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Optimal Unequal Clustering Maintenance Algorithm Using Sierpinski Triangle for Image Transmission in Wireless Sensor Networks

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Abstract— The nodes lifetime maximization is one of the serious problems in the wireless sensor networks (WSNs). Clustering technique demonstrate to the most popular solution for enhancing sum of expended energy of WSNs. Every sensor can oversee an occasion and send data to its cluster head (CH) which totals and transmits data to the BS (BS) through different CHs in the network in clustered WSNs. This situation induces the hot spot' issue where closer CHs to the BS will die prior due to the overwhelming transfer data. Unequal clustering techniques have attempted to tackle this issue and control the extent of each cluster in the network. In this paper, we proposed another unequal clustering calculation called energy degree distance unequal clustering algorithm (EDDUCA) planning with maintenance to adjust energy utilization and expand the lifetime of the network. EDDUCA utilizes the 'Sierpinski triangle' technique so as to divide network into unequal clusters. The derived outcomes show that EDDUCA-M can adequately adjust the energy utilization and thusly can extend the lifetime of network.

Keywords—Unequal clustering, WSN, Energy efficiency, Lifetime, Cluster maintenance

I. INTRODUCTION

WSNs comprise of a lot of little gadgets known as sensors arbitrarily disseminated in a land zone. Every sensor can direct a specific marvel (temperature, weight etc…) and send data to the accumulation point (BS or BS) by means of a wireless availability. WSNs commonly incorporate a substantial number of nodes (a huge number). Sensors are portrayed by their constraint in energy assets, which presents issues especially if the application must function for quite a while [1]. So as to enhance energy utilization and to keep up the availability of the network framework, nodes can be sorted out into clusters. In the WSNs based clustering, the network engineering separates into three layers: a sensor network that comprises of data collectors (sensors), the CHs that do the perplexing assignments of flag treatment, and a BS that gets data for the benefit of the CHs [2]. Inside this association, the intra-cluster and between clusters correspondences can be accomplished either in one hop or multi-hops. The multi-hop transmission from CHs to the BS results in an unequal energy utilization in equivalent clusters (problem areas issue). Truth be told, CHs closer to the BS transmit more transfer data than CHs a long way from the BS [3]. Unequal clustering size (UCS) clustering algorithms control the measure of each cluster in the network so as to adjust and limit energy dissemination among nodes and increment the network lifetime.

In this paper, another unequal clustering calculation known EDDUCA-M was proposed. EDDUCA-M frames fixed clusters so as to limit energy utilization amid the cluster's arrangement stage. It utilizes the 'Sierpinski triangle' strategy to separate the network into unequal clusters. Clusters having a similar distance to the BS will have equivalent sizes. This technique plans to broaden the lifetime of the CHs closer to the BS, to keep up the network of the structure and to adjust energy utilization between clusters. So as to adjust energy utilization between nodes in each cluster, the CHs decision methodology is based on three parameters: leftover energy, the degree and the distance. Then, a cluster maintenance strategy is initiated to lengthen the network lifetime.

The remaining of this paper was organized as follows: Sect. 2 reviewed some unequal clustering algorithms. Sect. 3 described EDDUCA clustering algorithm in details. The simulation results were given in Sect. 4. Finally, our conclusions were drawn in Sect. 5.

II. UNEQUAL CLUSTERING ALGORITHMS

In this section, we presented the advantages and the disadvantages of some unequal clustering algorithms. To take care of the problem areas issue, unequal clustering methods are characterized. These methods will in general limit the extent of clusters nearer to the BS, this later will have higher energy to accomplish the between cluster correspondence [4]. As of late, a few unequal clustering algorithms have been structured, for example, [3]. In this methodology, the network is separated into unequal clusters so as to expand the nodes lifetime near to the BS which can diminish, as indicated by Xiang et al., the packet loss proportion and enhance the network exhibitions. At last, researchers expected that the nodes are sent with uniform thickness density $\rho\,(nodes/m^2)$ in the wedge zone characterized by an edge h in particular clustering edge. From there on, the wedge zone is partitioned into m rings V1;V2;;….Vm that demonstrates clusters. The distances among clusters (d1; d2; ...; dm) indicate the communication in one-hop between clusters. At that point, the researchers decided the ideal one-hop distance and the ideal clustering edge that would limit energy utilization for both of communication in inter-cluster and intra-cluster cluster. The experimentation of the unequal clustering method depicted in [3] demonstrated that the network lifetime was broadened. Nonetheless, the proposed clustering model necessitates that nodes must be conveyed in the round zone, which isn't constantly conceivable practically speaking.

