Enhanced Energy Efficient Clustering Protocol - PSO

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ABSTRACT:

Numerous ways have been proposed in the past for dealing with node energy issues, focusing on developing effective energy management systems. Sensor clustering is a common strategy for dealing with network energy restrictions. EEECP-PSO, short for improved energy-efficient clustering protocol, is a new idea for enhancing network longevity while also enhancing overall system performance. The proposed methodology uses particle swarm optimization to choose the cluster head and relay nodes. The most ideal node for the cluster head is selected using a fitness function based on particle swarm optimization that takes into consideration the energy ratio (initial and residual energy) of nodes, the distance between nodes and the cluster head, and the node degree. According to the proposed method, relay nodes for the multi-hop data transmission to the base station are designated using fitness values derived from cluster head residual energy and distance from base station characteristics. Furthermore, EEECP-PSO is appropriate for networks with a long life span since it minimises node energy consumption by increasing clustering structure. The EEECP-PSO beats the present technique in terms of performance assessment outcomes, according to the evaluation.

Keywords: Wireless Sensor Network, Clustering Protocol, EEECP - PSO, PSO algorithm, Residual Energy, Multi-Hop

I INTRODUCTION:

More and more industries are benefitting from the Internet of Things (IoT). When it comes to industrial control, environmental monitoring, military surveillance, and intelligent transportation systems (ITS), wireless sensor networks (WSNs) have shown to be a useful tool.[1] In a two-tier WSN, sensor nodes are divided into numerous clusters. Each cluster has a cluster leader, who serves as a point of contact for all members of the cluster (CH). All sensor nodes collect local data and transmit it to the relevant CH. CHS then collects and normalises its own local data for transmission either directly or through other CHS to the base station (BS). The capabilities of a WSN cluster. Clustering sensor nodes has the following advantages:

Data may be aggregated at the cluster head, enabling duplicate and uncorrelated data to be eliminated, which saves sensor node resources.

It is easier to manage routing since only CHs are responsible for maintaining the local route configuration of other CHs. This results in less routing information being required, which increases the scalability of the network.

When sensors only interact with their CHs, there is no need for the exchange of duplicate messages.

The Wireless Sensor Network has seen a major advancement, however there are several current technologies that need to be changed, such as the fact that the sensor's battery life is solely dependent on that battery. Because of environmental limits, it is difficult to replace these batteries. A key difficulty in wireless sensor networks (WSNs) is to prolong the network's lifespan. It also has an effect on later network operations such as data aggregation and route discovery, where it prepares the network for operation [2] because of the WSN's insufficient clustering structure. The FCM method performs poorly on data sets having clusters of varying sizes or densities, and it is susceptible to noise and outliers, according to earlier studies. We came up with EEECP-PSO as a solution to these issues since it can handle cost functions with several local minima while avoiding the overlapping and mutation calculations of the PSO method. For its search space, this algorithm can switch between global and local searches with ease.

II RELATED WORK:

The lifespan of a network may be increased to some extent by using various routing techniques. According to a typical aggregate, the employment of essentialness harvesting methods reduces the energy consumption of one sensor node [3]. Solar-powered sensor nodes may be powered using a variety of routing algorithms, including sLEACH, A-sLEACH, IS-LEACH, modified s-LEACH, and more. Real-time data based on sunlight is missing from the LEACH [4, 5], advanced LEACH [6, 7], and IS-LEACH [8]. Since sunlight-based voltage and current accounting for sun-based power are taken into account in updated Sun Aware LEACH [7], real-time sun-oriented data is taken into account in this version. When it comes to the environment, the weather conditions prediction site is there to keep us updated. UV-list data may be found in the weather forecast, as well. Using these hourly UV indexes, the author computed the sun-oriented power in the LEACH method [8]. A wind energy-based wLEACH has been proposed to take use of various harvesting sources [9]. A wind turbine's output is determined by the current wind speed and direction. Using hybrid collecting sources like solar and wind energy, the network's lifespan may be prolonged. The HEH-LEACH sensor nodes are powered by both solar and wind energy, depending on their availability, in [10]. With this, the network's lifespan is extended while using less energy. Using balanced and static clusters, random node deployment concerns may be overcome.

