To Extend Network Lifespan Despite an Increase in Network Size Using Bio Inspired Crow Search Optimization Technique

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Abstract: Wireless sensor network (WSN) is a multi-hop self-organizing system that is composed of a large number of sensor nodes. A node is any point within a CH, which could be any point. With the energy usage nature of wireless sensors, clustering is an effectual way to address energy usage difficulties. It is the criterion by which the total price, the number of necessary cluster heads for optimal system utilization, as well as the durability of the system; as a result, it is widespread used in WSN applications. A form of optimization method, met heuristic processes, use a tradeoff of randomization and local search. The Crow New Algorithm is one of many nature-inspired meta - heuristic algorithms (CSA). Using bioinspired methods, optimize the cluster head as well as congregation node requirements. To put the suggested method in MATLAB for a 100-node network. Try comparing the current and proposed techniques for a simulation of 100 nodes based on the amount of alive nodes, the number of dead nodes, the amount of packet delivery to the base station, as well as the platform's residual energy.

Keywords: WSN, Clustering, LEACH, Crow Search optimization

I.INTRODUCTION

WSNs gather information about a location through continuous monitoring and are widely used in body area networks (BANs) since they are inexpensive as well as the setup appears to be simple [1]. Aside from BANs, WSNs are used for tracking fires, military tracking, as well as other purposes, so WSNs have short-range sensors that track the climate. The sensor nodes' designs are based on variables like limited computation, energy constraints, and storage capabilities, so that the sensor cooperates between them to perform the quantification. The control of detectors in harsh environments makes control system of detectors a difficult task [2]. Thus every routing algorithm in WSNs differs with application and has different objectives. In overall, WSNs use SN that run on batteries, so energy is a major issue for WSNs because battery-powered sensors are responsible for the network lifetime. Clustering is the method for managing the energy consumption of SN by grouping them into clusters, with the individual cluster head (CH) serving as the cluster controller and the other nodes serving as cluster members (CMs). The SN is part of a single cluster and is charged with transmitting the collected data to the CHs, which is then conveyed to the sink node via single or multi-hop interaction [3].

WSN has a set of constraints like energy, topology, & SN bandwidth, which are evaluated using transmission protocols [4]. Cluster-based multi-hop routing algorithms are used in WSNs with the concept of constraint control. Fuzzy C-Means (FCM) and low-energy adaptive clustering hierarchy (LEACH) [5] are two clustering-based procedures that make sure longer lifetime of the network. The effective system for WSN energy efficiency lies in the network level, routing protocol, and routing path, so that the network's energy and long life are optimised. Energy usage is one of the challenges related to network lifetime, which is managed by a variety of algorithms. The scientists make the simple assumption that the sensors are uniform, meaning that all of the modules in the system have same amount of energy as well as similar sensing as well as processing capabilities. In overall, for practical purposes, a WSN is made up of heterogeneous sensors with differing modes. The diversity of sensor nodes could indeed increase reliability, such as lifetime of the network.

The organization of the paper is as follows: Sect. II describes a clustering approach and Section III gives the introduction of crow search approach. Sect. IV deliberates the literature review of the paper along with the challenges of the existing work. The proposed methodology is highlighted in Sect. 3, and Sect. 4 displays the results of the proposed work. Section 5 gives the conclusion to the paper.

II. Clustering

In WSN, clustering is a helps to make sure for fuel efficiency as well as network consistency. Clustering in WSN is a well-known and long-used technique. Clustering over spread methodologies is currently being developed to address issues such as network lifetime and energy. Clustering in sensor nodes is critical for solving many sensor network problems such as virtualization, energy, as well as lifetime. Clustering optimization techniques limit communication within a local domain and send only necessary information to the rest of the network via forwarding nodes (gateway nodes).A cluster is made up of a group of nodes, as well as the local conversations among cluster members are managed by a CH, as shown in Figure 1. Cluster members interact effectively with the CH, as well as the data collected is grouped and merged by the CH to save energy. Before reaching the sink, the CH can also form another layer of clusters among themselves.

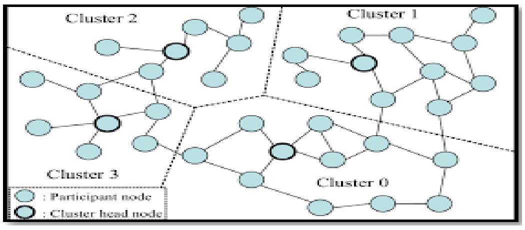

Figure 1:Cluster in WSN[6]

- **Applications of Clustering**

Clustering can be applied to a broad variety of subjects and areas.