In [5], researchers characterized another unequal clustering protocol called energy-driven unequal clustering (EDUC). In this technique, they utilized unequal challenge extends so as to characterize unequal clusters., An energy-driven CHs turn strategy is utilized to pivot the CH determination and to adjust energy utilization among the network for each cluster. In [6], researchers projected another unequal clustering plan to be specific energy effective clustering plan (EECS). For EECS, a distance-based clustering strategy is intended to create unequal clusters size. So as to take care of the problem area issue and augment the size of the clusters, a weighted function was projected. Another case of an unequal clustering technique was portrayed in [7] whereas the researchers presented another calculation known as energy effective and adjusted cluster-based data aggregation (EEBCDA). In this methodology, the network is removed into unequal rectangular zones (called swim paths) and each zone is thusly part into littler zones (called lattices). For every network, the node with the most noteworthy lingering energy turns into a CH. The between cluster transmission is accomplished by one hop towards the BS. EEBCDA has demonstrated its adequacy contrasted with EECS calculation in parts of adjusted energy and network lifetime. By the by, the one hop between cluster communication may build energy utilization particularly for huge size networks.

Energy-efficient unequal clustering (EEUC) algorithm was proposed in [8]. A restricted challenge is characterized to choose CHs. For every node, a competition range is determined by its distance to the BS. The inter-cluster communication is accomplished in k hops and relies upon the energy utilization of the CH and its distance to the BS.In [4], researchers presented another unequal clustering technique known as energy-aware unequal clustering fuzzy (EAUCF). The arrangement recommended by EAUCF is to limit the quantity of nodes in the clusters nearer to the BS so as to limit the quantity of transmitting packets. The CHs are arbitrarily chosen, at that point, the radius at competition of each CH is resolved by its lingering energy and its distance to the BS. Likewise, EAUCF utilizes the fuzzy logic to compute the competitive radius. EAUCF has demonstrated its great execution contrasted with other unequal and equivalent clustering algorithms. Be that as it may, the irregular CHs determination stage can't ensure the energy utilization balance if the chosen CHs have a frail energy hold.

In [9], new technique utilizing the fuzzy logic was characterized. The projected method known as improved fuzzy unequal clustering (IFUC) is depend on the model of fuzzy logic. The utilized fuzzy logic framework utilizes leftover energy, the BS distance and the neighborhood density as three attributes to choose CHs and its radii.

III. EDDUCA-M CLUSTERING ALGORITHM

In this section, we described a new clustering algorithm called energy degree distance unequal clustering algorithm (EDDUCA-M).

3.1. Clusters Formation Phase

In this area, the clusters development stage received in EDDUCA-M clustering techniques was presented. Our goal in this stage is to limit energy utilization and to adjust the energy utilization among clusters:

Limit energy utilization: generally, clustering algorithms utilize dynamic clusters. For this situation, the quantity of clusters and cluster individuals change powerfully. For these kinds of clustering, the energy devoured in the network will be equivalent to the total of the energy expended in the cluster's development stage, the energy devoured amid the clusters update stage and the energy expended amid the correspondence stage.

$$E_c(network) = E_c(clusters - construction) + E_c(clusters - update) + E_c(communication) \quad (1)$$

For our situation, we will characterize static clusters which are worked ahead of time. The energy devoured amid the cluster development stage will be nil and the energy expended in the network will be:

$$E_c(network) = E_c(clusters - update) + E_c(communication) \quad (2)$$

Parity energy utilization between clusters: we accepted that nodes are consistently conveyed in the square zone. In the cluster's development stage, we will characterize unequal clustering technique. The closest clusters to the BS have a lower estimate than different clusters. For this situation, they will have more energy to accomplish the between cluster correspondence. What's more, when two clusters are situated at a similar distance to the BS, they have a similar size and a similar number of nodes since nodes are conveyed consistently. These two conditions permit to adjust energy utilization among clusters in the network.

To accomplish our objectives recently referenced, we will utilize the technique for 'Sierpinski gasket'. At first, this method was depicted and, at that point, the clusters arrangement stage was clarified in subtleties.