TACAA [11] uses a modified FCM algorithm to re-arrange the degrees of belonging of the nodes. Using the number of rounds as a criteria is a waste of time. A new Energy Efficient Centroid Ground Routing Protocol (EECRP) [15] for WSN-supported IoT has been suggested by Shen and colleagues. When determining the centroid's location, EECRP takes into consideration the nodes' residual energy in particular. GEEC, LEACH, and LEACH-C were shown to have lower values than EECRP. EECRP is also suitable for networks that need a long period of time and whose base station (BS) is located inside the network.

OCM–FCM [12] was suggested to enhance the cluster organisation. A mathematical approach for determining the number of clusters is given based on the examination of node energy consumption models. Clusters are formed using an improved version of the FCM method. Unbalanced energy consumption by nodes might have a negative impact on a network's lifespan if sensors are randomly deployed, as is the case with FCM. A modified mathematical approach based on an evaluation of the energy consumption model for multi-hop communications and overlapping clusters is used to determine the appropriate number of clusters. A modified fuzzy C-means method (MFC) [13] was used to create balanced clusters. CH selection and rotation algorithm (CHSRA) is proposed as a combination of the back-off time mechanism for CH selection and a novel rotation mechanism for CH rotation across cluster members. Incorporating cluster overlap and multi-hop communication into a modified mathematical model for determining the optimal number of clusters. Balanced clusters may be formed by using an improved version of the fuzzy C-means method (M-FCM), which is the result of merging the FCM algorithm with a centralised mechanism. In a new algorithm known as the CH selection and rotation model, energy overhead from the CH selection process is reduced by new integration of the back-off timing mechanism for CH selection and the rotation mechanism (CHSRA), Setting a new goal function for the back-off mechanism and a new dynamic threshold for balancing the distance between CHs in the network and the life expectancy of chosen CHs in the cluster The lifespan of a network may be increased to some extent by using various routing techniques. According to a typical aggregate, the employment of essentialness harvesting methods reduces the energy consumption of one sensor node [3]. Solar-powered sensor nodes may be powered using a variety of routing algorithms, including sLEACH, A-sLEACH, IS-LEACH, modified s-LEACH, and more. Real-time data based on sunlight is missing from the LEACH [4, 5], advanced LEACH [6, 7], and IS-LEACH [8]. Since sunlight-based voltage and current accounting for sun-based power are taken into account in updated Sun Aware LEACH [7], real-time sun-oriented data is taken into account in this version. When it comes to the environment, the weather conditions prediction site is there to keep us updated. UV-list data may be found in the weather forecast, as well. Using these hourly UV indexes, the author computed the sun-oriented power in the LEACH method [8]. A wind energy-based wLEACH has been proposed to take use of various harvesting sources [9]. A wind turbine's output is determined by the current wind speed and direction. Using hybrid collecting sources like solar and wind energy, the network's lifespan may be prolonged. The HEH-LEACH sensor nodes are powered by both solar and wind energy, depending on their availability, in [10]. With this, the network's lifespan is extended while using less energy. Using balanced and static clusters, random node deployment concerns may be overcome.

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III PROPOSED METHODOLOGY:

Minimum transmission is preferred over direct transmission as shown in Table 1.

Direct Transmission	Minimum Transmission
The amount of energy used can be modeled by this formula: $Eamp = k(3d1 + d2)^2$	The amount of energy used: $Eamp=k(3d1^2 + d2^2)$