The clustering method can be applied by integrating multiple methods from various fields, such as mathematics , physics, statistics and artificial intelligence. Main examples are as follows:

1. Image processing and pattern Recognition
2. Spatial Data Analysis
3. Create thematic maps in GIS by clustering feature space
4. Detect spatial clusters or for other spatial mining tasks
5. Document classification and clustering on the World wide web

6. Importance of Clustering in WSN

A few points demonstrate the significance of clustering in WSN:

1) The transportation of data from sensor is limited.

2) Improvement in energy competence is achieved as a consequence of network subsistence is seen.

3) Clustering supports network scalability.

4) Reduced energy consumption by adding CH-level data.

5) Reduction in network traffic and contention for the channel.

6) Conservation of communication bandwidth.

7) Suitable for inaccessible places like mountains, over the sea, rural areas, and deep forests

III. Crow search algorithm

CSA is a meta-heuristic algorithm based on the behaviour of the crow, an intelligent bird that lives in flocks. The crows have the memory power to remember where the food was in previous iterations, and they protect the caches using probability[7]. Crows have a thieving habit when it comes to finding food. CSA is user-friendly and easy to implement. The method strives for a global optimal outcome while also ensuring greater diversity. The CSA position alert is as follows:

$$X_i(t) = \begin{cases} X_i(t) + R_i \times d_i^t \times (M_j(t) - X_i(t)); & R_j \geq A_j(t) \\ \text{Random Position}; & \text{Otherwise} \end{cases}$$

If the random likelihood surpasses the awareness possibility, the role is updated using Eq. Otherwise, the position is updated using the random search. The following is an update on the position:

$$X_i(t) = X_i(t) + R_i \times d_i^t \times M_j(t) - R_i \times d_i^t \times X_i(t)$$

$$X_i(t) = X_i(t)\ \left[1 - R_i \times d_i^t\right] + R_i \times d_i^t \times M_j(t)$$

$$X_i(t) = \frac{1}{\left[1 - R_i \times d_i^t\right]}\left[X_i(t+1) - R_i \times d_i^t \times M_j(t)\right]$$

Pseudo steps to implement CSA as an optimizer

The pseudo-step-by-step method for implementing CSA as an optimization algorithm.

1. Establishing this same issue and its variables. The issue, decision variables, and constraints have all been defined. Going to follow that, the customizable CSA parameters flock size, highest number of iterations flight length of time, and recognition likelihood are assessed.

2. The location as well as memory of the Crows should be reset. Certain numbers of crows are randomly placed in a d-dimensional search window as flock representatives. Every crow represents a viable issue solution, and d represents the number of possible solutions. The memory of each crow is reset to zero. Because the crows had no experience in the first iteration, it is assumed that they hid their meals in their original position.

3.Assess the objective function The quality of each crow's location is calculated by entering the choice variable values into the objective function.

4. Make a new crow position. To establish new roles in the search space, do the following: Let's say the first crow wants to create a new role. This crow randomly selects one of the flock crows and follows it to the location of the meals concealed by this crow. This process is repeated for each crow.

5. Consider the viability of a new point of view. Each crow's new position is evaluated for viability. If the new position of a crow is viable, the crow changes its position. Or else, the crow remains in its current location rather than having to move to the newly created role.

6. Ascertain the fitness/objective function of new locations. The fitness function value is calculated for every crow's new place.

7. The crows' memories are updated based on the objective method's value. If a crow's new role has a higher fitness feature value than the remembered position, the crow updates its memory with the new position.

8. Repeat steps 4 via 7 until the maximum threshold is reached. When the deletion criteria is met, the global optimization approach is available as the optimal storage position in means of objective function value.

IV.LITERATURE SURVEY

Mahesh et al.,(2018) focuses on the hybrid optimization technique to optimally handle CH selection in WSNs to ensure effective interaction as well as energy-aware routing. The hybrid optimization technique, dubbed dolphin echolocation-based crow search method, integrates the dolphin echolocation method and the crow search algorithm in such a way that the hybrid optimization effectively and effectively selects CH based on multiple constraints. The proposed methodology is used to initiate energy-aware forwarding in WSN. The suggested methodology provided a better lifetime of the network with energy remaining in the node of 0.0476 with 33 alive nodes at the end of 200 rounds in the Heterogeneous WSN utilizing 50, 75, and 100 nodes[8].

