ENERGY EFFICIENT CLUSTER-BASED ROUTING PROTOCOL FOR WIRELESS SENSOR NETWORK USING HYBRID BIO-INSPIRED SWARM INTELLIGENCE ALGORITHM

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Abstract

The sustainability and diversity of wireless sensor networks has forwarded the growth of emerging communication models. The survival factors of emerging communication models are energy, computational capacity, and low bandwidth. Energy is a major issue in the survival of wireless sensor networks. The sensor devices occupied the limited battery-operated energy and sank very fast during the propagation of data. The proper utilisation of energy increases the life of the network and enhances the suitability capacity of wireless sensor networks. The issue of energy-based routing protocols is the selection of a cluster head during the transmission of data. The LEACH protocol suffers from the selection process of cluster heads as well. This paper proposed an efficient energy utilisation approach for wireless sensor networks. The proposed algorithm is based on a bio-inspired swarm intelligence algorithm. The two swarm intelligence algorithms, firefly and glow-worm, were integrated and developed into a hybrid swarm intelligence algorithm. The unifying nature of both algorithms reduces the energy utilisation of the selection process of cluster heads. The proposed algorithm simulates and measures standard parameters using MATLAB simulation tools. The proposed algorithm compares with existing algorithms such as LEACH and LEAC-PSO. The experimental results analysis estimated that the proposed algorithm enhances the utilisation of energy by 2-3% instead of existing energy-based algorithms in wireless sensor networks.

Keywords: - WSN, LEACH, PSO, GSO, FA, Cluster, Routing, MATLAB

Introduction

A wireless sensor network is a group of sensor nodes applied to monitor some defined area and collect and report data to a base station (BS). Because of the wide range of wireless sensor networks deployed in military, agriculture, medical, and health-care applications, the journey of a wireless sensor network depends on some common factors such as energy, low bandwidth, and computation. The other two factors, low bandwidth and computational overhead, are not a big issue. The factor of energy is a major issue in wireless sensor networks. The limited constraints of energy factors of wireless sensor networks compromise the life of networks. The sensor network's maximum energy is expended on pathfinding and data transmission. The energy-based routing protocol plays a vital role in wireless sensor networks. The first energy-based routing protocol is designed by LEACH (Low energy adaptive clustering hierarchy). The

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LEACH protocol faces many challenges in terms of the efficient use of energy in the communication process. The limitations of the LEACH protocol are overcome by the various research scholars using swarm intelligence-based algorithms such as particle swarm optimization, ant colony optimization, and many other derived algorithms of swarm intelligence. The reported survey suggests that many authors applied probabilistic-based functions for the estimation of energy in wireless sensor networks. The process of routing in wireless sensor networks involves three different types of routing protocols, which have been specifically proposed: flat, location-based, and hierarchical. Each sensor node completes the same responsibilities as another in flat routing, which employs the multi-hop technique [13]. The cooperation of the sensor nodes with one another allows for the accomplishment of the sensing task. Instead of transmitting data over the whole network, location-based routing uses sensor node position information to distribute data to a particular area [14]. In hierarchical routing, sensor nodes with higher energy are in charge of processing and transmitting information while the network region is separated into clusters. The most energy-efficient routing protocols are those that are hierarchical [2]. The main goal of this research is to examine how current routing protocols operate and identify any flaws that may require improvement in order to create an effective and ideal routing system for next-generation networks. Energy efficiency is more significant than other identified WSN routing difficulties because of its connection to the complete computing process of the sensor nodes. The routing protocol's job is to link sensor nodes and receive data sent from various wireless nodes at the destination station. Sensor nodes continuously exchange hello messages to maintain contact with the active nodes in order to build a link between them and CH. The energy efficiency is also impacted by how far the communication nodes are from one another. Despite the many variants of LEACH protocols, many loopholes exist in current routing protocols. The several authors focus on improvements to the LEACH protocol and making it more efficient for communication. The many approaches of swarm intelligence algorithms enhance the cluster head selection in the LEACH protocol, such as particle swarm optimization (PSO). The initial molecule swarm enhancement in particle swarm optimization is a presumptive inquiry handle designed after a flying animal run. Every agent in the population is maintained by the calculation as a potential solution to an enhancement problem. With PSO, a swarm refers to several alternative solutions to the progress problem, with each such solution being referred to as a particle. The PSO algorithm moves forward by identifying the agent position that results in the most accurate evaluation of a certain wellness function. This paper proposes a hybrid swarm intelligence algorithm for cluster-based routing protocols. The proposed hybrid algorithm uses two different swarm intelligence algorithms: glow-worm swarm optimization (GSO) and the firefly algorithm (FA). The GSO algorithm helps the selection of the cluster head during the report and transfer of data. The firefly algorithm processes the energy factors of the clustering algorithm. The proposed algorithm incorporates the LEACH protocol. The two major factors of hybrid intelligence algorithms, similarity and unidirectional process, reduce the utilisation of energy and increase the life of wireless sensor networks. The rest of the paper is described as follows: related recent work in energy-based routing protocols Section III describes swarm intelligence and the proposed methodology. In Section IV, which describes the experimental analysis of simulation, In section V, we conclude our research work.