The 'Sierpinski triangle' to be specific additionally 'Sierpinski gasket' or 'Sierpinski Sieve' is the well-known fractal triangle made by the mathematician 'WaclawSierpilski'. It is developed utilizing an underlying symmetrical triangle as indicated by these means:

Step 1 Segment the primary triangle into four small triangles through linking the side mid-points.

Step 2 Eliminate the central triangle.

Step 3 Repeat the steps 1 and 2 to the outstanding triangles

3.2. CHs Selection Phase

In this area, the CH choice stage is portrayed. Our goal is to adjust energy utilization among nodes. The CH determination process is accomplished depending on three parameters for each cluster: degree, energy, and distance:

- Energy: for WSN, energy is a significant parameter. Truth be told, a node with low energy holds, is incapable to send data particularly if the distance among nodes is high and needs critical power. Hence, numerous specialists, for example, and have utilized this attribute amid the CHs determination stage to adjust the heap (energy utilization) among nodes so as to give a steady structure and to expand the network lifetime.
- Degree: the node degree is the neighbor's quantity (1-neighborhood). Analysts in the domain, for example, and picked degree as CHs choice model. The node with the most noteworthy degree is chosen as a CH. This methodology gives a structure strength.
- The distance among nodes is additionally a significant model in the CHs choice stage. This parameter impacts the transmission control and the quantity of hops to achieve the goal and, thus, the energy employed to create the transmission. Numerous different analysts pick this setting to limit the energy expended amid the communication in inter-cluster.

As these attributes are fascinating to limit energy utilization and to create a steady structure. These will be utilized in the CH determination stage. The CH have to be the most amazing remaining energy to have the capacity to deal with the inter-cluster and intra-cluster interchanges. We pick the CH with the most elevated degree so as to be a neighbor of a few CHs and encourage the between cluster correspondence. To limit the expended energy in between cluster correspondence, the closest node from the cluster focus is chosen as CH.

For every cluster, nodes compute their joined weights, at that point, the node with the littlest weight turns into a CH. For every round, this method is rehashed so as to adjust the energy utilization between nodes.

3.3. Transmission Data to the BS Phase

Every node recognizes the data and sends it legitimately to its CH. The CH gets data and advances it to the upper layer cluster until achieving the BS. For each dimension I, the CHs of the clusters hi and *li* send data to the CH of the focal cluster ci. The last transmits the received data to the CH of the focal cluster $c(i+1)$until achieving the BS. This procedure is additionally depicted in the accompanying figure (Fig. 6).

3.4. Cluster maintenance

Cluster maintenance phase [10] is much important to balance the load among clusters. After some rounds, the clusters closer to BS are burdened with more inter-cluster traffic and exhaust their energy quickly. So, a cluster maintenance phase is needed for uniform distribution of load, eliminate hot spot problem and maximizes the network lifetime [11]. In the proposed method, cluster maintenance phase operates on two levels: CH rotation in the cluster and cross-level data transmission as shown in Figure. 1.

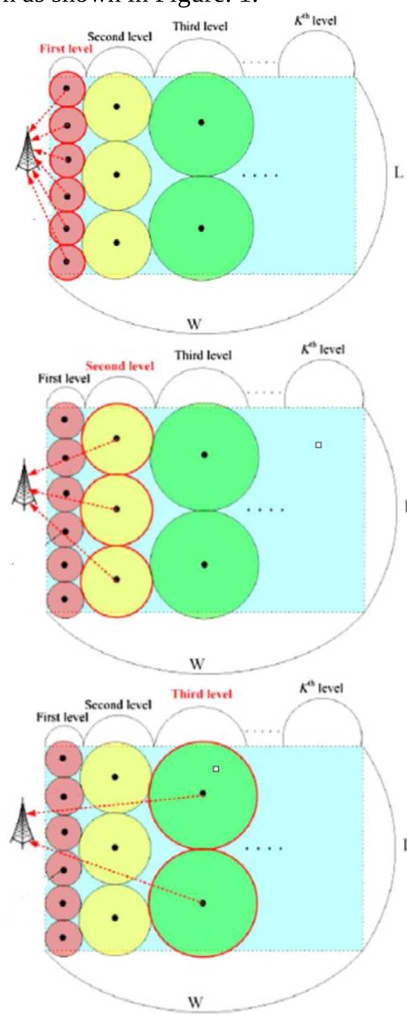

Figure 1. The architecture of cross-level data transmission

IV. Results and Discussion

This method examines the proposed methods performance. Table 1 demonstrates the parameters used for simulation. The model of radio hardware energy dissipation is employed.

