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Energy Efficiency in Wireless Sensor Networks using Advanced LEACH Protocol

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Abstract

The wireless sensor network is the best research subject matter with huge applications in various domains. By and large, a wireless sensor network involves hundreds to thousands of sensor nodes, which transmit and communicate with each other by the utilization of radio transmissions or signals. A portion of the difficulties that exist in the sketch of wireless sensor networks are confined computation power, storage capacity, battery, and transmission transfer speed or bandwidth. To determine these issues, clustering and routing algorithm have been introduced. Clustering and routing processes are viewed as an optimization issue in wireless sensor networks which can be settled by the utilization of swarm intelligence-based approaches. This article presents an original multitude of insight-based grouping and multihop routing protocol for wireless sensor report giving a new swarm optimization technique applied for picking the cluster heads and organizing the cluster capably. Then, at that point, the grey wolf optimization algorithm-based routing process takes place to choose the ideal ways in the network. The introduced better particle swarm optimization-grey wolf optimization approach consolidates the advantages of both the clustering and routing processes which prompts the greatest energy efficiency and network lifetime. The proposed model is reproduced under a broad arrangement of experiments, and the outcomes are approved under a few measures. The acquired trial result exhibited the predominant qualities of the improved particle swarm optimization–grey wolf optimization method under all the test cases. It enhances LEACH protocols in terms of energy efficiency, network Lifetime, and throughput. Maintaining the Energy Efficiency of a wireless sensor network has been a great concern nowadays. The main aim is to overcome the drawback of Improvement of the energy efficiency of a wireless sensor network. It may be improved with the performance of an optimization algorithm using swarm Intelligence. The novelty of the project is Network lifetime and Energy Consumption. The future of this project is to share the complete information which is present in the cluster head without any interruption.
Keywords: Wireless sensor network, Swarm intelligence, Clustering, Routing, Energy Efficiency

Introduction

A wireless detector network (WSN) comprises multitudinous detectors that collect information from the matching atmosphere and transfer it to the base station (BS). The main thing is to observe, gather data and transfer it to BS. Detector bumps present in colorful another corridor of the field could combine the data gathered and give a de utmost exact report regarding the original areas. Several WSNs organized are used in measuring physical parameters similar to pressure, humidity, and temperature differently the place of objects, to enhance the dedication of reported criteria and aggregation of information that minimizes the communication outflow in the network which leads

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to saving more quantum of energy. Some of the features like minimal power behavior and multifunctioning gets of sensor bumps make WSN more attentive.
In recent days, with the assistance of cloud innovation improvement, WSN is utilized in some certifiable applications that contain house security purposes, military observation, checking the way of behaving of non-homegrown creatures, medical clinics, and indecencies, etc. These days, broadly spread research exertion is committed to a new investigation of WSN in lengthy a region which couldn't be accessed. A sensor network comprises of detecting unit, correspondence unit, memory unit, and correspondence unit which is restricted in nature. WSN is sent in automated conditions that harm the hubs for a substitution or more costly hubs. Subsequently, generally speaking, the remote hub should be registered for a more extended timeframe without a battery. Subsequently, energy effectiveness is a most difficult issue while fostering an organization switch with the state of a long lifetime for the organization. Energy monitoring could be upgraded and kept up with by adjusting the organization's geography and changing the sensors communicating energy level in the switch.
The clustering model is applied for diminishing the use of force in routing protocols.10 This architecture contains the sensors which are gathered as clusters, the sensor hubs having the least power are gotten to execute detecting activity and send the information which has gone through sensing to their cluster head (CH) at a small distance. Hub in a cluster is supported as a CH, to keep away from the connecting information from the excess individual from the cluster, regarding minimizing the number count of gathered information moves to BS.
The clustering design is portrayed in Figure 1.

