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Improving Lifetime of WSN-IOT Network using Cuckoo Search Optimization

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Abstract: Data from the physical world is connected to IoT-powered computational models through wireless sensor networks. Specialized transducers used in wireless sensor networks enable limited-energy Iot devices to sense their surroundings. One of the most important design considerations in WSNs is energy consumption due to the practical difficulty of replacing batteries in sensor networks.

The clustering method is essential for raising the energy effectiveness of a sensor network. The right cluster head choice can help with network load balancing, energy conservation, and increased durability. The cluster head selection process using the Cuckoo search algorithm and the data transmission process using multi hop AODV routing are the key themes of the study. By calculating network efficiency using an average of throughput and remaining energy, the final conclusions are obtained. Simulated findings show that the suggested strategy performs better than the current I-SEP method.

Keywords: AODV, Wireless Sensor Networks, Internet of Things, Clustering, Energy Efficiency, CSA

I. INTRODUCTION

IoT is a system of interconnected devices and services that allows for the sharing of data. These gadgets range from everyday objects like furniture, coffee makers, and farm equipment to things that can be implanted with different software and electrical connections. By exchanging data across the Internet of Things (IoT), wireless connectivity helps physical items become more prevalent in our daily lives and grow in number [1].

The WSN acts as a link between the digital and real worlds. Tiny sensors or actuators coupled to one another sense the environment and transmit data to the Internet. Sensors are installed in the network to keep an eye on a number of WSN properties. There are many nodes in this network, and each of them serves a certain purpose. The WSN can be linked to the internet using IP-based sensor networking technologies.

WSNs can be used to keep an eye on a variety of internet-based applications. It enables data collection from physical items that are interconnected by nodes, activators, and connections. Based on a variety of needs, several academics presented a number of WSN systems that are designed for real-world applications. While WSNs suffer a variety of deployment challenges, they have been widely accepted in practical applications.

The development of an ideal clustering and routing protocol that overcomes the various challenges it entails is the key issue that arises from the deployment of WSNs. WSNs are made up of a number of dispersed, small, dense, inexpensive, and low-power sensors [2]. The network uses these constraint-based nodes to collect and spread environmental data since it has memory, processing power, energy, and resource restrictions.

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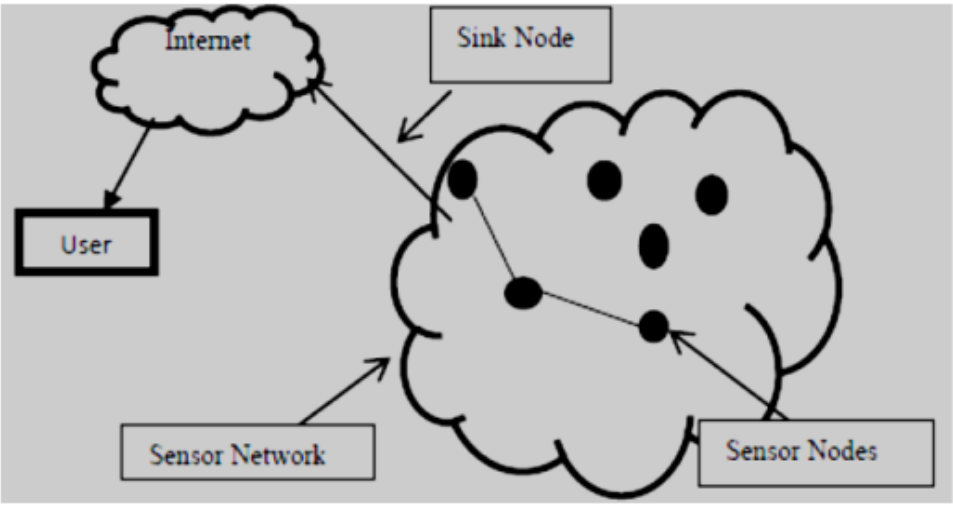

Figure 1: Wireless Sensor Network [3]

The above figure shows a fundamental WSN structure. In order to transfer their newly revealed information to a sink and to carry out local cooperation, all sensor nodes in a WSN will connect with one another. The WSN's inefficiency and shorter network longevity as a result of the poor battery life of the sensors are its main flaws. The batteries not only shorten the sensor's lifespan but also hinder WSN design and management. A network monitors the consistency of service measures like latency, throughput, jitter, usability, and even safety.

