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"OPTIMIZED DEEC(Distributed Energy Efficient Clustring) IN WIRELESS SENSOR NETWORK"

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Abstract: Because of its sensor-based working standards, the WSN is becoming a common topic among numerous investigators. This research is an analysis of WSN, as well as various as well as clustering in WSN. The system is made up of sensor nodes that operate on the basis of assigned energy. If this assigned energy is exhausted, the system will stop working. As a result, the clustering method has been proposed so that the nodes energy usage could be limited and the system can conduct data transfer proficiently with an increased network lifecycle. In the proposed protocol, the nodes will be evaluated based on their fitness value. This will be dependent on residual energy of the node, its proximity from the base station and the size of the cluster it desires to form in the neighborhood. The residual energy of the node must be high else if the node having lower energy is elected as cluster head, it is likely to die out soon. Therefore, performance in the proposed scheme is better than existing scheme.

Keywords: WSN, Cluster Head, Energy, Clustering .

I.INTRODUCTION

The most recent advancements in small-scale micro-electro-mechanical system (MEMS) technology, remote connectivity, and cutting-edge hardware make it possible to build and create multifunctional sensor nodes with low cost, low power, or smaller size. The sensor nodes carry out activities such as data processing, sensing, and transmission. The concept of a wireless sensor network is utilised by a collection of small sensor nodes [1].

Fig. 1[2] depicts the structure of a sensor network. A wireless sensor network is a collection of networks made up of a sizable number of nodes that are deeply rooted in the physical environment and used to track variables such as temperature, humidity, vibration, objects, colour, and more. Information is delivered to the sink by sensor nodes. The task manager node and the washbasin must communicate through satellite or the Internet. Healthcare applications, environmental applications, public safety applications, military systems, industrial applications, and transportation applications are just a few examples of the many uses for wireless sensor networks.

A sensor node with four fundamental parts (see figure 2) a processing subunit that processes and stores the sensed data fed by the sensing unit, a wireless communication system for transmitting information, and a power unit, which frequently consists of a battery, that supplies energy to the device so it can carry out the task that has been set up. Nodes are powered by a battery with a limited energy supply, so it's important to look into alternate energy sources. Additionally, it may not always be able to recharge batteries due to nodes that have been set up in an inconvenient location. But the lifetime of the network needs to be sufficient to fulfill the needs of the application.

One important factor in the effective operation of wireless sensor networks is energy. The most effective use of the energy that is available is absolutely necessary for the network to last; as a result, optimization is crucial for effective energy use.

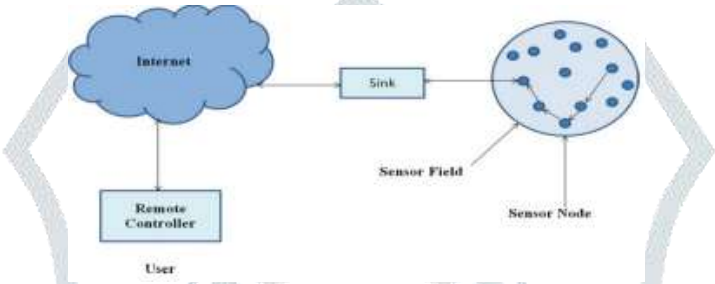


Fig. 1. Sensor Network Architecture [2]

The remaining paper is arranged as follows: Section II provides an overview of the taxonomy of energy optimization techniques in wireless sensor network. Section III describes the literature review. Proposed work are described in Section IV . Section V explains the results. Section VI concludes the paper.

II. TAXONOMY OF ENERGY OPTIMIZATION TECHNIQUES IN WIRELESS SENSOR NETWORK

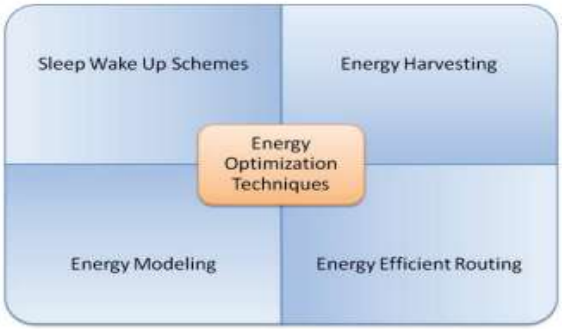


Fig. 2. Energy Optimization Techniques

A. S1eep/Wake up Schemes

Establish Ideal states use a large portion of the energy. Energy-saving sleep wake-up strategies put radios in sleep mode when they are inactive [3].