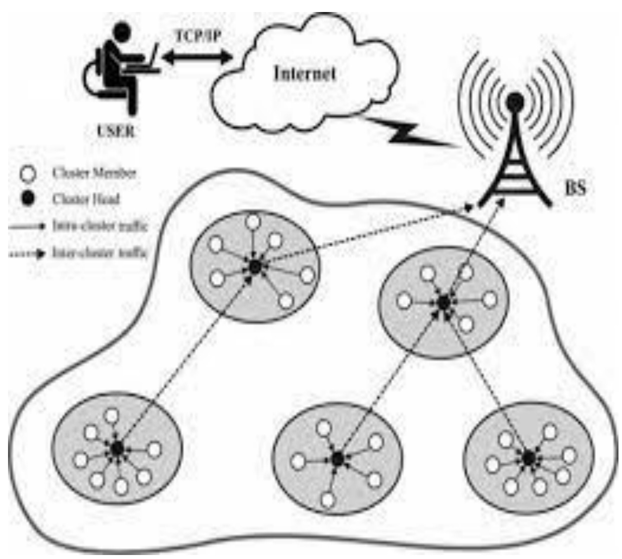

Figure 1. Clustering via Internet

Clustering technology has the capacity of upgrading energy productivity by diminishing whole power protection and handles it between the hubs while considering network lifetime. Moreover, it is equipped for further developing channel content along with information impacts that outcomes in expanded network throughput as far as most extreme load. Based on a portion of the imperatives like confined energy, data transmission, and computational capacities, a few routing conventions are created to further develop the network lifetime. Low energy versatile clustering ordered progression (LEACH) is an expert WSN clustering protocol that helps for choosing CH with a pre-decided probability of pivoting CH between the sensors to dispose of the faster crumbling of CH energy. Yet, choosing CH happens hap the

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hazard. Therefore, a hub that has the least power could be chosen as CH and they are not similarly spread. Additionally, the LEACH convention needs the transmission among CH and the BS to be finished however one bounce saves a greater amount of energy and annihilates the equilibrium of sensors when CH is put away from BS. LEACH-centralized (LEACH-C) protocol is implemented for improving the features rather than LEACH that utilizes a centralized clustering technique in forming clusters. LEACH-C improves the network performance by establishing an extended cluster through the distribution of CH for entire network. The nodes whose energy level is very high could be chosen as CH. However, LEACH and LEACH-C are not capable of using knowledgeable CH electing process, distributing CH is done randomly, and that results in more amount of energy consumption. Consequently, base-station controlled dynamic clustering protocol (BCDCP) is presented to build mostly balancing clusters. BCDCP consists of an equal number of members for every single CH, which is to eliminate excess CH and it uses CH– CH routing for transmitting data to BS. To improvise the lifetime, a few position-aware protocols are projected for reducing the transmitting price between the nodes. In hybrid energy-efficient distributed clustering (HEED) protocol, CHs election is dependent on energy integrating with alternative parameters like proximity of node to the respective neighbor node. The CHs forward information to BS using a multi-hop communication system.

HEED guarantees that a single CH can attain even CH distribution over the network. Yet, a head node consumes maximum energy in HEED protocol, which results in quick draining of energy. energy efficient clustering scheme (EECS) protocol is applied for better distribution for CHs, where CH is chosen with respect to lasting energy as well as placement of nodes. In EECS, a competing technique is optional for selecting CH, a permanent communication range is provided for every candidate sensor. If a sensor identifies it with massive energy when compared with others, then designates it as CH and telecasts it to all remaining nodes. Therefore, this technique makes possible issues in intense networks to contain many numbers of nodes competing to become a CH

The proposed IPSO–GWO algorithm

The IPSO-GWO algorithm that has been presented consists of two primary stages: IPSO-based clustering and GWO-based routing. In a sensing field, several sensor nodes are initially deployed. BS broadcasts a beacon signal to the entire network once the nodes have been placed in the area to be detected. Based on the received signal intensity indicator, each node will receive the beacon signal and determine its approximate distance from the base station (RSSI). In order to learn more about its neighbors, the sensor nodes then send a handshaking message within their communication range. The clustering procedure begins once nearby data have been collected. The IPSO method is then used to choose the CHs and expertly arrange the clusters. The GWO algorithm-based routing procedure is then used to choose the best routes in the network. The presented IPSO–GWO approach incorporates the benefits of both the clustering and routing processes which leads to maximum energy efficiency and network lifetime. The entire process is shown in Figure 2, and the stages are briefly explained in the following subsections.