Hassan et al., (2020) suggested a IEECP to extend the lifespan of WSN-based IoT, which comprises of 3 sequential sections. Namely , an optimal set of clusters for the overlapping balanced clusters is motivated. The balanced-static groups are founded using an altered FCM algorithm as well as a method to reduce & alignment the power usage of the SN. Finally, CHs are chosen in ideal regions by rotating the CH function among cluster members using an innovative CH selection-rotation technique that combines a back-off timer method for CH selection as well as a rotation method for CH rotation. The outcomes demonstrate that the IEECP outperforms current practices[9].

Kale et al., (2019) create a new CH selection prototype to optimize lifespan of the system & energy efficiency, or more suggested a latest Fitness-based Glowworm Swarm with FGF, which is a combination of GSO and FFOA to choose the best CH in WSN. The section discusses how the suggested FGF outperformed other common approaches including GA, PSO, ABC, GSO, ALO as well as CS, GAL-LF, FFOA, GOA in terms of alive node evaluation, energy performance, as well as cost function. The outcomes have been demonstrated, but at the 2000th round, the suggested FGF demonstrates superior performance by having so much alive nodes in the scope of 20–30[10].

S. M. Mahdi et al., (2019) Examine the problem of interaction, which accounts for the majority of energy usage. As a result, efficient routing is an appropriate solution under consideration. The researchers introduced a new clustering technique that takes the GWO to select CHs. GWO is a latest SI approach concentrated on grey wolf behaviour that has interesting characteristics as well as challenging outcomes. The strategies for choosing CHs are regarded based on the estimated energy usage as well as existing RE of every node. The suggested technique also restricts energy waste due to the unnecessary implementation of the pattern set - up phase in cycles where the existing clustering is adequate. The researchers also recommended that the suggested protocol might not be appropriate for applications where FND has a considerable impact on the system. It is also unsuitable for fault-critical apps since no fault tolerance method is included in the procedure[11].

Sonam L. et al., (2020) introduced a latest centralized fuzzy-based clustering method & used FL to select a CH based on 3 parameters (energy level, concentration, as well as centrality). LEACH generates clusters depend on the obtained signal intensity. Related nodes are placed by utilizing fuzzy logic and 3 variables (energy level, node distance to BS, & node distance to CH). The authors also used FL to select a vice cluster head, again taking 3 variables into account. The first two modification are introduced to enhance lifetime of the system, as well as the final change is implemented to enhance WSN consistency. The suggested approach has been observed to be efficient in balancing the energy load at every node as a outcome improving the stability of WSN [12].

Mishra et al.,(2020) Apply a new multi-input multi-output clustering method (OCSSP) to better utilize node energy & increase network longevity. The regulations of the FIS serve as the foundation for an improved network consequences. Numerous rounds of simulations are used to complete the regulations. To fully describe the clustering scenario, there are three input variables as well as three output variable. To correctly load balance the overall system, researchers impose a double limitation on the length of each cluster. The capacity of a SN to bear load demand rapidly as energy is depleted. The proposed change to reduce the growth of a cluster performs better due to CH nomination. And contrast OCSSP to the well-known clustering approaches LEACH and DUCF, which are useful for clustering in WSN. Extensive numerical work demonstrates that the OCSSP accomplishes better results[13].

V. Research Gap

1. The researchers' current method, made available through EESRA, suggests the idea of cluster congregation nodes, which gather data from cluster members and transmit it to ground station. The study work has not given much attention to the CH selection. This was accomplished via the LEACH clustering protocol, in which the cluster head is chosen at random; however, this could seriously harm system performance.

2. Additionally, the cluster congregation nodes were chosen only based on their leftover energy. To determine how much energy will be used to gather the data, additional factor like the cluster congregation node's closeness to the other members must be taken into account.

In order to overcome the above flaws, the following objectives have been considered:

3.2 Objectives:

1. To study various techniques that focus on optimizing the lifetime of sensor network.

2. To optimize the cluster head and congregation nodes criteria using bio inspired techniques.

3. To implement the proposed technique in MATLAB for a network of 100 nodes.

4. To compare the existing and proposed technique for simulation scenario of 100 nodes based on number of alive nodes, number of dead nodes, packets delivered to base station and remaining energy of the network.

To achieve the above objectives, following methodology will be adopted.