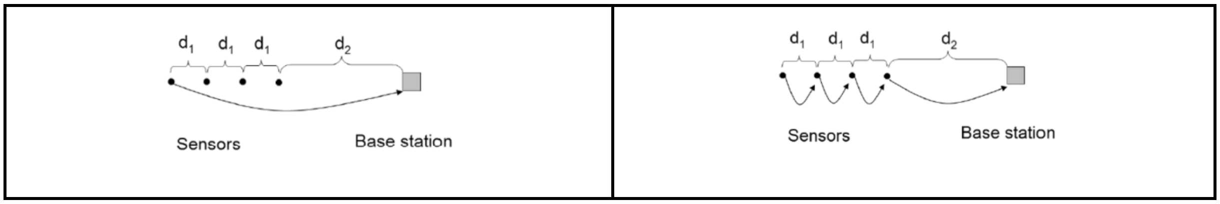

Table 1: Direct vs Minimum Transmission

A. CH SELECTION:

- Using the PSO method, the CH and relay nodes in this network are chosen.
- When the cluster head is chosen, this is what it looks like:
- using the fitness feature based on PSO
- The distance between the cluster head and the nodes
-
- An improved energy-efficient clustering protocol particle swarm optimization (EEECP-PSO) is presented to increase network life and performance.
- The proposed protocol uses the particle swarm optimization approach to identify the network's cluster head and relay nodes.
- Nodes' energy ratios (initial and residual) are taken into account as well as the distance between nodes and the cluster head in order to determine which node is best suited to be the cluster head. Node degree is also taken into consideration.
- This paper proposes an Enhanced Energy-efficient Clustering Protocol (EEECP-PSO) for WSN-based IoT devices in order to overcome the aforementioned issues.
- The energy consumption of the CHs is more evenly distributed, resulting in a longer network lifespan. For routing and clustering, a fitness function and an efficient particle encoding system were developed separately.

B. PSO ALGORITHM:

- Using the PSO method, the CH and relay nodes in this network are chosen.
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$$\mathbf{V_{i,d}(t) = w \times V_{i,d}(t-1) + c_1 \times r_1 \times (Xpbest_{i,d} - X_{i,d}(t-1)) + c_2 \times r_2 \times (Xgbest_d - X_{i,d}(t-1))\ ; \qquad X_{i,d}(t) = X_{i,d}(t-1) + V_{i,d}(t)}$$

where w is the inertial weight, c1 and c2 are two non-negative constants called acceleration factor and r1 and r2 are two different uniformly distributed random numbers in the range [0,1].

- The update process is iteratively repeated until either an acceptable Gbest is achieved or a fixed number of iterations tmax is reached.
- The various steps of a PSO are depicted in the flowchart.

C. ALGORITHM:

Proposed algorithm of the system is written down.

```
For each particle
        Initialize particle with feasible random number
End
Do
        For each particle
            Calculate the fitness value
            If the fitness value is better than the best fitness value (pbest) in history
           Set current value as the new pbest
        End
Choose the particle with the best fitness value of all the particles as the gbest
        For each particle
           Calculate particle velocity according to velocity update equation
Update particle position according to position update equation
End
While maximum iterations or minimum error criteria is not attained
```

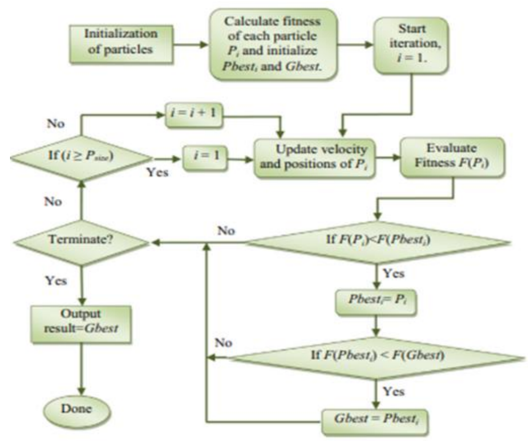

Fig 1: Flowchart of EEECP-PSO

The flowchart of the proposed algorithm is displayed in Fig 1. It showcases the execution of the PSO (Particle Swarm Optimization) algorithm for the proposed EEECP-PSOprotocol.

IV RESULTS AND DISCUSSION:

MATLAB implementation of the suggested protocol is shown in this section. Using a WSN with randomly placed nodes in a 100mX100m simulated region, the suggested protocol works. 150mX50m is the size of the base station's footprint beyond the network's coverage region.