System model

Network design. A WSN consists of N sensors that are deployed in the field and periodically scan the atmosphere. Units of sensors that include the sensor node, microcontroller component communicating unit, and power management component are shown in Figure 1. Following are some factors related to the sensors:

Sensor nodes can operate in a sensing mode to observe physical variables or in a communication state to immediately transmit information between each node to the BS and gather data from the CM.

The traffic is handled via each node's connectivity;

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1)Each node is assigned an index Corresponding its position.

2)Stability of the sensors and BS even after deployment, which is unique for sensor networking applications;

3)Primary energy is preferable for all sensors, and the assumption is that the unique.

4)Every node measures the physical parameters.

5)Each node is made up of many transmitting levels of energy. Nodes possess the capacity for adaptation. The transfer of power in terms of the far-off character of the designated receiver;

6) The connections between nodes are of a similar nature, The signal could be used to measure this distance.

7)The detected data are closely connected. As a result, the CH compiles data categorized from the cluster to a packet of a set length;

8)BS appears to be feeling energetic. Model of Network lifetime. There are numerous approaches to defining the network lifetime of WSNs. This research specifies the network lifetime as the number of rounds finished till the nodes perish. Given that the nodes in the similar statistics from the neighboring region, The first node's loss has no effect on the whole network functioning, However, with a slight degradation in quality, A network loses when half of a node dies. As it runs out of energy and decays, the data quality gets worse When the network's final node perishes, the network ceases to function. Analyzing the lifespan of the First node die (FND), half node death (HND) in WSN is taken into account. Even if some nodes are lost, the networks could still function well in a number of tasks. A node will have many more neighboring nodes with a high potential for comparable features once more sensors are used in a location, making it simple for networks to manage broken nodes. Time till the FND is therefore not just a way to gauge network survival rate. As a result, the lifetime that is an HND is a useful metric for assessing performance in situations of maximum node density.

$$PQ_P^a = PQ\left[\rho - \frac{a}{P}\right] \quad (1)$$

where P is the network's total number of sensors. an is the number of active nodes. According to this definition,

the duration of p-persistent neighbor discovery (PND) is the period of time until the portion of the active node

falls below the predetermined threshold value.

IPSO based Clustering process

1)Let N represent the sensor nodes that are randomly arranged in the field and divided into n clusters. It refers to the collection of non-CH nodes as CLH while describing the group of CH as CLH= $\{CLH_{1,} CLH_2, \ldots.. CLH_y \ldots\ldots CLH_n\}$. In the architecture, as it is now given, the CH is careful to coordinate across cluster nodes, gather information within the cluster, and communicate with RNs. When selecting the CH S, consideration is given to the nodes locations and energy levels. The BS tends to construct clusters with the same allocation of sensor nodes by selecting CHs with high residual work and ideal placements. This approach is viewed as an optimization challenge and is described scientifically as

$$F_{CLH} = \propto \times\ R_{engy}^{CLH} + (1-\propto) \times\ R_{loc}^{CLH} \quad (2)$$

As revealed in equation (1), FCLH comprises two divisions. The stable a denotes the involvement of RCLH energy and RCLH loc in the suitability function FCLH: RCH energy indicates the ratios of CHs'

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average residual work to non CH nodes average residual work.