Clustering algorithms basically act as communication protocol that groups the sensors together and uses the least amount of energy. A cluster head (CH) is in charge of gathering data from sensing nodes for each cluster [4]. The WSN's inefficient network and shorter network longevity as a result of the poor battery life of the sensors are its main flaws. The batteries not only shorten the sensor's lifespan but also seriously hinder WSN design and management. A network monitors the consistency of service measures like latency, throughput, jitter, usability, and even safety. However, each CH must perform additional jobs, which causes their own energy to run out more quickly than the energy of nearby sensors. A replacement cluster head must be chosen from among the remaining cluster sensors when a cluster head's batteries run out in order to continue performing its functions. As a result, great consideration should go into CH selection and data transfer in order to keep the network balanced enough for effective energy management. There are numerous methods for generating different routing schemes that authors have suggested.

In this investigation, it seems that the CSA-based CH selection and AODV routing algorithms are effective. The life of a "cuckoo" bird served as the inspiration for the Cuckoo Optimization Concept [5]. This efficiency strategy is based on the cuckoo bird's unique egg-laying and breeding habits. Every egg in a nest corresponds to a different way out since a cuckoo egg relates to solutions. The intention is to replace less-than-ideal alternatives with new and maybe superior ones (cuckoos) in the nests. AODV routing will be used in proposed work to convert direct data transmission into multi-hop communication, greatly reducing the distance among CH and BS communication. This increases the network's overall lifespan.

The rest of this article is divided into the following sections. In Section II, review of literature is described. The proposed technique for this investigation is presented in Section III. The results are shown graphically in Section IV, and the work's conclusion is provided in Section V.

II. REVIEW OF LITERATURE

The research of several academics on various energy-efficient clustering techniques has been published. The various cluster-based approaches used in WSNs are reviewed in this section.

Sarma et al. [6] simulated Firefly and Jumper Firefly protocols for energy efficient clustering in WSN. Modern cost functions have also been designed to reduce intra-cluster and increase network energy usage. MATLAB is used to analyse the Firefly model's output. The BS is situated at centre of city, and the virtual network comprises of 100 nodes in a 200 m by 200 m network area. According to the simulation results, clustering with the Jumper Firefly protocol delivers a longer network life than Firefly and LEACH. In the future, a hybrid optimization technique for clustering in WSN will be introduced.

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Amit et al. [7] It is advised to use Firefly with Cyclic Randomization (FCR) to choose optimal cluster header. The effectiveness of network is increased by utilizing this method as opposed to other conventional topologies. In actuality, data transport with the least amount of latency and the most amount of energy efficiency is WSN's main challenge. The key contribution to the current discussion has been to enhance an effective CH selection mechanism by considering range, energy and delay of SA all the way through network. These issues have been the focus of the discussion. In this meta-heuristic approach, the network model can also be changed to include security needs allowing it to be constructed with greater complexity.

Anup et al. [8] devised a hybrid CH selection method using firefly and Harmony Search algorithms. A straightforward firefly-centered routing algorithm that concentrates on evaluation measures such as no. of alive nodes, network energy consumption, data packets acquired by BS, First Node and Last Node Dead is contrasted to proposed protocol along with clustering methods like LEACH, LEACHC, and EOICHD. The hybrid CH selection system exceeds the previously stated routing protocols, according to the methodology created using NS 2.34. The conclusions of the study are viewed as positive and quantitative. The currently used method will soon be enhanced by looking into intra cluster data aggregation.

Vishal et al. [9] created a method for installation stage of WSN sensors. A cycle is essentially split in 2 segments. TCOV procedure is implemented in first half of approach, and NCON is created among nodes in second portion. Target designs for TCOV and NCON are both created as minimization problems. By employing FireFly (FF) optimization to pinpoint the ideal sensor destination, the issue is resolved. This results in the development of a more sophisticated model that choose ideal site for WSN deployment. Suggested FF-TCOV and FF-NCON models are also contrasted with existing methods like TCOV and NCON models using GA, PSO, ABC, DE, and EA. Results show that proposed technique is effective than the original one.

Salem et al. [10] fixed the energy efficiency concern which needs multi-path routing using Chicken Swarm Optimization and Fractional Firefly algorithm. The network is first partitioned into groups and once communication between and within clusters has started, the Cluster Head (CH) is selected. In order to address the firefly algorithm's slower convergence issues, FFA was developed. FFA chooses CH based on its capacity, delay, effectiveness, and longevity. Then CSO considers delay, energy consumed, longevity and hence the optimal path is determined. Using the Network Simulator-2, the proposed FFA+CSO routing protocol will be examined. Outcomes for 100 nodes demonstrated that in contrast to conventional routing algorithms, proposed methodology empowered efficient multi-path data transfer for networks with 24 percent lower delay, 28 percent greater throughput, 18.7 percent less energy consumption, 21.64 percent longer life, 20 percent higher PSNR, and 37.54 percent fewer hops.

