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Energy Efficient Clustering Algorithm for Wireless Sensor Network Using Minimum Connected Dominating Set with Multi-hop Information (MCDS-MI) and Bi-Partite Graph (BG)

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ABSTRACT: Wireless sensor network comprises vast number of little, less energy, minimal effort sensor nodes with restricted memory, computational, and correspondence assets and a Base Station (BS). These nodes consistently screen ecological surroundings, gather full data about the environmental condition in which they are introduced, and at that point transmits the gathered information to the BS. Using Minimum Connected Dominating Set with Multi-hop Information (MCDS-MI) and Bi-Partite Graph (BG) based technique is used for identifying the cluster head. This cluster head model depends on different parameters like remaining energy, concentration and distance. These parameters optimize the cluster head selection such that best node can be chosen which can serve as CH of any of the level. Levels are decided based on distance from the cluster head. Various performance parameters like residual energy, alive nodes, and dead nodes count has been evaluated. All the performance parameters have shown the better performance, in nutshell better life time.

KEYWORDS: WSN, BG, MCDS-MI.

I. INTRODUCTION

Wireless sensor network comprises vast number of little, less energy, minimal effort sensing nodes with restricted memory, computational, and correspondence assets and a Base Station (BS). These nodes consistently screen ecological surroundings, gather full data about the environmental condition in which they are introduced, and at that point transmits the gathered information to the BS. The BS has an expansive repository and huge information handling abilities. It paths the information it gets from sensing nodes to the server from where end-client can get to them [1]. WSN has leverage of being worked unattended in nature where non-stop human observing is unsafe, wasteful or unusable. Sensor nodes keep running on batteries and as the nodes are conveyed their batteries can't be revived, thus have small life expectancy.

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Wireless sensor network is shown in Figure 1.1.

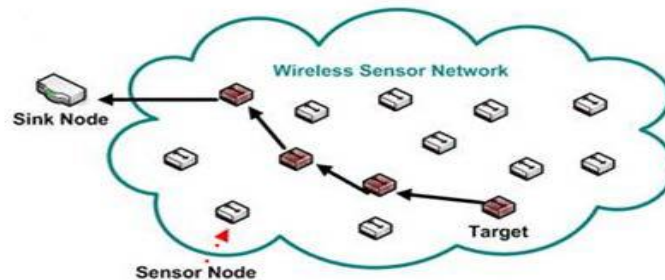


Fig. 1 Wireless network containing sensor nodes [2]

There are various uses of WSN that includes environment applications and health applications like forest fire detection in perspective of temperature information it gets from considerable number of dispersed sensing nodes, landslide detection, following and checking specialists and patients, and natural disaster [2]. They are also applied in military applications like zone observation, fight harm evaluation, and so forth [3]. Home applications include home automation, smart environments.

1.1 Characteristics of WSN

- Restricted computational limit: each sensor node in the WSN is small device with very less power. They are battery operated. While having sensor nodes each sensor node collects the data and transmit the data to the base station. While having sensing of the data does not performs the calculations. Because sensor node has very less computational power.
- Restricted vitality assets: all the sensor nodes ate cost effective nodes. They have few components contained into it. One is the receiver, transmitter and small memory buffer. Every time they receives the data will store them into the memory buffer. Once the buffer is filled either over write the data or retransmit to the base station.
- Scalability: sensor network is small area network where nodes are distributed in small area. Every time the data is required they will collect the data from small area. By considering one or two relay nodes in between they transmit the data to the base station.
- Restricted memory limits: Each sensor node has small memory capacity. They receives the data from the neighboring environment and store into the memory buffer. This memory buffer is small. It need to be refreshed after certain interval of time.
- Ease of use: The sensor node is small powered memory buffer. Also each sensor has one receiver, transmitter, or may be amplifier. These devices are easy to setup and put into the work.
- More risk of breakdown of nodes due to unattended condition and low power: each sensor node is low powered node. As each node has small battery power. After the elapse of the time these nodes energy will get destroyed and node will become dead node. So immediately stops working.
- More thickly deployment of nodes: it is dependent on the application that how sensor nodes are positioned in the network area. Sometimes these network have highly dense positioned. Or some time these nodes are positioned distance apart.

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1.2 Advantages of WSN

- **Flexible:** Wireless sensor networks are flexible as they can easily adapt to any kind of changes.
- **Improved Lifetime:** In WSN, the nodes are assembled together into different clusters. So only one node from their respective cluster can take the responsibility of passing information to the BS instead of all the nodes participating in communication, thus upgrades the lifetime of the system [5].
- **Cost:** Cost of implementation is less.
- **Robustness to withstand rough environmental conditions:** Ideal for the hostile environment, for example, over the ocean, mountains, country territories or profound woods. .
- **Fault Tolerance:** In WSN, various sensor nodes are deployed near each other. They are able to overcome node failures, by simply using another routing path.

