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To improve lifetime of WSN-IoT network using bio-inspired flower pollination Based cluster head selection

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Abstract: Wireless Sensor Networks (WSN) acts as a virtual layer in the Internet of Things (IoT) paradigm. It connects data from the physical world to computer systems powered by the Internet of Things. WSN offers all-encompassing access to location, the condition of various environmental entities, and data collection for long-term IoT monitoring. Recent developments have allowed for the projection of numerous energy-efficient protocols because energy is a fundamental design restriction for WSNs. Data clustering requires a significant amount of energy to complete. Many heuristic clustering protocols have been discussed recently to achieve the goal. This article enhances the current Stable Election Protocol (I-SEP) by modifying cluster head selection process. In the proposed technique, CH is selected through nature inspired Flower pollination approach. According to simulation results, proposed method FP I-SEP performs better than the I-SEP protocol, with approx. 30% increase in throughput.

Keywords: WSNs, Internet of Things, Clustering, Energy Efficiency, SEP, Cluster Head selection, FPA

I. INTRODUCTION

The Iot concept has developed over last few years into one of the most significant technological breakthroughs in modern science. With the development of wireless Internet connectivity, IoT-enabled devices like computers and mobile phones may now access data about the surroundings without requiring human involvement [1]. Increasing lifespan of WSNs is crucial since they serve as the foundation of IoT networks. The Figure 1 shows a fundamental WSN structure. It consists of sensor nodes, sensor network, user and Internet. The WSN is widely used in military and civilian applications. Usually, WSN tracks specific areas using sensors, gathers data and sends them to Base Station (BS). The WSN constant characteristics include network bandwidth, speed of processing, as well as storage capabilities [2]. The nodes are set up with a specific architecture, and they all self-organize with multi-hop interaction. Using low-cost data acquisition, a WSN is made up of spatially scattered sensor nodes that are designed to capture and keep track of a wide range of physical and environmental parameters. Due to energy-starved nature of sensor nodes, novel strategies have been developed to prevent energy loss that could enhance network lifetime . When source nodes transmit data straight to the Base Station, they use a lot of energy. They must therefore rely on intermediate nodes in order to function [3].

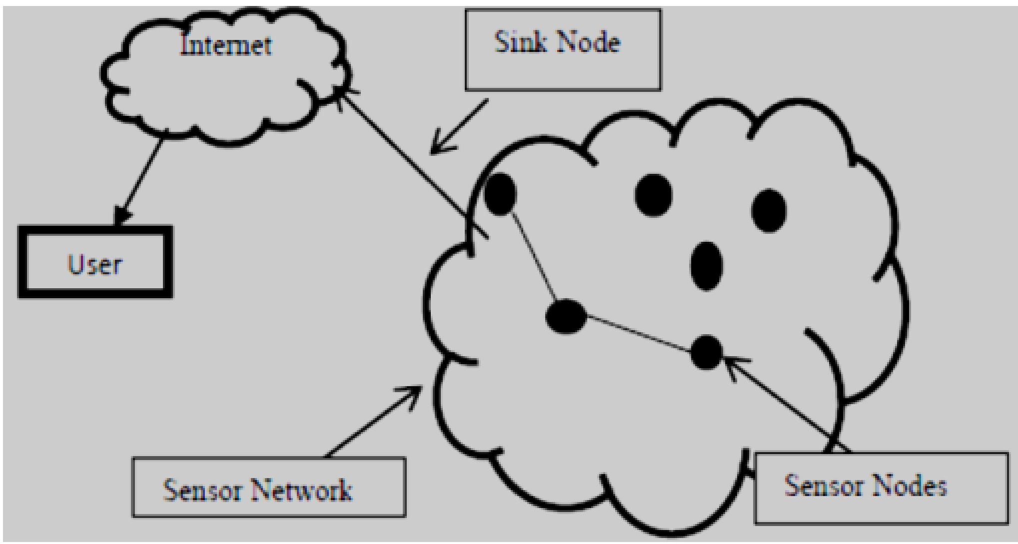

Figure 1: Wireless Sensor Network

To reduce energy consumption of sensor nodes, several clustering approaches have been applied in previous work [4]. Because of their potential remote locations from the base station, sensor nodes may expend a considerable amount of energy while sending data there over a greater distance. The communication protocol that clusters the sensor nodes most efficiently are known as clustering algorithms. Each cluster is managed by a cluster head (CH), who is in charge of gathering data from the sensing nodes. The CH combines data to eliminate any redundant information before sending it to BS. Therefore, it is important to choose the CH carefully in order to maintain the right network balance for energy management.

