of the node as one metric for calculating the competition radius

TABLE-1 :FUZZY RULES (COMPETITION RADIUS)

Distance_BS	Residual energy	Node degree	Competition radius
Close	Low	High	Very Small
Close	Low	Medium	Small
Close	Low	Low	Rather Small
Close	Medium	High	Rather Small
Close	Medium	Medium	Small
Close	Medium	Low	Medium Small
Close	High	High	Small
Close	High	Medium	Medium Small
Close	High	Low	Medium
Medium	Low	High	Rather Small
Medium	Low	Medium	Medium Small
Medium	Low	Low	Small
Medium	Medium	High	Medium Small
Medium	Medium	Medium	Medium
Medium	Medium	Low	Medium Large
Medium	High	High	Medium
Medium	High	Medium	Medium Large
Medium	High	Low	Rather Large
Far	Low	High	Medium Large
Far	Low	Medium	Rather Large
Far	Low	Low	Large
Far	Medium	High	Rather Large
Far	Medium	Medium	Large
Far	Medium	Low	Large
Far	High	High	Rather Large
Far	High	Medium	Large
Far	High	Low	Very Large

TABLE-2 : FUZZY RULES (CH_CHOICE)

Distance	CH_Node_Degree	CH_Choice
Close	Low	Very Large
Close	Medium	Large
Close	High	Rather Large
Medium	Low	Medium Large
Medium	High	Medium Small
Far	Low	Rather Small
Far	Medium	Small
Far	High	Very Small

The key advantage of using this attribute is the degree of the node increases, lowers the rivalry radius. The three fuzzy variables used in this work are distant from the BS, the residual energy of the attempt cluster head and the node degree of the attempt cluster head. The fuzzy input variables and their linguistic variables used for competition radius computing are given below. Table 1 Fuzzy rules (competition radius) Distance BS Residual energy Node degree Competition radius Algorithm 1 Fuzzy-based unequal clustering algorithm The third variable Node degree is newly proposed in this work.

Distance BS—— (close, medium, far)
Residual energy—- (low, medium, high)
Node degree—- (low, medium, high)

The fuzzy performance variable is the competitive radius of the attempted cluster head.Head is determined, the final cluster head is selected within the maximum competition radius of high residual energy. Once the final cluster header is chosen, the non cluster header nodes should be connected to the cluster header for data transmission. In and in other works the sensor nodes are attached to the nearest cluster head. But in uneven clustering, if more nodes are close the cluster head, which has a limited competition radius, then the cluster head.
The cluster head can deplete its energy sooner, since it has low energy and is very close to the base station. In this work, once the final cluster head has been selected, non-CH members can join the cluster head not only based on the distance to the cluster head but also on the CH-degree, the ratio of the number of nodes within the competition radius to the total number of nodes. Here, once again the fuzzy logic is used for ambiguity. The key benefit is that it increases the existence of the cluster head nodes near the base station.The fuzzy input variables and its linguistic variables used for determining cluster head are given below:
Distance—(close, medium, far) CH_Node_Degree—(low, medium, high)

5. CONCLUSIONS

Energy conservation is a key problem in WSN architecture. In this paper, we suggest a fuzzy logic based on an unequal clustering algorithm in which the final cluster is selected, taking into account the energy level of the tentative cluster head within the cluster radius determined on the basis of residual energy and the node degree of the attempted cluster heads. Members enter the cluster head based on distance and cluster head to allow effective use of resources and prolong the life of the network. The proposed algorithm is tested by simulations using MATLAB.

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