1.3 Disadvantages of WSN

- Short lifespan.
- Restricted energy of nodes.
- Speed of communication is less.
- Low bandwidth.
- Slow access time.
- Limited processing.

1.4 Hierarchical Clustering

In hierarchical based clustering choosing the cluster heads in WSNs is the main level and second level includes the information transfer from sensor nodes to a BS by means of cluster heads shown in Figure 1. A broad number of groups will be having zone with minimal size clusters and few numeral of clusters will deplete CH by huge measure of messages to be transmit from group individuals. To accomplish network scalability, high vitality efficiency and drag out system lifetime in substantial scale wireless sensor networks, sensor terminals are frequently gathered into non-covering groups called cluster procedure in WSN.

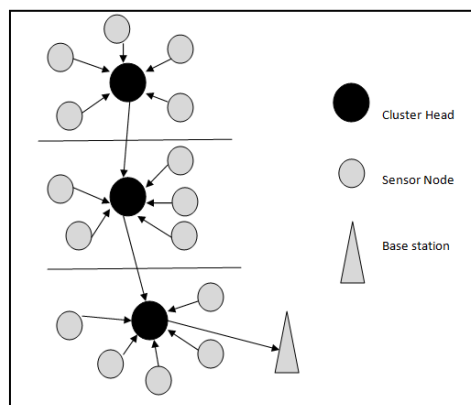


Fig. 2 Hierarchical clustering in WSN

II. LITERATURE SURVEY

Kaur et al. [1] looks at the contending issues of vitality utilization effectiveness in remote sensor systems. For this reason, an adjusted Broader Grid Algorithm (GA) in the choice of Cluster Head (CH) was proposed such that its vitality is utilized consistently with load adjusting among groups for deferred deterioration of system. GA clustering

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has replaced irregular grouping approach has. The enhanced GA convention has been contrasted and arbitrary LEACH, Max Energy LEACH and k-implies calculation and straightforward GA which group just for space equi-dispersion not for the heap adjusting among clusters. Remote sensor networks are recreated utilizing a MATLAB programming and power utilization calculations mull over all parts of energy utilization in the task of the hub. Simulating diverse schemes conspires on a similar system framework, same introductory power sources, and steering convention, an expansion of general framework lifetime is illustrated. The execution of GA cluster based routing protocol indicates upgrades in lifetime however Max Energy LEACH perform better in organize deterioration rule.

Ma et al. [2] proposed another power-effective collaborative communication system. This system depends on the Broader Grid algorithm. By imposing the limit for another age judgment work, suggested calculation will fit for deciding whether the sensor hubs can be a CH. At that point Broader Grid algorithm would shift through a few hubs from these impermanent CHs to get the last and final CHs. Observation demonstrates that suggested calculation can apportion vitality to every node of WSN and delay demise of a primary hub. This way, the lifespan of wireless sensor network is successfully drawn out.

Pal et al. in [3] provides a load balanced approach network by performing clustering. Clustering of sensors is a proficient method for extending the lifespan of system. With clustering, problem of scalability and energy depletion is addressed. In this work, author has done cluster head selection using Broader Grid algorithm. Calculations have proved that selecting cluster head with Broader Grid algorithm provides better outcomes as contrasted with another existing traditional algorithm for lifetime improvement of a network. In this work remaining energy and inter-cluster as well as intra-cluster distance is used for cluster head selection. This proposed scheme is for centralized clustering algorithms and it also improves the quantity of CHs for a round. Comparison of this technique has been done with LEACH and LEACH-C.

Norouzi et al. [4] conducted a survey on various operational stages of wireless sensor networks. Theses stages include sensor node placement, system area coverage, clustering, data gathering, and routing. Various limitations were found out to find out the best optimized parameters for the network system. At long last, utilizing Broader Grid algorithm, a wellness work with optimum formula was acquired and the show conventions were optimized. The consequences of recreations in JPAC, MATLAB, and NS were contrasted and are of the introduce conventions and streamlining of the two parameters affirmed. It is likewise perceptible that the charts acquired from the reproductions demonstrated a change in vitality utilization parameters and lifetime of the system; this implies more perfect WSNs. An application based convention without particular confinement in regards to its application—reasonable for military, medicinal, and business applications—will be subject of our future examinations.

Maheshwari et al. in [5] considered that routing is an essential to enhance the lifespan of system. Advance Hybrid Multi-hop Routing Network (AHYMN) techniques was proposed or usage process. Choice of CH depends on power line in sensing hub. They actualized the HYMN techniques with Broader Grid calculation to collect the information in sensor arrangement. Another strategy which depends on AHYMN approach and GA is spoken to pick CH in WSN. Accordingly, it's speedier and furthermore precise to recognize hub with more vitality and to choose the CH. In addition, system utilized hubs with heterogeneous attributes. A portion of varied hubs is: extended lifespan of systems, increment in system dependability and diminishing information transfer interruption.