Duty Cycling: Duty rotation takes into account the network subsystem. Setting the radio's transmitter to an inactive mode when no communication is required is the most effective way to save power. Depending on the network activity, nodes rotate among the sleep and awake modes. Duty cycle, or the portion of the instance for which nodes are active for their whole lifespan, is what is meant by this.

Categories of duty cycling schemes are On-demand, asynchronous, scheduled rendezvous.

On-demand methods: The on-demand scheme's guiding principle states that a node will only enter the awake state when another node requests communication [3].

Schedule rendezvous: According to the wakeup schedule, the node and its neighbor will awaken at the same moment in the Schedule Rendezvous scheme.

Asynchronous: Each node wakes up on its own, but its active duration must coincide with that of its neighbor.

Duty cycle schemes: Duty cycle methods are important when developing a wireless sensor network. Duty cycle systems are designed to alternately turn on and off a mode's radio in order to decrease node energy consumption and, as a result, lengthen the lifespan of sensor networks. Duty cycling programmes take emphasis to reducing idle listening in particular. There have been several duty cycle techniques developed, and they can generally be divided into synchronous, asynchronous, and semi-synchronous designs [4]. The protocols for duty cycling are SMAC, BMAC, XMAC, and TRAMA.

B. Energy Harvesting

Sensor nodes in WSN are powered by batteries with limited energy backup. The battery cannot be replaced or recharged since nodes may be positioned in dangerous or unusable environments. Therefore, it is necessary to investigate other energy sources for battery-powered nodes. Energy harvesting is the process of obtaining energy from the environment (solar, heat, footfall, fingertip movement, etc.) and transforming it into electrical energy. Energy source, Harvesting architecture, and load make up the system's fundamental parts. There are two forms of energy harvesting design: harvest use architecture, which may be built to use mechanical energy, and harvest store use architecture, which can store gathered energy until it is needed to operate the system properly[5]. Solar energy, piezoelectricity, wind energy, and radio energy are the energy harvesting techniques.

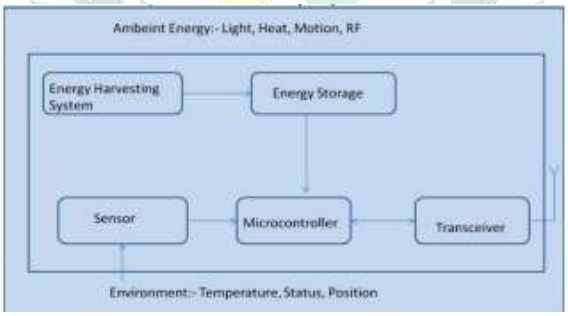


Fig. 3. Energy Harvesting Module of Sensor Node[5]

C. Energy Modeling Of Sensor Nodes

In order to maximize power usage in Wireless Sensor Nodes, energy modeling is crucial. In the design and implementation of wireless sensor networks (WSNs), energy modeling is a crucial component. A better understanding of the sensor node's energy consumption patterns is crucial for protocol development, system design, performance evaluation, and the creation of energy-saving measures in WSN.

D. Energy Efficient Routing

Wireless sensor network nodes are powered by batteries and have a finite amount of energy. The additional stress of routing depletes the power of sensor nodes, particularly in environments with several hops. Because

they must send more packets or data to the sink than other nodes in the network, nodes that are closer to the sink experience battery depletion more quickly. Thus, energy-efficient routing strategies are required.

Cluster Architecture

Clusters are used to organize the network. Nodes in clusters are controlled by the CH, who is responsible for coordinating the actions of the members & facilitating communication with either the other (CH) or the sink [4]. The methods used for clustering are LEACH, EECH, PGASIS, TEEN, and APTEEN.