Cluster-based routing is an energy-efficient technique for choosing high-energy nodes. These application goals are achieved by the cluster-based routing protocol. The key constraints of WSN are energy efficiency, scaling, fault tolerance, node dispersion, and overall service quality [5]. In the world of wireless sensors, there are several energy-efficient clustering protocols that emphasize best CH choice. FP-ISEP is one recommended algorithm for energy efficiency. It is an expansion of heterogeneous I-SEP protocol, which prolongs period before the first node dies and is crucial for a number of applications. The suggested method offers a greater average production and a longer stability duration.

The sections below make up remainder of this article. Review of literature is discussed in Section II. Section III presents investigation's suggested methodology. Section IV presents results graphically, and Section V offers the work's conclusion.

II. REVIEW OF LITERATURE

Numerous scholars have published their research on various energy-efficient clustering approaches. This section reviews the various cluster-based strategies applied in WSNs.

Jinpa et al. [6] established energy-efficient WSN protocol known as M-SEP (Modified Stable Election Protocols), which autonomously selects its cluster head depending on its beginning energy ratio. Unlike SEP protocol, which functions similarly but presupposes same energy for all modes of transmission, M-SEP protocol increases stable region by leveraging multilayer energy transfer. Due to extended stable area and extended network lifetime, this protocol exhibits a higher throughput than SEP and Mod-leach protocols.

Naeem et al. [7] It combines traits of remaining energy efficient SEP with direct transfer and range-based algorithms to create hybrid distance aware residual energy efficient SEP (DARE-SEP). The new strategy aims to provide optimum routing path from WSN to CH while taking topology changes into account. To save energy, sink nodes and CHs utilise a multi-hopping path. Network's life span is increased by 10% due to data showing a 10% gain in power efficiency in heterogeneous WSNs compared to conventional setups.

Anthony Jesudurai et al. [8] The Improved Energy Efficient Cluster Head Selection protocol (IEECHS) was created to communicate data gathered using an energy routing scheme. The study investigates dual cluster heads selection using LEACH algorithm, which is built on data fusing methods. CH selection approach chooses two CHs in each cluster to carry out a wide range of tasks that can be used to extend network lifetime and reduce energy consumption of IoT devices. Proposed method is based on grouping dual CHs for information entropy during data fusion process, and then using this data entropy for fusion and categorization, leading to efficient data transmission.

Amrita Ghosal et al. [9] Created a novel clustering method that dynamically generates clusters to address the problem of maximising longevity in WSNs. This work investigates system lifetime maximisation problem by controlling power consumption across CHs and suggests an efficient clustering method that employs alternating direction multiplication method to calculate cluster radius. An on-demand optimum clustering technique for WSNs was developed by researchers. Authors then ran comprehensive simulation tests to gauge how well OPTIC algorithm performed in real-world scenarios. Results from simulations show that OPTIC method can significantly extend network lifetime while preserving network performance indicators like throughput and end-to-end latency.

Khan et al., [10] Advanced Zone Stable Electoral Protocol (AZ-SEP), an unique heterogeneous routing protocol, has been suggested. It uses a hybrid node connectivity with BS, where some nodes communicate directly while others use cluster mechanisms to transmit data to BS. Unknown field parameters are divided into 3 regions based on node capacity. Z-SEP procedure is examined for CH selection and its contact with BS, and a novel cluster-highlight strategy is put into place. Multi-hop interaction occurs between nodes and BS. Z-SEP is evaluated by comparing it to parent protocol in terms of evaluation scenarios, like altering BS's position, skewed nodes, and variable node power.