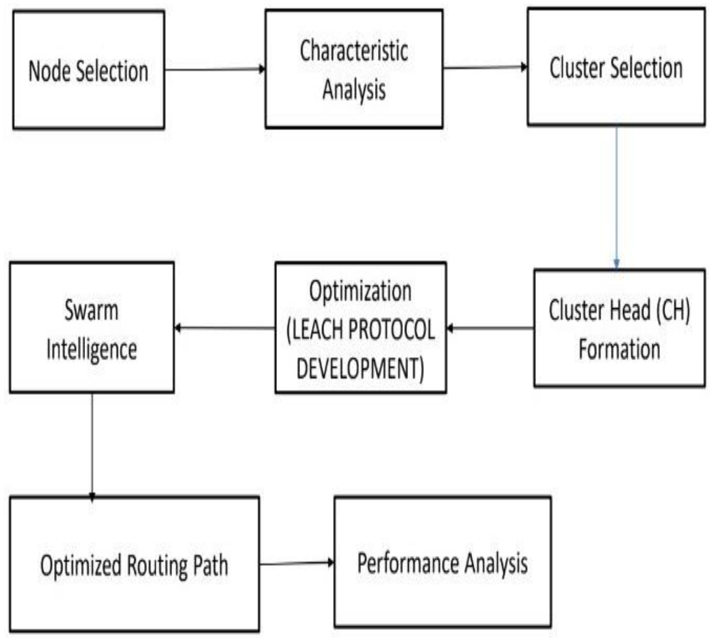

Figure .2

The IPSO technique is used to exploit fitness goals while also improving the traditional PSO technique by adjusting the inertial weight to avoid particles individually trapping to local optimum. As a result, additional suitable CHs and a dispatch node are identified, making the protocol even more effective. This division demonstrates the proposed improved PSO algorithms for the best clustering in WSN. The next five key phases are as follows:

First, initialization Make a specific number of the elements. Every element e has a speed vector$s_e = \frac{1}{2s_{e1}}, s_{e2}, .. s_{ed}$, and a location vector $q_e = \frac{1}{2q_{e1}}, q_{e2}, .. q_{ed}$ is used to characterize particle size as M is used to describe the current situation, where I represents the element in the swarm as a positive integer, and d stands for the issue's dimensions.

2. Establish the role of fitness. The components manipulate each element's fitness values as they travel through a d-dimensional hyperspace. Each component keeps track of their own personal optimal (pbest) solution during the search process. $p_e = \frac{1}{2p_{e1}}, p_{e2}, .. p_{ed}$with the global best (gbest) solution.

$p_g = \frac{1}{2p_{g1}}, p_{g2}, .. p_{gd}$was achieved using a number of swarming elements. Additionally, the global and local ideal placements are put up.

3. Updating the vectors of velocity and position. Each phase affects how quickly each element moves toward its gbest and pbest placements.

4. Change the inertial weights. It uses an updated PSO approach that modifies the inertial weight to prevent elements from being stopped in local optima and prevents technique from deteriorating in one.

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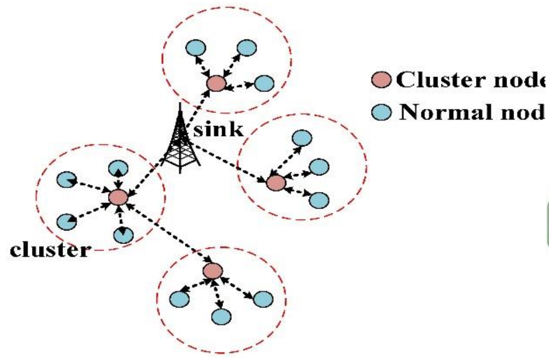

Figure.3

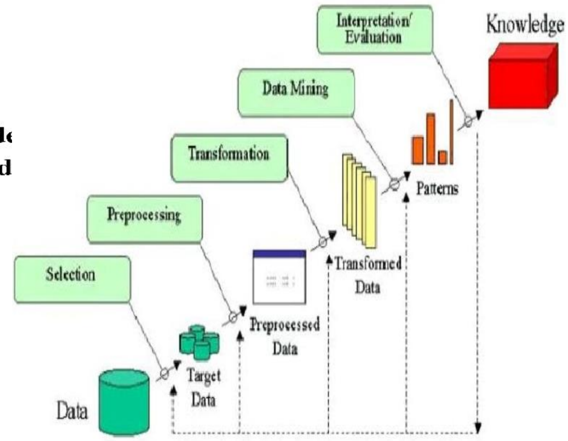

Figure.4

$$w = (w_{mx} - w_{mn}) \times \frac{Interaction_{mx} - Iteration_{e}}{Interaction_{mx}} \pm w_{mn}$$

where the constant values for w_{mx} and w_{mn}, which stand for the maximum and lowest inertial weights, respectively, are 0.9 and 0.4. As International stands for the current iteration, $Interaction_{mx}$ denotes the greatest number of allowable iterations.