Shankar et al. [11] analysed network lifespan and remaining energy based on nature inspired techniques. Firefly and hybrid scheduling optimization strategies are observed to continue to deliver better outcomes than current approaches like direct broadcast and LEACH procedures. ABC and FA optimization are combined to create the hybrid model. The suggested methodology improves the WSN's performance, residual energy, and network durability.

Aqib et al. [12] developed Firefly algorithm which is a meta heuristic technique used to tackle multimodal complexities more proficiently. A new fitness function in the suggested technique uses remaining energy, proximity and node degree. Effectiveness of suggested methodology is analyzed using a variety of scenarios and contrasted with well-known approaches including DHCR, EADC, and hybrid routing, which depicts that new approach works superior than existing technique.

Barzin et al. [13] Shuffled Frog-leaping and Firefly Algorithms are used as clustering strategy for improving WSN lifetime. The multi-objective fitness method used by SFFA examines a number of factors, including the distances of CHs from sink, remaining energy, overlap and cluster loads, before selecting best CHs in every round. SFFA variables in the clustering procedure are adjusted and modified to perform accurately according to the requirements of the network. Simulation results show an average lifespan improvement over LEACH, ERA, SIF, and FSFLA of 49.1%, 38.3%, 7.1 percent, and 11.3 percent under various network conditions.

Misbahuddin et al. [14] implemented the Data Similarity Aware for Dynamic Multi-hop Network Algorithm. This vibrant routing technique checks the information of adjacent nodes in order to prolong network lifespan and fulfill the needs of a multi-hop algorithm for dynamical node grouping. DSA-DMRP divides network in various group sizes using a fuzzy technique and calculates coefficients of similarity of attributes. All nodes recognize and keep track of adjacent nodes as well. Using K-hop Clustering Algorithm that is improved by taking a priority factor into consideration improves residual energy and proximity to BS. To confirm quality, DSA-DMRP is assessed using this algorithm. As per network lifespan, DSA DMRP surpasses existing technique and complies with dynamic multi-hop routing requirements.

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Ravuri et al [15] A clustering protocol based on the firefly and midpoint algorithms is proposed in this paper as EEC-FM. Midpoint formulas are utilised for the CH selection and Firefly algorithm is employed for cluster formation to prevent imbalanced clusters. The proposed method produces unbiased groups that effectively balance workload on CHs and increase lifespan of system by utilising remaining energy and Euclidean distance as criteria for proper cluster production. The results of the simulations show that the proposed method performs better in terms of cluster balancing, energy efficiency, and network life than LEACH-B, BPK-means, Park approach, Mk-means, and EECPK-means. According to this study, suggested EEC-FM procedure is better than LEACH-B in aspects of half energy usage module, 17.8 % greater than BPK-means process, 12.5 % tougher than Park strategic plan, 9.1 percent greater than Mk-means process, and 5.8% greater than EECPK-means process.

III. PROPOSED METHODOLOGY

The technique used in proposed methodology is discussed in this section.

Step 1: Choosing the best cluster head for the network is the first step. In the current method, the node with the highest network residual energy has been given preference; however, in the suggested scheme, we will employ cuckoo search optimization to choose the cluster head. Each solution or node in this optimization must have a fitness value across which it may be assessed. Based on the node's residual energy, range from BS, and no. of cluster members, fitness function of node will be calculated.

Step 2: As soon as the network's cluster heads are chosen, they create clusters with the nodes that are closest. In the cluster that has been created, every cluster member transmits data to CH, which subsequently transmits it to BS.

Step 3: The current strategy uses single hop communication to conduct this data relaying, which is an energy-intensive method. As a result, in the proposed work, data will be forwarded from the cluster head to the base station using multihop communication. To do this, the AODV routing protocol will be used. From source cluster head to base station, several pathways will be constructed as a result. The cluster head will select the shortest path to BS from among these options.

IV. RESULTS AND DISCUSSION

This section includes a graphical depiction of experimental investigation. The network efficiency was determined by determining the throughput and remaining energy with respect to no. of rounds.

Number of Alive Nodes: The set of alive nodes was determined for every round to determine the device's energy usage. For the suggested work the set of rounds contains is [1000,2000,3000,4000,5000,6000, 7000, 8000].