Rana et al. [6] proposed a coordinated technique of CH choice furthermore; steering in 2-level WSN utilizing Broader Grid Algorithm based CH choice with A-Star approach based routing strategy to broaden existence of wireless sensor network. The method prompts noteworthy changes in the system lifetime over other strategies. This strategy was compared with many other existing routing protocols and various CH election mechanisms. Current CH election according to current routing and routing schedule selection with the thought of CH chosen helps in searching for the

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best combinations. Performance results clearly prove that the conveyed method significantly enhances the network lifespan for different sizes of the networks. Parameters

III. PARAMETERS

Remaining Energy (RE): It's an amount of energy being left while making the communication amid source node, then to CH and lastly to BS. On each communication, there will be receiving energy, transmission energy, and aggregating energy etc utilized. Remaining energy can be calculated by subtracting energy consumed (CE) during the communication from the total initial energy (IE) of hubs as shown in following Equation 1.

$$RE=IE - CE \quad (1)$$

Dead Nodes Count (DNC): As the sensors have restricted power and it's next to impossible to replace or recharge their batteries so these sensor nodes become dead i.e. their energy gets totally consumed while making communication. So dead node count is the count of number of nodes that have been dead while their energy becomes zero and their activity has been dormant. Dead nodes can be counted by subtracting alive nodes (AN) (having some power for communication) from the total no. of hubs present as shown in Equation 2.

$$DNC= N - AN \quad (2)$$

Alive Nodes Count (ANC): It is the count of number of nodes that still have some energy for communications. It is calculated by subtracting the dead nodes (DN) from total count of hubs as given in an Equation 3.

$$ANC= N-DN \quad (3)$$

IV. DEPLOYMENT MODELS

4.1 Topology with fixed number of nodes.

- i. Subdivide the network area of size M*M in N number of clusters.
- ii. Distribute the nodes randomly in whole network such that each cluster should have equal number of nodes as shown in Figure 4.2.
- iii. Based on Broader Grid model select one node to be the optimal for being a cluster head from each cluster. The set parameters for Broader Grid will be concentration, residual energy and distance.
- iv. Transfer the information from sensor nodes to the CH where data will be aggregated.
- v. Distance to BS and distance to other CH present within another cluster is chosen which ever will be less will be transmitted.
- vi. BS will collect whole data and chain of transmission will be terminated.

V. ENERGY MODEL

Sensor nodes are being scattered within a space. The total network area will be sub divided into smaller parts. Each small part is denoted as cluster. Based on various parameters the cluster head will be chosen. Each time the sensor hub passes info to the CH. This info will be received by the cluster head which will in turn send this info to either second level CH or to the BS. Each sensing hub and the BS are situated in light of battery control. The transmitter devours the vitality in transmission to run the gadgets. Similarly receiver will also consume the energy will receiving the data because it has to run the electronics. So energy or batter power is expended for forwarding 1 bits to the distance. This distance is the measured distance between transmitter and the collector given in Equation 4.2.

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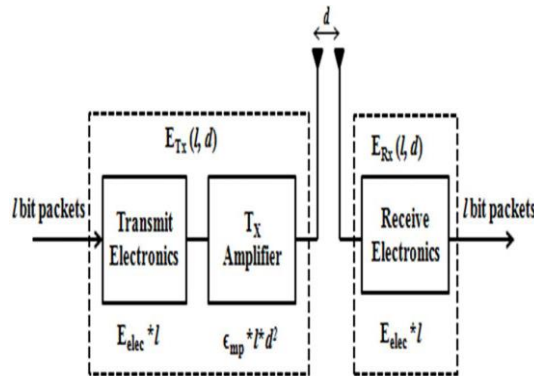


Fig. 3 Energy diagram [11]

$$E_{Tx}(l, d) = E_{Tx-elec}(l) + E_{Tx-amp}(l, d)$$

$$= \begin{cases} l * E_{elec} + l * \epsilon_{fs} * d^2 & \text{if } d < d_0; \\ l * E_{elec} + l * \epsilon_{mp} * d^4 & \text{if } d \geq d_0; \end{cases}$$

E_{elec} denotes the energy dissipation by the transmitter and recipient for transmitting per bit. E_{fs} and E_{mp} are features of source and amplifier.

VI. PROPOSED ALGORITHM

Population: Population is consisting of the network solutions. Higher is the population size the higher is the precision of the Broader Grid algorithm. Beginning populace is haphazardly selected.

- **Selection Function:** Every Individual's fitness value is calculated depending on this fitness function as given in Equation 4.1. Various variable parameters are being used for the function, such as:
 - Remaining Energy (RE).
 - Concentration or Density (C)
 - Distance among sensor node to the CH and then CH to the BS (D).

$$Fitness\ Function = RE + (N - C) + D/N \quad (1)$$

where count of sensor nodes is denoted by N.