Table 1. Simulation parameters

Parameter	Value
Simulation Area	(0,0) ~ (1000,1000)
BS Location	(0,0)
Number of Nodes	200
Initial Energy	18720J
E_{elec}	50 nJ/bit
E_{amp}	10 pJ/bit/m2
E_{DA}	5 nJ/bit/signal
Data Packet Size	200 bits
Packet Rate	1/sec
Radius (R)	200m
Simulation Time	25000 sec
Number of Runs	10
Round Time	25 sec

Figure. 2 gives the sum of energy utilized through the CH in various rounds of data transmission. It is clear from the fig. that the EDDUCA method shows higher variances in each round count. For instance, for the 200 round it takes high pace of energy consumption, for 400 number of rounds it takes 5000 as energy consumption rate. At 600 number of rounds, it takes 10000 as energy consumption rate and it increases rapidly in subsequent rounds, and gives it needs 25000 as energy consumption in 1000 rounds itself. The proposed shows the steady pace by maintaining constant position. The steady rate in energy utilization at different rounds of data forwarding create to oscillate at reduced magnitude. The projected methods require 6000 as energy utilization at 1000 as round counts.

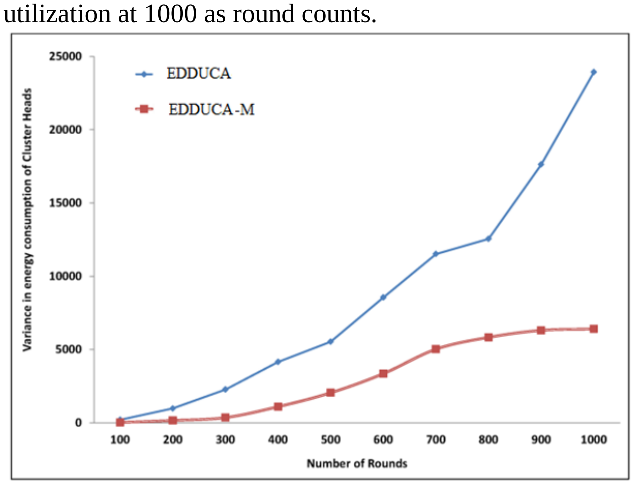

Figure 2. Energy consumption analysis

The number of chosen cluster head (CHs) are demonstrated over the experimentation time as shown in Figure. 3. The lifetime of network estimated until primary node dies within sensor network. EDDUCA-M outperforms when compared to the existing method. For example, at the primary round itself, the CH counts are high as it reaches 55 CHs. At 100 number of rounds, it gains nearby 60 as cluster heads whereas the existing method gains only 36 as CH counts. It gains 50 CH with 300 number of nodes and at 900 rounds, it reaches nearby 60 as CH whereas the existing method gives only 35 as CH rate. At various levels, Stabilized energy indulgence increases networks lifetime. The EDDUCA degrades by performance over time gradually when comparing with the projected method.

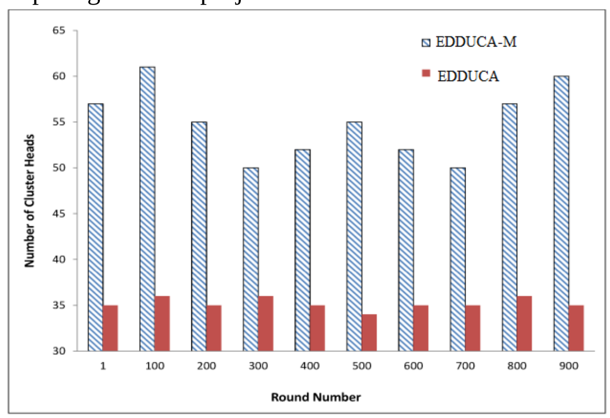

Figure 3. Energy consumption analysis

Therefore, for both the parameters like energy consumption and cluster head counts, the projected method attains the enhanced performance over the existing method.

V. Conclusion

With a view to reduce energy utilization, balance energy utilization among clusters and remaining energy utilization among nodes, a novel unequal clustering method employing 'Sierpinski triangle' in this paper. The modelled cluster has unequal sizes and static. The clusters that comprise similar distance towards BS comprise equivalent sizes. Then, a cluster maintenance strategy is initiated to lengthen the network lifetime. For extending the lifetime of network and energy consumption balancing, and experimental outcomes demonstrates that the projected method is efficient.

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