3.3 Research Methodology:

On the basis of the crow search optimization method, the CH will be chosen. Every crow uses this technique to hide its food, which it may later find whenever it wants. However, it is necessary to assess the location's fitness at each location where food is concealed. Similar to connectivity, where nodes stand in for hiding spots as well as the crow can roam between them to find the optimal solution. As a result, the research project will calculate every node's fitness based on its residual energy as well as its distance from the BS. The best CHs would then be selected using crow search optimization.

After choosing the CH, the cluster congregation node will be chosen depending on the cost of energy interaction with the other cluster members as well as remaining energy. Each node can aggregate the data at the cluster congregation node when the election process is complete, which will then pass the information to the cluster member. The data could then forwarded by a cluster member to the base station.

VI.RESULTS

The results of the proposed CR–EESRA algorithm are presented in this section. The power efficiency and clusters transmitted to BS are chosen as output parameters to validate the proposed algorithm. In the above sensor area, all sensor nodes are uniformly distributed and BS is expected to be located within the sensor region. In the MATLAB setting the proposed protocol is implemented. The parameter for energy efficiency is defined by the number of live and dead nodes. Four cases were generated randomly distributed nodes in the network for simulation.

The network's performance was evaluated based on the amount of average residual energy consumed, the number of alive nodes, the number of dead nodes, and the network's throughput.

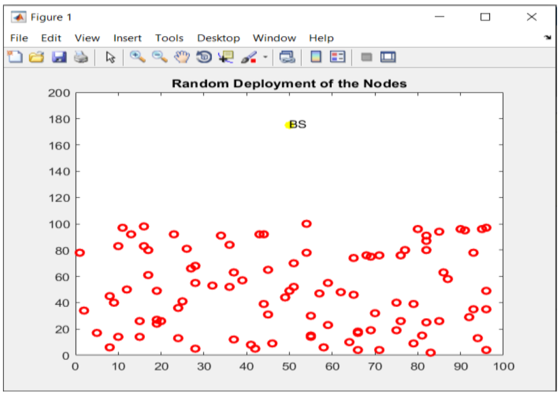

Figure 2: Random Deployment of the Nodes

- **Number of Alive Nodes:** The number of alive nodes was calculated for each round in order to find the energy efficiency of the network. For the proposed work the number of rounds consists is [500,1000,1500].

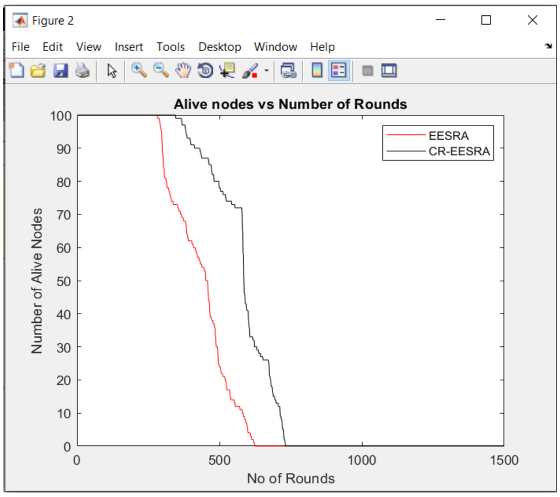

Figure 3:No. of Alive Node

Table 1: Comparsion of Alive Nodes

Technique	Number of Rounds
EESRA	600
CSA-LEACH	700

From figure 3 demonstrate that , for existing work first node dead immediately on 600 round and for proposed work first node dead on 700 round. So ,it is clear that network stability is better in proposed work because cluster head select properly by using proposed Approach GSA.

• **Number of Dead Nodes:** The number of dead nodes was calculated for each round in order to find the energy efficiency of the network. For the proposed work the number of dead rounds consists is [500,1000,1500].