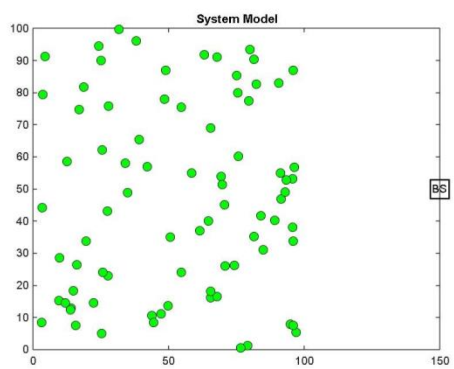

Fig 2: System model

On a WSN with 80 randomly distributed nodes in a 100X100m simulated region, the suggested protocol works well. The base station is 150X50m away from the network.

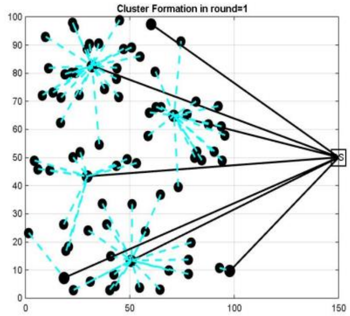

Fig 3: Cluster formation in Round 1

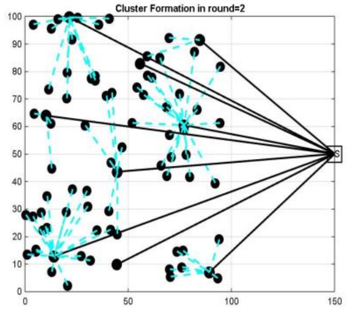

Fig 4: Cluster formation in Round 2

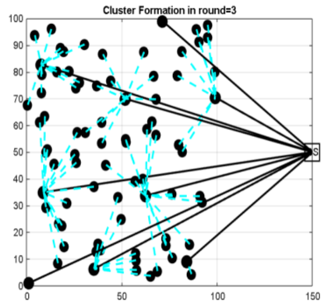

Fig 5: Cluster formation in Round 3

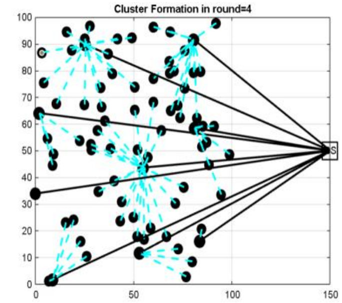

Fig 6: Cluster formation in Round 4

Nodes are randomly oriented, cluster heads form, linkages to the base station (BS) are shown in Figures 3, 4, 5, and 6, respectively, for Rounds 1, 2, 3, and 4. .

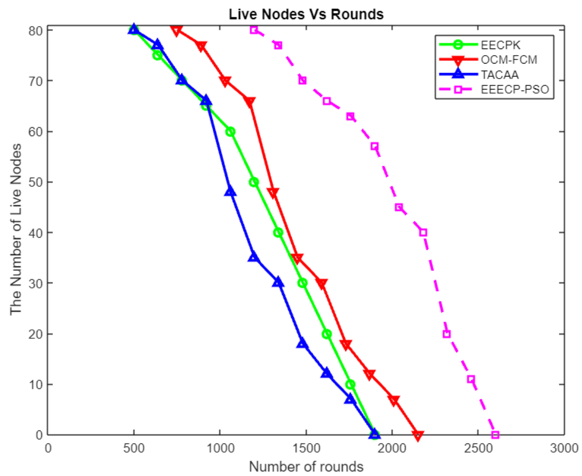

Fig 7: Live Nodes vs Rounds

PROTOCOL	FND	LND
EECPK	500	1900
TACAA	520	1950
OCM-FCM	750	2150
EEECP-PSO	1200	2600

Table 2: Comparison of different protocols on the basis of FND and LND

For 3000 rounds, the line graph in Fig 7 compares the current protocols (EECP-PSO) with the proposed protocol (EECP-PSO) in terms of the number of live nodes. With the suggested protocol, nodes will be active for a longer period of time than with other alternatives. The first node to die (FND) and the last node to die (LND) are two of the most important metrics used to evaluate the network's lifespan (LND). Table 2 compares the LND and FND of several methods in light of this situation. EECPK[14], TACAA, OCM-FCM, and EEECP-PSO protocols are compared in this study. The FND of EECPK, TACAA, and OCM-FCM happens sooner than our suggested protocol, and as a result, their performance is worse than that of EEECP-PSO in comparison. OCM-LND FCM's is superior to those of EECPK and TACAA. In comparison to OCM-FCM, LND happens during the 2600th round in the proposed protocol.