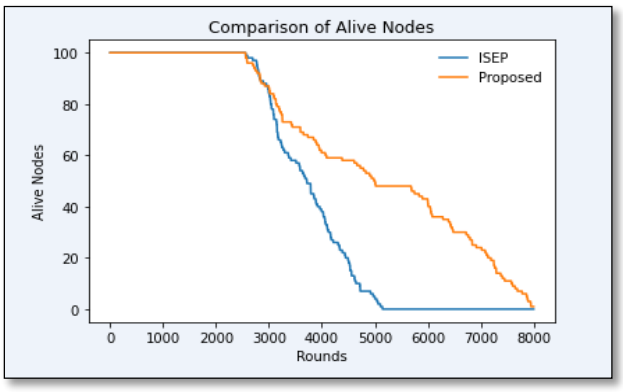

Figure 3: Alive Nodes

Figure 3 shows that for current work, the first node dies on the 5200th round, while for suggested technique, the first node dies on the 8000th round. As a consequence, it is clear that the provided method improves system stability because CH are chosen correctly using the suggested approach CSA.

Number of Dead Nodes: Each cycle, the number of dead nodes was calculated to find the system's energy consumption. The number of dead rounds for the suggested task is [1000,2000,3000,4000,5000,6000.7000.8000].

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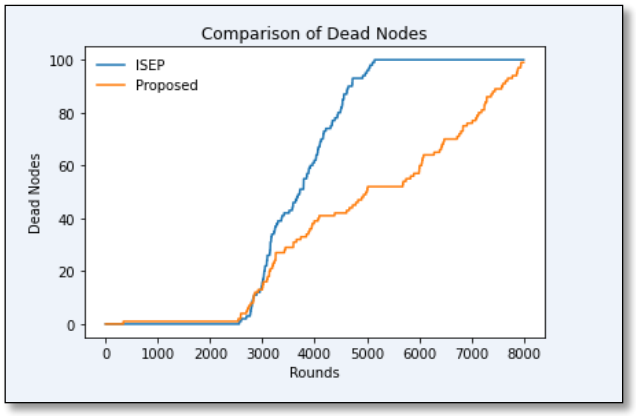

Figure 4: Dead Nodes

Average Residual Energy: Energy is the primary resource used by WSN nodes, and this determines how long the network will last. In contrast to the suggested CSA-AODV approach, Figure 5 shows that the existing I-Sep method has steeper average RE drops, indicating a higher rate of energy depletion.

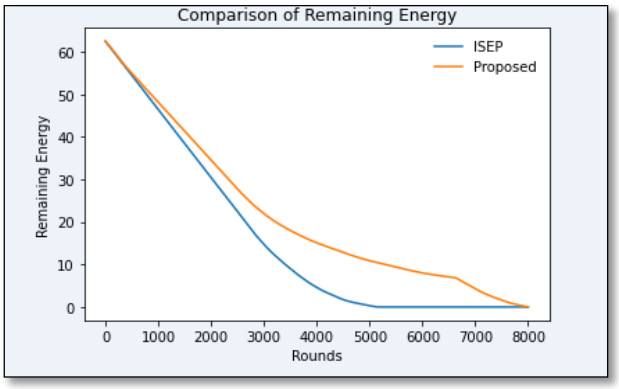

Figure 5: Remaining Energy

Throughput: The amount of successful data transfer in a network is referred to as throughput. The formula mentioned below is used in this situation to calculate throughput.

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

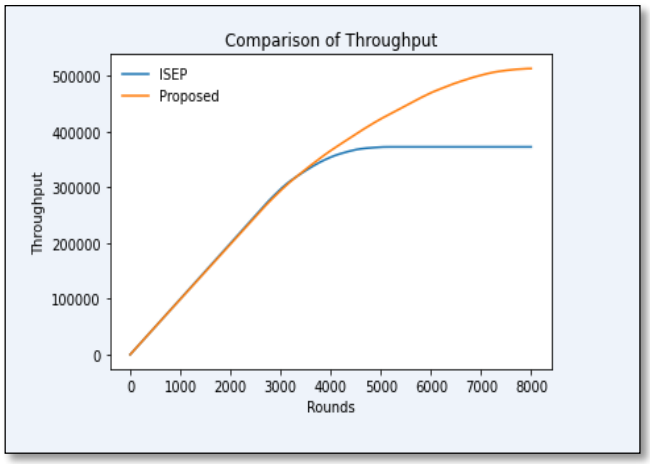

Figure 6: Throughput

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Since alive nodes in the system for a longer period of time provide a superior bandwidth, the suggested CSA-AODV method's throughput increased to 5 105 packets successfully transmitted, which is larger than the current technique I-3,70,000 Sep's packets sent directly, as shown in Fig 6. As a result, the values for both measures, including RE and throughput, are improved by the suggested technique.