II.LITERATURE SURVEY

Behera et al.,(2020) the creation of the present SEP's threshold-based CH selection for a heterogeneous environment. The threshold makes sure that both CH nodes and member nodes receive an equal amount of energy. Based on their initial energy supply, SN are divided into three types: normal, intermediate, and developed, in order to distribute the network load fairly. The recommended approach outperforms SEP and DEEC procedures by 300 percent in cluster creation and 56 percent in throughput, according to the simulation results[6].

Kumar et al.,(2018) In compartmental design-based cluster size optimization, opportunistic transmissions are used. Comparing the compartmental design to the incremental as well as the log designs, there is a realistic increase of 6% and 8% in average power utilization for both. It is found that the visible light signal is 13% more successful than both WiFi and acoustic communications. Additionally, there is a benefit to merely analyzing the second order Taylor series term. Future research on recommendation systems, malicious sensor identification and localization, the SGD method in a large WSN, and the Cramér-Rao constraint for variable prediction will all build on the current design[7].

Neamatollahi et al.,(2018) suggests a HCSP that causes node-driven grouping rather than time- driven clustering as in GRBP. Every cluster is modified only once at thus every local super round, according to HCSP. As a result, the periodicity of cluster reconfiguration differs on demand as well as may vary from one cluster to the next all across the networks lifetime. Even so, global clustering is conducted at the end of each global hyper round to recharge the system communication framework. As a result, HCSP motive to be more adaptable, energy-efficient, & expandable than GRBP in clustering-task scheduling. The main disadvantage of clustering methods is clustering overhead, which is reduced by this method. The effectiveness of HCSP in reducing energy consumption and extending network lifetime is shown by calculations of power utilization as well as by extensive computation [8].

Lata et al.,(2020) The LEACH- FC approach was recommended to high rise decade, and a FL-based CH selection & cluster development was carried out. For cluster head selection as well as cluster formation, we choose a centralized strategy as opposed to a dispersed one. Authors also utilized FL, a centralized method, to choose the vice CH. The power load at each node may reportedly be calculated using the suggested method, improving WSN dependability. It outperforms previous recommended algorithms in ways to lengthen system life and reduce power consumption[9].

Behera et al.,(2019) co focused on a precise Ch election method that switches the CH position between numerous nodes with faster speeds than others. The technique computes remaining energy, power consumption, and an average value of CH to choose the next group of CH for the system that is appropriate for IoT apps like environmental observation, smart cities, & devices. According to the findings of the simulation, the alternative version surpasses the LEACH strategy by boosting throughput by 60%, lifespan by 66%, and RE by 64%[10].

Ali et al.,(2020) Proposed an IEECP to increase the longevity of WSN-based IoT. Three sections of the suggested IEECP must be finished in that sequence. First, a commitment is made to the ideal number of clusters for the overlapping equitable clusters. The consistent clusters are then created using a modified fuzzy C-means algorithm and a framework designed to reduce or maintain the SN's energy usage. In the end, many cluster members rotate the CH feature to employ a novel CH selection-rotation approach by combining a back-off timing technique for CH selection as well as a rotation technique for CH orientation. This results in CHs being picked in optimal roles. The suggested approach, minimize & balances node power usage by enhancing the functional structures, where IEECP is appropriate for systems that take a significant lifespan. The outcomes show that the IEECP outperforms as compared to previous algorithms [11].

Liu et al.,(2019) to balance energy loss among the CHs, leads a new uneven scheduling technique called an EAKDE. To evaluate the attention of nodes contending for CH, EAKDE employs fuzzy logic. The adaptive kernel density prediction method is used to allocate the suitable unequal cluster diameter to SN in ability to adjust to the dynamic change of node circumstances. The simulation outcomes prove that EAKDE superior on existing approaches in means of system throughput, communication range, as well as energy consumption in various scenarios[12].