5. Until the stop requirement is met, skip to step 3. After the extinction criteria are satisfied, the current best options are picked. The optimization problem has a prepared resolution.

Performance assessment

The IPSO-GWO protocol's performance analysis is constructed, and the simulation's results are confirmed, with the aid of the evaluation parameters stated below:

❖ Efficacy in using energy It is used to calculate how much energy each node has used throughout the course of implementation.

❖ FND: It is based on the round number at which the network's principal node expires. It could be used to calculate how long each node in a wireless sensor network (WSN) is fully operational.

❖ HND: It also depends on the round number at which 50% of the network's nodes are down. It is used to calculate the time required by the 50% of nodes in the network that are active.

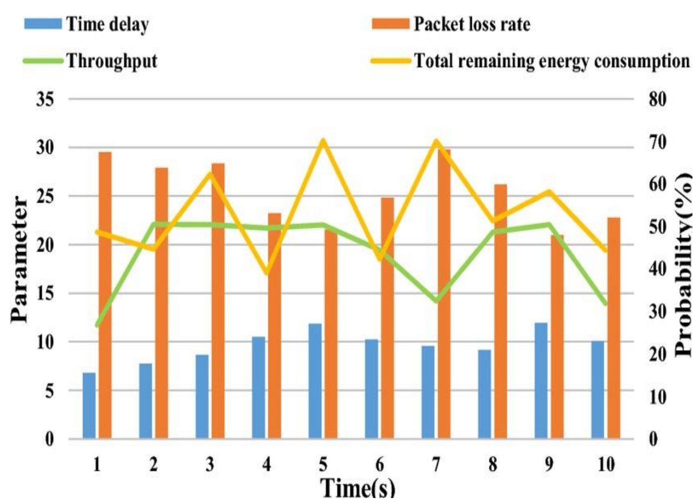

Figure.5

❖ Analysis of energy efficiency. The maximum energy consumption of three scenes is analysed and given in order to demonstrate the energy efficiency of the discovered IPSO-GWO method. The energy used is calculated using the average energy saved by each sensor node under 2500 rounds, in turn. Due

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to the inherent characteristics of the IPSO and GWO techniques in the clustering process and routing operation, respectively, IPSO-GWO achieves great energy efficiency when compared to other models.

- The IPSO-GWO protocol reduces the amount of energy needed for data transmission inside the cluster.
- Due to the careless choice of CH and the usage of one-hop communication,
- These are just a few of the factors favoring maximal energy loss over alternative methods. The reactive Advanced LEACH approach implements low energy consumption compared to TEEN approach.
- It cannot, however, perform as well as the IPSO and IPSO-GWO models. When compared to other models, the IPSO achieves a greater energy level.
- The random selection of CH is degradable of TEEN, nevertheless, produces results that are inferior to IPSO and IPSO-GWO.

Setup Phase:
With the aid of sequential modeling implementation under various circumstances based on the position of BS, the IPSO-GWO approach is evaluated. An S1, S2, and S3 are the case numbers for the trio of three cases.
S1 - BS is positioned in the center of the target area;
S2 - BS is positioned in the corner of the intended area;
S3: The BS is far from the target location.
A network with 300 nodes in this instance has rare deployment takes place in the targeted area of 200*200 m^2 .The measurements made for validation. Three clustering methods, such as LEACH and threshold-sensitive energy-efficient sensor networks, were used for comparison (TEEN), IPSO and PSO are used.

Result Analysis:

- Analysis of energy efficiency. The maximum energy consumption of three scenes is analyzed and shown as evidence of the energy efficiency of the discovered IPSO- GWO technology. Energy expended is calculated using the average energy saved by each sensor node under 2500 rounds, in turn.
- Due to the inherent characteristics of the IPSO and GWO techniques in the clustering process and routing operation, respectively, IPSO-GWO achieves great energy efficiency when compared to other models.
- The IPSO-GWO protocol reduces the amount of energy needed for data transmission inside the cluster. Due to the careless choice of CH and the usage of one-hop communication, LEACH achieves poor results. These are just a few of the factors favoring maximal energy loss over alternative methods. Next, compared to LEACH, the reactive TEEN technique uses less energy. It cannot perform as well as IPSO and IPSO-GWO models. Despite using an effective process, IPSO chooses the initial CHs in the most flexible manner.