Lata et al.,[11] FL-based CH selection & cluster development was carried out, and LEACH-FC approach was recommended to high rise decade. For both CH selection and cluster building, authors adopted a centralized method as opposed to distributed one. In addition, FL, a centralized algorithm, was employed to choose vice CH. According to reports, suggested solution helps improve WSN dependability by calculating power load at each node. It outperforms other suggested algorithms in ways to lengthen system life and reduce power consumption.

Julie et al.,[12] A neuro-fuzzy energy aware clustering algorithm (NFEACS) is proposed to create optimal and energy-conscious clusters. A fuzzy element and a NN system helped WSN to form clusters and CH with much less energy. NFEACS employed a NN with an outstanding training set connected to energy and received signal strength of all nodes to estimate expected energy for tentative CHs. BS centre location is taught to sensor nodes with more energy in order to select CHs that are energy mindful. Fuzzy rules are used in FL portion to cluster inputs. The purpose of NFEACS is to control node mobility in a WSN. FL-based CH election procedure and energy-aware fuzzy uneven clustering, are compared to proposed NFEACS. The results of this investigation show that NFEACS performs better than other comparable systems.

III. PROPOSED METHODOLOGY

After revieing the existing techniques that focus on improving the lifetime of sensor network, we found certain gaps that need to be overcome:

The most crucial component of a sensor network is energy conservation. The energy of the nodes must be conserved in every protocol. The current ISEP is one such algorithm that groups the nodes into clusters and chooses the cluster head depending on the nodes' remaining energy; as the network under consideration is heterogeneous, it is wise to give higher energy nodes more importance. However, in addition to the nodes' remaining energy, there are other factors that might be taken into account while choosing the cluster head.

Also, the energy consumption model followed in sensor network is that of radio energy model where the energy consumption and distance of communication between two nodes is directly proportional to each other. In the framework of the radio energy model, direct communication between the cluster head and base station during ISEP is an energy-intensive procedure due to the greater distance involved. In order to reduce the network's energy usage, this must be optimised.

So, **we** propose and implement flower pollination Based cluster head selection technique. This method uses a flower pollination algorithm to optimise the cluster head selection process. The fitness function of the nodes will be calculated throughout this procedure, and it will then be optimised using flower pollination. The flower pollination algorithm either undergoes global pollination or local pollination depending upon the probability; in the global pollination the Levy's flight is used to optimize the solution. Cluster density and node energy remaining will be the key factors utilised to choose the best cluster head.

After the formation of clusters, each cluster member will aggregate their data at cluster head.

The data is sent directly from the cluster head to the base station under the current system. Since the energy consumed is directly proportional to the distance between the communicating nodes, direct communication over a large distance consumes significantly more energy. As a result, we'll use the idea of a mobile agent to collect information from cluster leaders. In this approach, the base station will dispatch a mobile agent to the various cluster heads to gather data. The mobile agent's route is a crucial factor to take into account in order to conserve network energy. The mobile agent's route in the planned work will begin at the cluster head that is the farthest away from the base station and travel to the one that is the closest.

IV. RESULTS AND DISCUSSION

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

- **Number of Alive Nodes:** Based on alive nodes, Figure 2 depicts an outcome scenario for impact of network region variation in I-SEP and FP-ISEP. Each protocol's performance drastically declines as network size grows. It is also clear that FP- ISEP outperforms I-SEP when the protocols' effectiveness in such a diverse environment is compared to one another.