Kalantari et al.,(2017) A method for choosing the SN as CH has been created in the sense that choosing the SN closest to low-energy nodes will result in significantly less energy expenditure and node death prevention. The numerical results showed that the suggested strategy may extend a system's lifetime[13].

III.PROPOSED WORK

- **PROBLEM DEFINITION**

In DEEC-ET, the heterogeneous environment has been considered for the WSN where three types of nodes have been deployed. The probability that a node gets elected as cluster head depends on the threshold value which has been modified by the authors by using energy factor and number of optimal clusters. However, there have been certain gaps identified in the paper:

1. The features of the nodes like their distance from the base station or the number of cluster members have not been considered while selecting the cluster heads.
2. The cluster heads forward the data to the base station directly via single hop communication. This mode of transmission consumes a lot of energy and therefore can be replaced to increase the network lifetime.

- **OBJECTIVIES**:

To remove the drawbacks identified in the former section, the following objectives are laid out:

The main research objectives are as follows:

1.To study various energy efficient techniques used in WSN.

2.To select the cluster head based on fitness function and to transfer data using multi hop routing technique.

3.To implement the proposed protocol in MATLAB.

4.To compare the performance of proposed protocol with existing technique based on number of alive nodes and energy consumption.

- RESEARCH METHODLOGY

The selection of the CH is one of the imperative thing while designing the clustering protocol for WSN. In the proposed protocol, the nodes will be evaluated based on their fitness value. This will be dependent on residual energy of the node, its proximity from the base station and the size of the cluster it desires to form in the neighborhood. The residual energy of the node must be high else if the node having lower energy is elected as cluster head, it is likely to die out soon. Furthermore, the cluster head also aggregates the data from the entire cluster and if it dies out, the entire data gets lost.

The second parameter to be considered for the head election is the distance of the node from the base station. The energy consumption in WSN is directly proportional to the distance between two communicating nodes. Therefore, the cluster head chosen must be near to the base station.

Third factor is related to the size of cluster that node will form if it gets elected as cluster head. If the size of cluster is huge, the data aggregation cost and cluster formation cost increases. This is not beneficial for cluster head or cluster members either. Also, if the size of cluster is very small, it defeats the entire concept of clustering the entire network to save the energy. Therefore, it has to near the average value.

Considering this, the fitness function is defined as:

$$f_i = \alpha * \frac{Remaining\ energy}{initial\ energy} + \beta * \frac{d0}{d_{base\ station}} + \gamma * \left(CS_i - \frac{\sum_{j=1}^{N} CS_j}{N} \right)$$

Where: α, β, γ are the weights assigned to three parameters and has sum equaling to unity; $d0, d_{base\ station}$ is the threshold distance and distance of the node from the base station; CS_i, N is the cluster size of the node and number of nodes in the network respectively.

Once, the fitness values have been computed for the nodes in the network, the best nodes will be selected as cluster heads. These heads will form clusters with nearby nodes.

Once the clusters have been created, the next step is data transmission where the cluster members will aggregate data at the respective cluster head. Each cluster head will send data to the base station via other cluster heads. The main question is to choose the relaying cluster head. This will be done by using firefly optimization technique. In this, the attractiveness value will be computed for all the neighboring cluster heads. The one neighbor which will have highest attractiveness will be used for data transmission by the cluster head. The attractiveness value will depend on the distance from the base station as well as remaining energy of the neighboring cluster head.

IV.RESULTS

Both planned and actual work was simulated using MATLAB. Simulation made use of 100 square metre network with 100 randomly placed nodes. Various model parameters used in simulation are listed in table below:

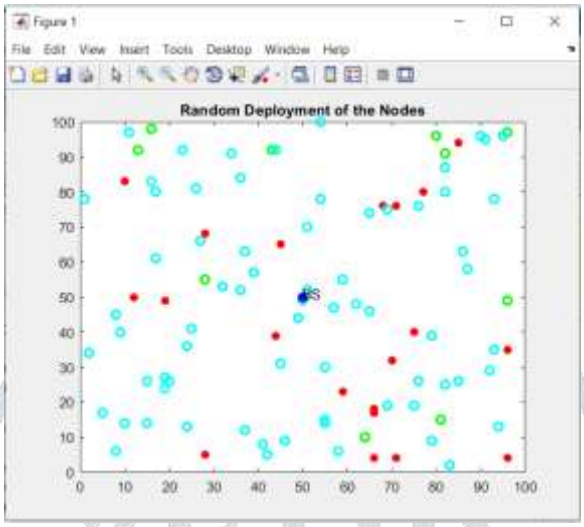


Figure 4 :Random Deployment of Nodes

The number of active nodes, dead nodes, residual energy, and throughput are used to gauge network performance. Throughput is the quantity of packets transferred to BS, whereas the number of active nodes affects the network's longevity. Nodes are scattered unevenly over a 100 by 100 metre area. The BS is located in (50, 50). Results of suggested approach are shown in this chapter. Energy conversion efficiency and clusters supplied to BS are chosen as output measures to test suggested strategy. In aforementioned sensor area, where BS is supposed to be, all SN are uniformly dispersed. S suggested solution was created using MATLAB programme. Ratio of live and dead nodes determines energy-saving factor. Four different scenarios were simulated using network of 100 nodes that were dispersed randomly. Effectiveness of network was evaluated using average RE usage, no. of active and inactive nodes, and throughput.

- **Number of Alive Nodes:** No. of alive nodes was used to compute device's energy usage for each round. Suggested technique has [500,1000, 1500,2000, 2500, 3000, 4000] rounds in total.

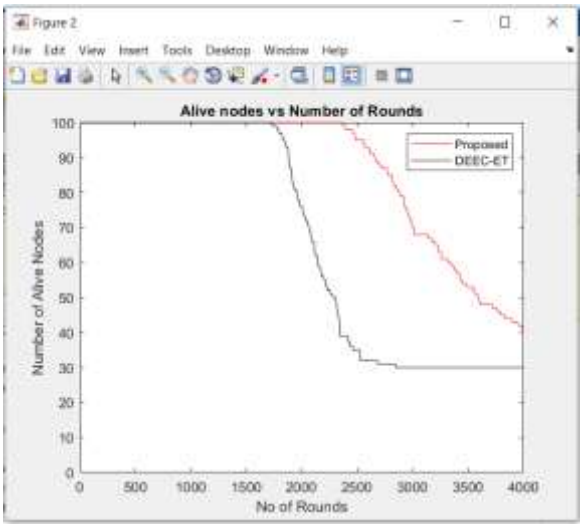


Figure 5:Alive nodes

➢ **Number of Dead Nodes:** No. of dead nodes was used to calculate device's energy consumption for each cycle.

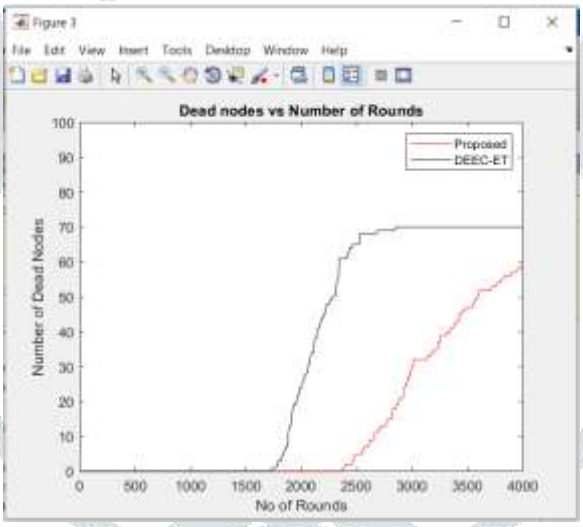


Figure 6:Dead nodes

This graph shows nodes that are dead in the network against rounds for both schemes. This indicates better network lifetime in the case of proposed technique. CH selection in new scheme is based on proposed algorithm in which fitness function of the node is computed depending upon energy and distance of node with respect to BS. Therefore, performance in the proposed scheme is better than existing scheme.