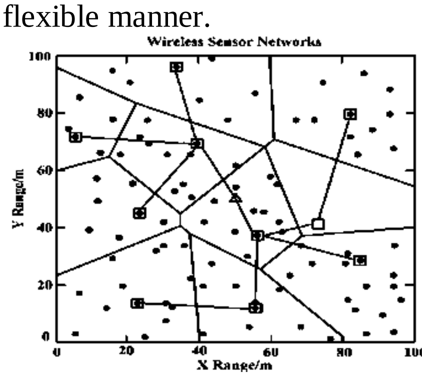

Figure.6

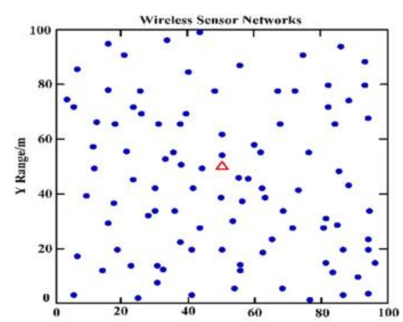

Figure.7

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General Comparision follows as table:

Routing protocol	LEACH	PEGASIS	TEEN
Network type	Proactive	Reactive	Reactive
Mobility	Fixed BS	Fixed BS	Fixed BS
Power Required	High for BS	Max	High for BS
Overhead	High	High	High
Data Aggregation	At Cluster Head	Low	At Cluster Head
Cluster Head Formed	Distributed	No	Distributed
CH selection	Random	N/A	Attribute Based
Cluster Stability	Moderate	N/A	High

Figure.8

Parameters	**Value**
Number of nodes	300
Area	200 x 200
Packet size	4 kbits
Number of rounds	2500

Figure.9

Network Lifetime: The network lifespan can be described using a variety of approaches. Round integers that finish until WSN nodes expire represent the network's lifespan. Because there are nodes in the vicinity that share the same data, the FND only slightly degrades the quality of the network's operation. When a WSN user reaches the HND level, the information's quality drastically declines. The WSN becomes dormant and ceases transmission to BS after the last node in the network dies.

❖ FND and HND values are taken into account while calculating network lifetime. The findings of FND and HND are under three situations. The FND in the first case outperforms alternative methods according to the IPSO-GWO model. In the first scenario, IPSO-GWO and LEACH FND occur at the second scenario, and IPSO-GWO and LEACH FNDs occur at 542 and 1564 rounds, respectively. In the third scenario, LEACH's FND occurs at 452 rounds whereas IPSO-does GWO's so at 1438 rounds 802 and 1982 rounds, respectively. In The IPSO-GWO model mainly extends the network's life by obtaining efficient energy. The IPSO-GWO approach is improved. FND in the first scenario compared to other methods. In the first instance, LEACH's FND occurs after 1126 rounds, and 2056 rounds of IPSO-GWO. In Second instance, the FND of LEACH occur at 849 rounds and IPSO-GWO 1897 rounds later. In the third instance, IPSO-GWO's FND is at 1620 while LEACH is at 614 rounds respectively

❖ IPSO-GWO model concentrated on extending the network's life by accomplishing the efficient use of energy. **Figure 10&11** are given below.