V. CONCLUSION

It is quite difficult to develop a WSN protocol that is energy-efficient. The cluster-dependent routing protocol, an unique method for improving the quality of a sensor network, aids in choosing CH and information transmission. In the proposed work, the relay cluster head that will transmit data to the base station is found using the cuckoo search method. The research looks at routing algorithms like I-SEP, AODV, and CSA that prioritise the best CH selection. The ultimate goals of these algorithms are energy consumption reduction and network life optimization. In order to compare the two techniques' performance, network throughput and average residual energy are taken into consideration. python is used to run the simulation. The node's fitness value is calculated in the proposed scheme's CH selection process based on its energy and distance from the base station. As a result, the proposed design has greater throughput values and reserves more energy. We can conclude that the suggested plan is superior to the current approach as a result. The suggested approach can also be assessed using a range of real-world WSN-based IoT scenarios. The application may have a connection to catastrophe preparedness or management, among other things.

REFERENCES

[1]. Arampatzis, T., Lygeros, J., "A Survey of Applications of Wireless Sensors and Wireless Sensor Networks", Proceedings of the IEEE International Symposium on Control and Automation Intelligent Control, 2016.

[2]. Agnihotri, RB, Singh, AV & Verma, S., 'Challenges in wireless sensor networks with different performance metrics in routing protocols', In Reliability, Infocom Technologies and Optimization (ICRITO) (Trends and Future Directions), 4th International Conference on IEEE, pp. 1-5,2015.

[3]. Prasad, P., "Recent trend in wireless sensor network and its applications: a survey", Sensor Review, vol. 35, no. 2, pp. 229-236,2015.

[4]. Abdullah, M & Ehsan, A., "Routing protocols for wireless sensor networks: classifications and challenges", Journal of Electronics and Communication Engineering Research, vol. 2, no. 2, pp. 05-15,2014.

[5]. Kuo, Y.-W., Li, C.-L., Jhang, J.-H., & Lin, S. , "Design of a Wireless Sensor Network-Based IoT Platform for Wide Area and Heterogeneous Applications", IEEE Sensors Journal, Volume 18,No.12, pp. 5187–5197,2018.

[6]. N.V.S.N Sarma , Mahesh G., "Energy Efficient Clustering using Jumper Firefly Algorithm in Wireless Sensor Networks", International Journal of Engineering Trends and Technology (IJETT), Volume 10,No.11,pp.525-532 ,April 2014.

[7]. Amit S. , T.S. Murugan, "Review paper on Firefly algorithm with cyclic randomization in wireless sensor netowork", International Journal for Research in Engineering Application & Management (IJREAM),2018.

[8]. Anupk. ,M. Bongale , C. R. Nirmala, "Hybrid Cluster Head Election for WSN Based on Firefly and Harmony Search Algorithms", Springer Nature , 2019.

[9]. Vishal, P., & Ramesh Babu, A., " Firefly Algorithm for Intelligent Context-Aware Sensor Deployment Problem in Wireless Sensor Network", Journal of Circuits, Systems and Computers,2018

[10]. Salem A. A . B H., V., "Multipath Data Transmission in IoT Networks Using Fractional Firefly Algorithm and Chicken Swarm Optimization", International Journal of Intelligent Engineering and Systems, Volume 13, No.3, 2020.

[11]. *T. Shankar, S. Shanmugavel, "*Hybrid Approach for Energy Optimization in Wireless Sensor Networks Using ABC and Firefly Algorithms",Volume 8 , No.10,2013.

[12]. Aqib R. Bhat, A. I. Khan , "Efficient Coverage and Routing in Wireless Sensor Network using Firefly Algorithm IJSTE", International Journal of Science Technology & Engineering , Volume 4 , Issue 5 , November 2017

[13]. A. Barzin ,A. Sadeghieh, "Hybrid swarm intelligence-based clustering algorithm for energy management in wireless sensor networks", Volume 12, No.3,pp. 78-106,2019.

[14]. M. Misbahuddin, "Dynamic Multi-hop Routing Protocol Based on Fuzzy-Firefly algorithm for Data Similarity Aware Node Clustering in WSNs",Volume 13,No. 1,2018.

[15]. Ravuri D.,K. N. Rao, "EEC-FM: Energy Efficient Clustering based on Firefly and Midpoint Algorithms in Wireless Sensor Network",Volume 12, No. 8.