➢ **Throughput:** Amount of successful data transfer in network is referred to as throughput. Formula mentioned earlier is used in this situation to calculate throughput estimates:

$$\text{Throughput} = \frac{\text{Total No.of packets successfully transferred}}{Total\ Number\ of\ \ packets\ \ transferred}$$

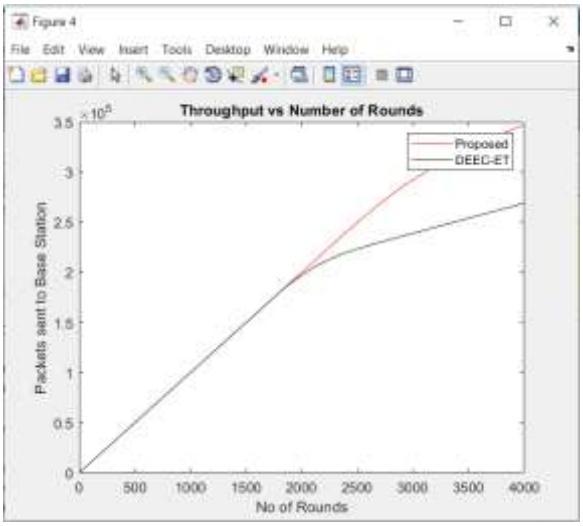


Figure 7:Throughput

Since alive nodes in system for longer period of time offer better bandwidth, throughput of recommended approach improved packets successfully transmitted, which is higher than current method MA-I-LEACH packets sent directly.

➢ **Average Residual Energy:** Energy is primary resource used by WSN nodes, and this determines how long the network will last. Figure 4.4 shows that average RE for current DEEC approach is steeper than for proposed method, indicating that steeper decreases indicate higher rate of energy depletion.

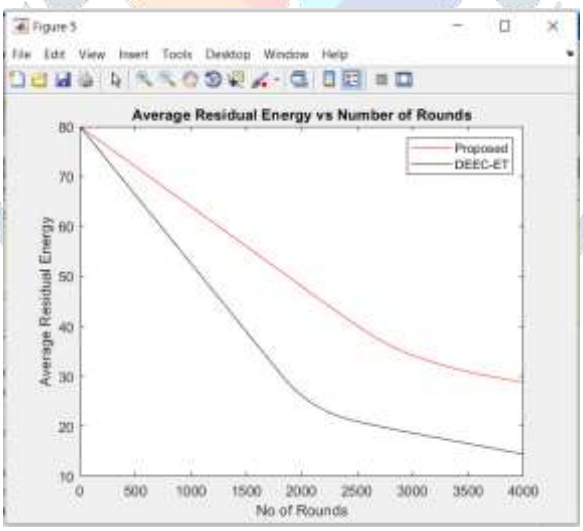


Figure 8:Average Residual energy

The four metrics, including RE, throughput, and the number of active nodes, are all improved by the suggested method. Additionally, the stress on the CH building the route is increased because only one route is used. Previously, the CH would either send data directly to the BS or through another CH that was close by (if the BS could be extended immediately.

V.CONCLUSION

Designing an energy-efficient system is the most difficult task in a wireless sensor-based system. In this article, it was discovered that the different authors created an energy efficient wireless network by employing an

energy efficient routing based clustering method. Authors highlighted the advantages of clustering in a WSN , as well as the numerous factors to consider when developing a clustering method. Authors have provides a summary of certain existing clustering procedures as well as the advantages of clustering. Eventually, authors have provided a comparison of the different algorithms predicated on some essential factors. In this study, Network performance is defined by the quantity of active nodes, dead nodes, residual energy, and throughput. Throughput is the amount of packets sent to BS, but the lifespan of the network is influenced by the set of active nodes. A 100 by 100 metre region is unevenly covered in nodes. BS is situated in (50,50). the results of the suggested technique are displayed. Clusters provided to BS and energy conversion efficiency are used as output measures to test the proposed plan. All SN are uniformly distributed within the aforementioned sensor area, where BS is meant to be. Using the MATLAB application, the suggested solution was produced. Energy-saving factor is determined by the live/dead node ratio.

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