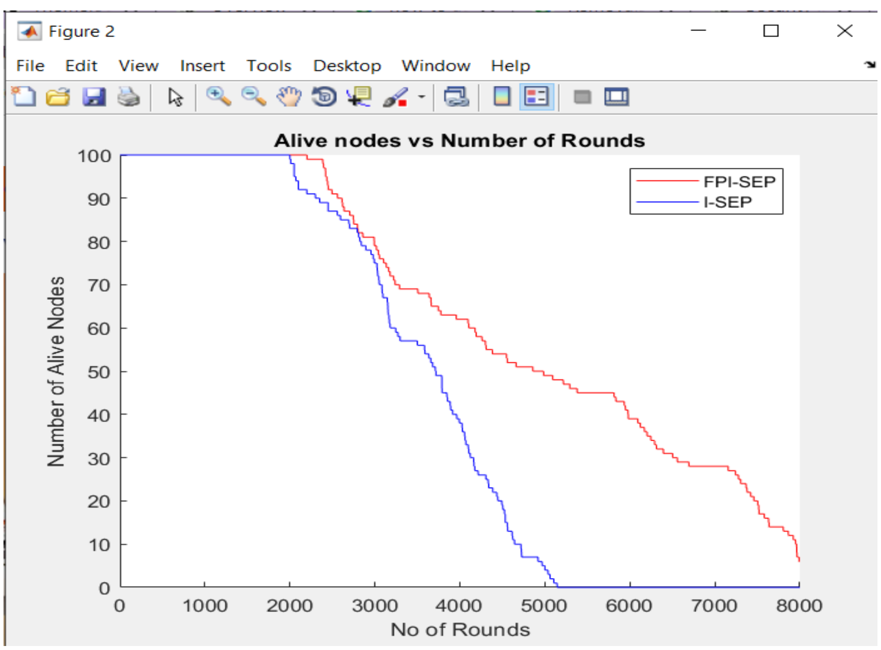

Figure 2. No. of Alive Nodes

- **Number of Dead Nodes:** Figure 3 shows dead nodes in I-SEP and FP-ISEP. Dead nodes increase as network area increases. As a result, protocol effectiveness suffers. FP I-SEP continues to outperform the current protocol in terms of performance.

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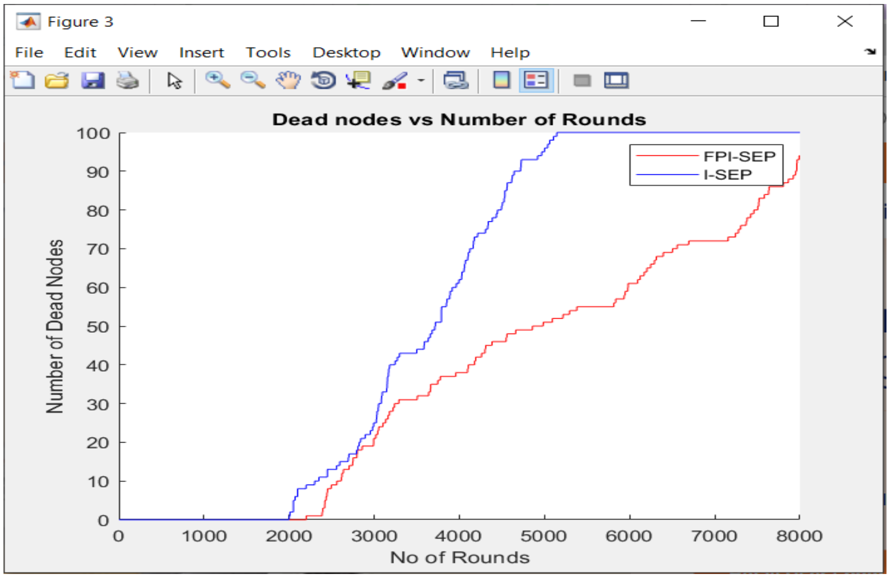

Figure 3. No. of Dead Nodes

- **Throughput:** Throughput is a crucial indicator of network's performance. Throughput describes how much data is successfully transferred through a network. Throughput is determined in this scenario using the formula listed below**.**