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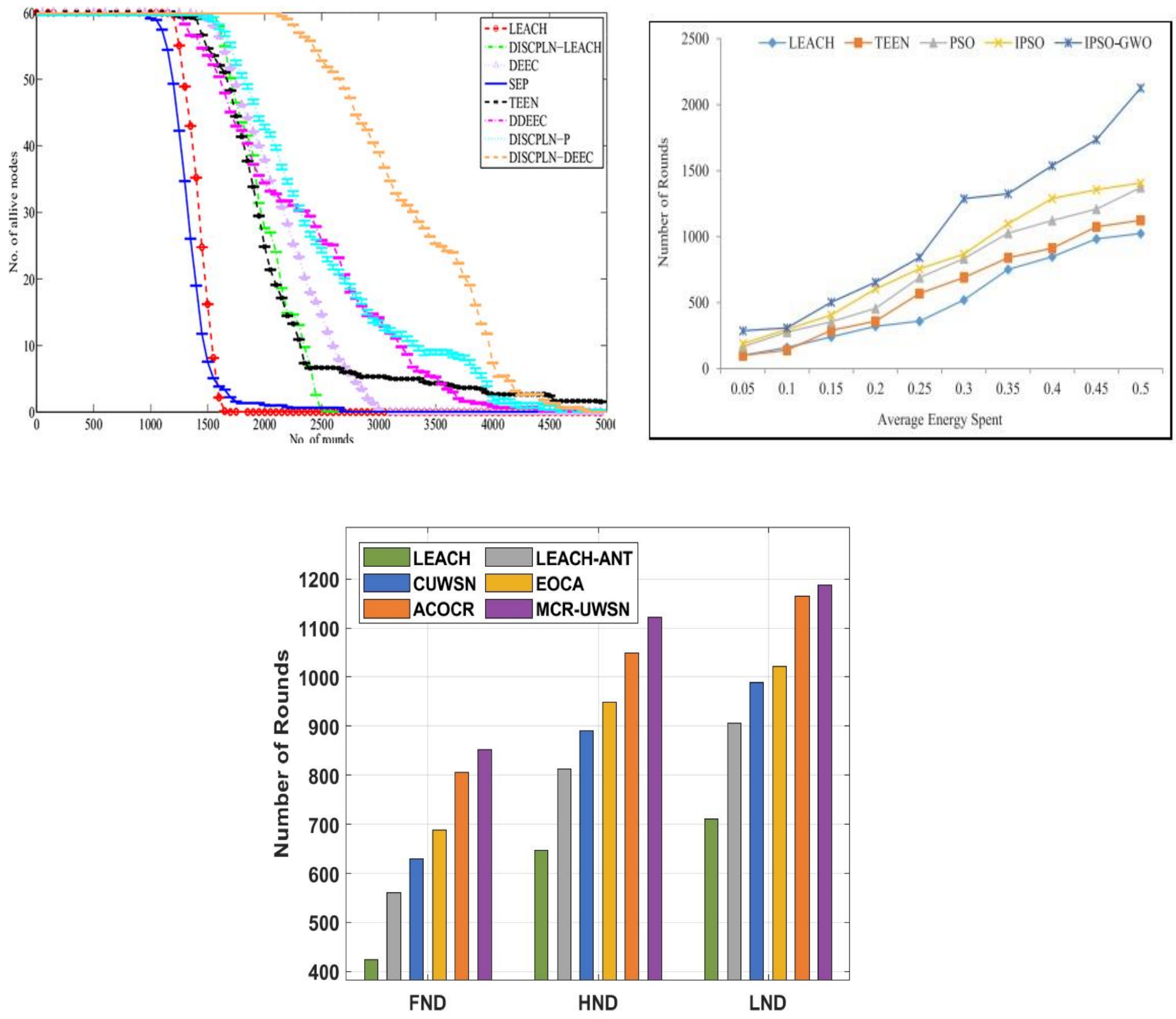

Figure.12

CONCLUSION

Thus we conclude the performance of Energy Efficiency in WSN using ALEACH Protocol which has the equal probability at each node to be a cluster head and it saves energy leads to less energy consumption. This research proposes an IPSO-GWO algorithm that uses swarm intelligence for the optimized path of routing. with that, we analyze the performance of the nodes. The IPSO-GWO algorithm that has been presented consists of two primary stages: IPSO-based clustering and GWO-based routing. The IPSO algorithm is initially used for selecting and competently arranging the clusters and the CHs. Then, there is a GWO algorithm-based routing procedure to choose the network's ideal routes. Thus with the use of an algorithm, we achieved energy efficiency and a longer network lifetime, Throughput. In the future, work may be extended by TEEN Technique. A-TEEN enhances the TEEN's CH election process, improving the stability and dependability of the routing link. A-TEEN enhances the network's energy effectiveness and life cycle even more than TEEN did.

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Declaration of Conflicts Interest

No potential conflicts of interest were disclosed by the author(s) with regard to the research, writing, or publication of this paper.

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