II. Related Work

Despite several efforts, continuous improvements in the LEACH protocol still have many issues. Many research scholars proposed probability-based functions and swarm intelligence algorithms with the LEACH protocol and the LEACH protocol to enhance the energy efficiency of wireless sensor networks. Here are some recent major contributions of works. This paper [1] modified the LEACH protocol for the minimization of energy utilization. However, the LEACH protocol will increase the network's energy consumption because it does not account for the distribution of the cluster heads (CHs) on a rotation basis. In this study, a brand-new clustering methodology called IEE-LEACH is suggested to cut down on energy use and lengthen the lifespan of WSNs. This paper [2] describes the real-time fixed slot assignments used in the core network design. Through the combination of data regarding the direct link of single-way routing, it was able to further reduce the amount of data being transferred. The use of just two parameters was intended to streamline the configuration procedure. In this [3], the Multiple data sink-based Energy Efficient Cluster-based Routing Protocol (MEEC) and the Improved Dual Hop Routing Protocol (IDHR) are proposed. IDHR's recommended CH selection and energy-efficient inter-cluster communication are what enable this performance improvement. While in MEEC, it is because using numerous data sinks reduces the communication distance. An analytical and current survey of these techniques is provided in this article. This analysis clearly demonstrated the numerous disparities in their purported structure and operation. In particular, protocols that fell under the category of communication models were further divided into query-based, coherent or non-coherent, and negotiation-based categories. [5] describes an energy-efficient routing schema coupled with sink mobility and clustering technology. We first segment the entire sensor field into sectors, and each sector chooses a Cluster Head (CH) by weighing the contributions of its members. To transmit data to their associated CHs via single or multiple-hop communication, cluster members calculated the routing method with the lowest energy consumption. Then, to create a chain for inter-cluster communication, the CHs chose a greedy method. In this [6], the "internet of things" is a collection of interconnected computational, digital, and mechanical devices that can be recognised by other internet-capable devices. Wireless sensor networks are a collection of independent sensing components along with actuators, computers, communication, and energy storage devices to monitor the ongoing changes in the physical world. The suggested method combines clustering with simple fuzzy rule-based neural networks to have good energy efficiency, avoiding the waste generated during the selection of the head and the cluster patterning. In this [7], A priority-based and energy-efficient routing technique (PriNergy) is suggested in this paper's section on energy consumption. The approach is based on the Routing Protocol for Low-Power and Loss Networks (RPL) concept, which establishes routing based on content. This paper suggests a brand-new RPL-based technique to reduce IoT device energy usage. Our approach took into account the quality of service (QoS) of IoT applications, where a TDMA time slot is used to synchronise the sender and receiver and save energy. In this paper [8], According to the suggested technique, each sensor node's weight value is also determined depending on the number of data packets it gets from other sensor nodes. A novel approach based on particle swarm optimization (PSO) was put forth in this work to enable the mobile [9] K.Thangaramya and colleaguesThe Internet of Things (IoT) uses wireless sensor networks (WSNs) to sense the environment, gather data, and transfer it to the base station and other places for analysis. This method of cluster formation in wireless sensor networks (WSNs) makes use of energy modelling for packet routing through the use of machine learning, utilising convolutional neural networks with fuzzy rules for weight adjustment, extending the lifetime of the network. Reeta Bhardwaj and co-workers [10]: This work addresses these issues by creating an energy-conscious multi-objective routing technology. The multi-objective fitness function based on energy, delay, traffic rate, distance, and cluster density is proposed in this study. The proposed MOFPL calculates the fitness function by taking into account a number of variables, including energy, delay, traffic rate, distance, and node density. By changing the population size and the WSN nodes, the proposed model is simulated. Innamullah Khan and others [11]. In this research, a novel AntHoc Net-based routing protocol for FANET is presented. Compared to