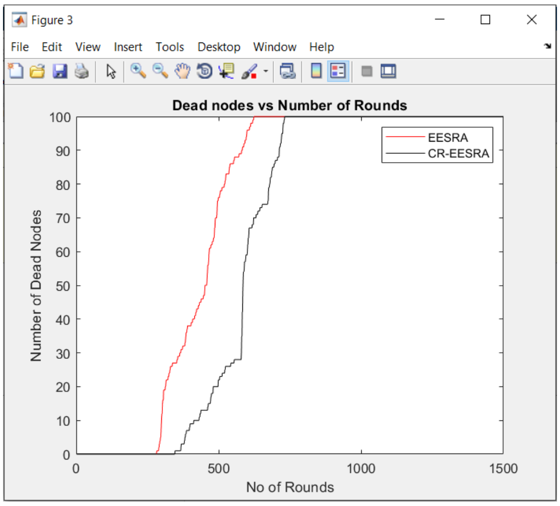

Figure 4:No. of Dead Nodes

Table 2: Comparsion of Dead Nodes

Technique	Number of Rounds
EESRA	300
CSA-LEACH	350

From figure 4 demonstrate that , for existing work network dead on 300 round and for proposed work network dead on 350 round. So ,it is clear that network lifetime is better in proposed GSA approach .

• **Throughput:** The throughput is generally defined as the amount of success data transmission in the network. In this context, the following formula is used to calculate the throughput:

Throughput = $\frac{\text{Total Number of packets successfully transferred}}{\textit{Total Number of packets transferred}}$

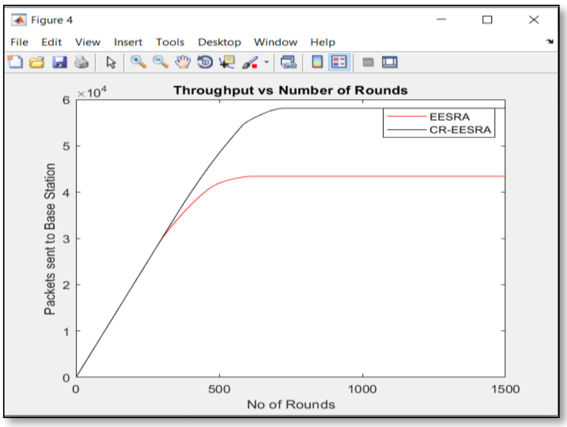

Figure 5:Throughput

From Fig 5, the throughput for a proposed CR-EESRA algorithm increased the total Number of packets successfully transferred is 700 which is more than existing algorithm R-LEACH where packets transferred is 350 because if alive nodes exists in the network for a long period it provides a better throughput.

Average Residual Energy: Energy is the main resource of WSN nodes, and it determines the lifetime of system.

From fig 6 is shown that existing EESRA exhibit steeper drops in the average residual energy as compared to the proposed CR-EESRA algorithm, where the steeper drops indicate faster energy depletion.

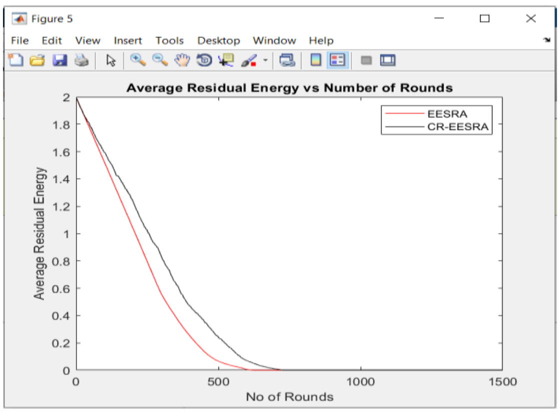

Figure 6:Average Residual Energy

Above mention tables clearly shows that the proposed CR-EESRA algorithm improves the values for all four parameters like Residual energy, throughput, no. of alive nodes and dead nodes because the concept of single path will not be used as it will increase load over the cluster heads forming the path. The cluster heads will forward the data to the base station via neighboring cluster head or directly to the base station (if base station can be reached directly) as compared to existing techniques.

VII.CONCLUSION

Wireless sensor networks (WSN) are randomly deployed different sensors that track physical or environmental circumstances such as temp, sound, force, and so on, and also co - operatively push data through the network to a base station. The WSN is made up of nodes ranging from a few to hundreds or even thousands, with every node linked to certain other sensors. Clustering is a critical approach for extending the system lifetime in WSNs. It entails clustering SN and electing cluster heads (CHs) for all clusters. CHs gather information from specific cluster nodes as well as send the aggregated data to the BS. The article concentrated on the hybrid optimization technique for addressing cluster head selection ideally in WSNs to ensure efficient communication as well as energy-aware routing. The hybrid optimization technique, known as the Clustering-based crow search method, ensures the efficient as well as rapid selection of CH based on multiple restrictions. The experiments demonstrated that the proposed method is more effective than the current methods, with the suggested technique providing a longer lifetime of the network than the current methods.

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