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VII. RESULTS

7.1 Comparison of proposed and Minimum Connected Dominating Set with Multi-hop Information (MCDS-MI) and Bi-Partite Graph (BG)

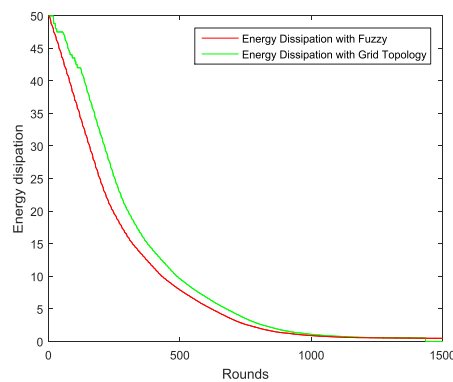


Fig. 4 Energy Dissipation

Figure 4 shows comparison between type-2 fuzzy and proposed Broader Grid algorithm on the basis of energy dissipation. As it can be observed from the graph there is an improvement in case of proposed Broader Grid algorithm over existing type-2 fuzzy rule. In case of former energy starts depleting faster as compared to the proposed work. More residual energy will remain in case of Broader Grid based approach that means more residual energy will lead to more duration of nodes belonging to network.

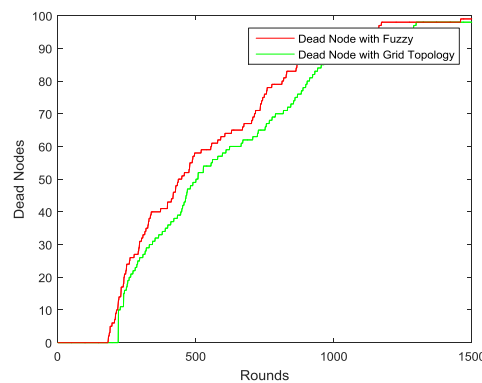


Fig. 5 Dead node count

Figure 5 shows dead node count comparison between type-2 fuzzy and proposed Broader Grid algorithm. In case of former, the sensor nodes start becoming dead (i.e. their energy gets completely exhausted) earlier as compared to proposed Broader Grid algorithm.

At the end of 1500 iterations, less number of nodes will become dead in the proposed work that undergoes rise in lifespan of sensor system.

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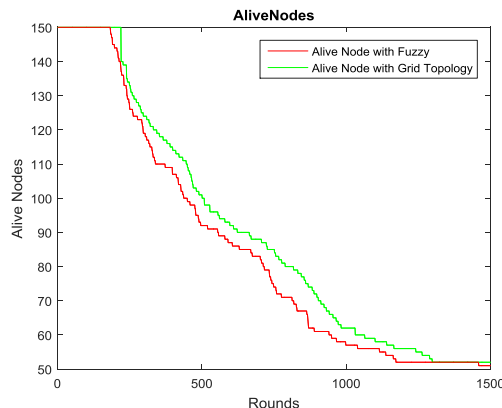


Fig. 6 Alive node count

Figure 6 shows alive node count comparison between type-2 fuzzy and proposed Broader Grid algorithm. In case of former, the sensor nodes start becoming dead (i.e. their energy gets completely exhausted) earlier as compared to proposed Broader Grid algorithm.

At the end of 1500 iterations, more count of hubs will be alive in proposed work that undergoes rise in lifespan of sensor system.

VIII. CONCLUSION

Various hierarchical routing protocols TEEN, APTEEN and so forth are productivity based directing conventions. These conventions are to sub divide the system into small clusters. Based on left over energy the cluster head is chosen. The thresholding of time is performed so that less number of transmission and receptions. In current research Broader Grid based technique is used for identifying the cluster head. This cluster head model depends on different parameters like remaining energy, concentration and distance. These parameters optimize the cluster head selection such that best node can be chosen which can serve as CH of any of the level. Levels are decided based on distance from the cluster head. Various performance parameters like residual energy, alive nodes, and dead nodes count has been evaluated for both Broader Grid and Fuzzy. All the performance parameters have shown the better performance, in nutshell better life time.

IX. FUTURE WORK

Fixed topology, the network area of 100x100 is split in eight clusters. These clusters are of equal sizes where each cluster will have equal number of sensor nodes. The sensor nodes are randomly deployed within a network but each group will have equal number of nodes.

In this scenario, total 150 sensor nodes are deployed in system range, so each cluster will have 15 number of nodes whereas there will be few more number of nodes in a cluster closer to the BS as more power is utilized for communication bulk amount of data from CHs to the BS.

In future this work can be further extended by considering mobile sink. Multiple mobile sinks can also be taken.

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