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

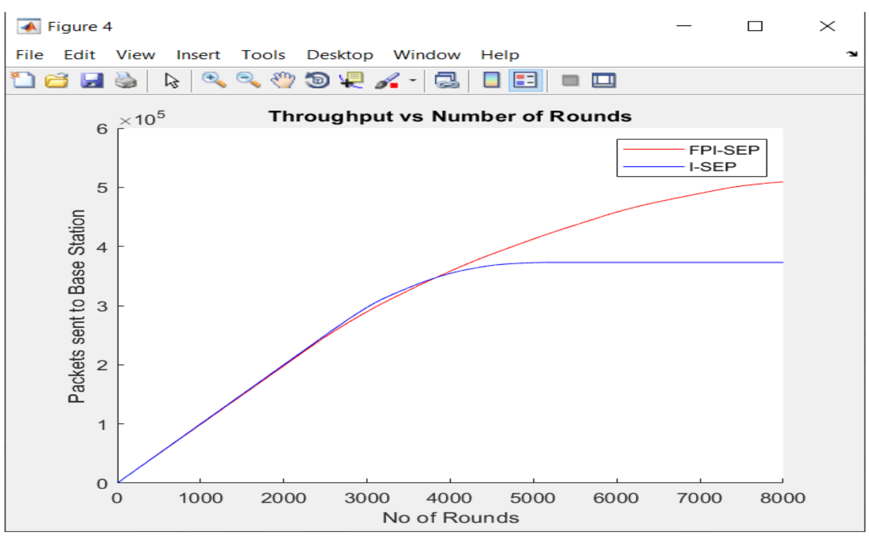

Figure 4: Throughput

Figure 4 shows that both protocols see a drop in packets transmitted to BS as the network area grows. However, the suggested technique's throughput is higher than I- SEP's since it chooses more effective cluster heads.

- **Average Residual Energy:** The main resource that WSN nodes require is energy, which determines how long the network will last. Figure 1 demonstrates that current I-SEP method has steeper average RE reductions than suggested FP I-SEP strategy, indicating faster rate of energy depletion.

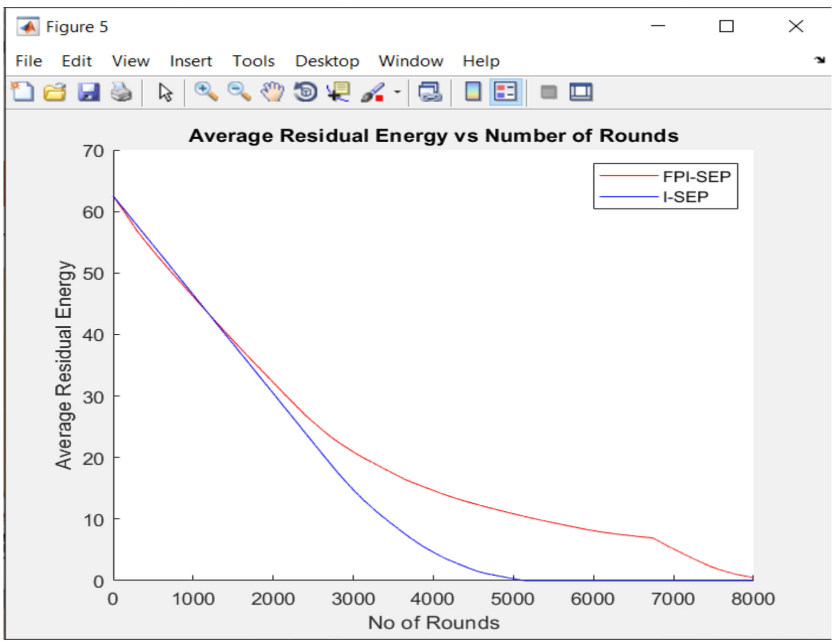

Figure 5: Average Residual Energy

V. CONCLUSION

The research looks at a number of energy-efficient WSN protocols, including FP-ISEP and I-SEP. The ultimate goals of these algorithms are energy consumption reduction and network life optimization. This paper offers methods for choosing an energy-efficient cluster head based on fitness function. I-SEP and FP-ISEP's performance was assessed based on the proportion of active and inactive nodes, network throughput, and average residual energy. Simulation findings show that new approach worked better than the old one. The outcomes show that FP-ISEP worked better than earlier technique by reducing the rate of packet losses.

The goal of current study is to create WSNs with minimal energy consumption. However, when more energy-efficient techniques are created, newer wireless transmission potential uses will start to appear.

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