Fig. 8 shows the energy usage for the protocols (EEECP-PSO, TACAA, OCM-FCM, and EECPK) while choosing the channel head with the least, average, and maximum accuracy. In comparison to the current protocols, the EEECP-PSO consumes 0.9 joules of energy with maximum precision and 0.42 joules with least accuracy (TACAA, OCM-FCM, EECPK). Figure 9 shows the residual energy in the network after 2000 cycles. For the protocol EEECP-PSO, a proposed PSO algorithm surpassed the FCM method in terms of energy consumption efficiency.

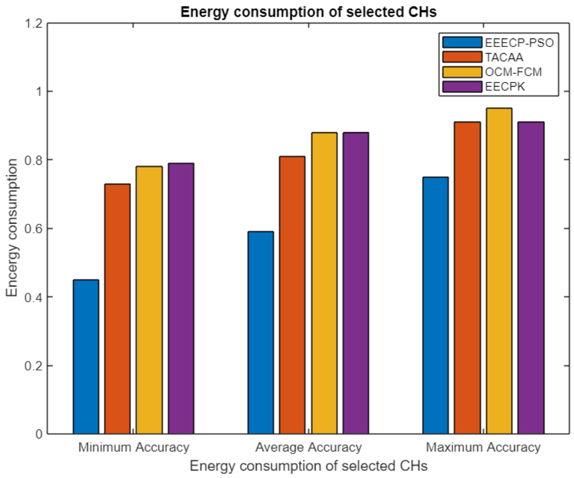

Fig 8: Energy consumption of selected channel heads

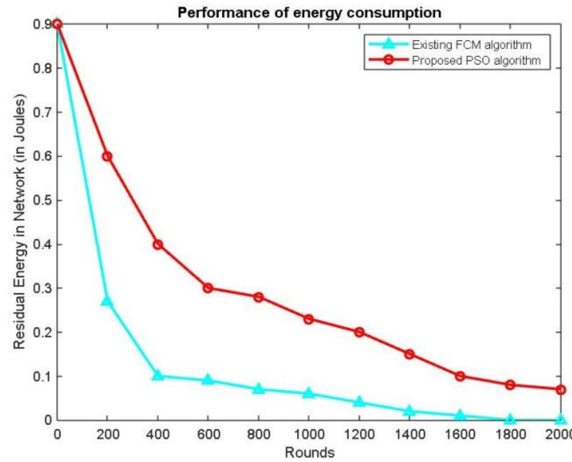

Fig 9: Performance of energy consumption

V CONCLUSION:

Since WSNs are used in many aspects of everyday life, our proposed protocol will be a vital addition to the IoT world. If you use the PSO algorithm with overlapping clusters, you may look at the network's energy usage to figure out how many clusters to use depending on how far they are from the central hub. For WSN-based IoT networks with clustering structure difficulties that detract from protocol performance, we propose an improved energy-efficient clustering protocol (EEECP-PSO). Nodes' energy consumption is reduced and balanced thanks to the recommended technique's optimization of the clustering structure. EEECP-PSO is thus suggested in networks with a longer expected lifetime. Overall, the EEECP-PSO outperforms the current protocols.

VI FUTURE SCOPE:

In the future, it may be possible to construct multihop routing among the CH nodes to increase energy efficiency and inter-cluster connectivity for relaying information to BS. Data aggregation may be used to increase the efficiency of data collection. A mix of FCM and PSO algorithms may also be used to boost the network's efficiency with this protocol.

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