other traditional optimal path selection strategies, ant colony optimization techniques or met heuristics in general, have demonstrated higher dependability and performance. The energy stabilising parameter that was established in this study enhances network performance in general and energy efficiency in particular. The base protocols, AntHoc Net and TORA, DSR, and MDART, older routing protocols, are contrasted with the proposed routing protocol, eAntHoc Net. Subash, Harizan, and coworkers [12] have suggested an enhanced genetic algorithm (GA) based scheduling for WSNs in this study. The generation of a valid chromosome following crossover and mutation operations is demonstrated using an effective chromosomal representation. The suggested approach may completely cover the target points while also maintaining connectivity between the base station and active sensor nodes to convey sense data. When scheduling takes place, Among others, Maryam Naghibi [13] In order to collect the data sensed by these cell nodes, this study proposes a mechanism for geographically segmenting the network into a number of cells. In this strategy, anchor points are chosen for sinks to stay steady and collect data from sensor nodes after the orbits are determined. Eyman Fathel Rahman, Ahmed Elsmany, and colleagues [14]The energy-efficient scalable routing algorithm is a new energy-efficient clustering and hierarchical routing technique presented in this research (EESRA). The suggested technique seeks to maximise network longevity despite growing network size. EESRA's development aims to increase network size while maintaining network lifespan. A hybrid MAC protocol with TDMA slots for data, sleep, and data sensing collision avoidance methods. Balaji and others [15] suggest using multiple hops to transmit data packets, moving them from one hop to the next. Finally, the base station receives these data packets. Any node in this cluster has the ability to function as both a source and a destination. The CH is then used to transmit data packets from the source to the base station. In this study, Premkumar Chithaluru et al. [16]. Using adaptive participatory criteria, it determines which node is the most useful to participate as a cluster head. This paper suggests novel adaptive ranking forwarder node and forwarder node algorithms. Also, choosing a forwarder node depends on an ideal energy strategy that focuses on residual energy. [17] Using a multi-objective fractional gravitational search technique, the best cluster head for an energy-efficient routing protocol in an IoT network is found in this research. In order to locate the cluster head iteratively, the proposed FGSA algorithm was created by fusing fractional theory with a gravitational search algorithm. Then, the fitness function for choosing cluster heads was made by taking into account distance, delay, link lifetime, and energy, among other things. This research proposes the Geometric programming-based Energy Efficient Routing protocol (GEER), a revolutionary routing construction algorithm for hybrid ad-hoc networks. It optimises two sets of objectives: (1) increasing throughput and network lifetime; and (2) decreasing packet loss and routing overhead. The suggested approach, GEER, combines GP and IFS to provide a multi-objective solution for HANET. When these methods are used together, they help optimise a number of goals that are at odds with each other and estimate nonlinear network properties.[19] To increase the network's stability period, a threshold-sensitive energy-efficient clustering protocol (TECP) based on moth-fame optimization (MFO) is suggested in this research. The use of MFO for multi-hop communication between CHs and BS enables the achievement of the best connection cost for load balancing of distant CHs and energy conservation. Additionally, multi-hop communication via MFO is used to balance the load and reduce the energy use of the distant CHs. Performance indicators like network lifespan, Among others, A.C. Jeba Malar [20], a collection of cutting-edge mobile devices with self-organization capabilities, is known as a mobile ad hoc network (MANET). Due to the variety of mobile devices and wireless connectivity, MANET encounters a number of problems, including topology management; energy management because of battery power limitations; data communication problems, etc. In this research, we provide an energy-efficient routing method for MANET called MCER-ACO, which is based on ant colony optimization. [22] In order to improve the exploitation capabilities of the proposed met heuristic and to increase its global convergence, we propose an improved artificial bee colony (iABC) met heuristic with an updated search equation. In order to increase the exploitation capabilities and convergence rate of the current ABC met heuristic, this work offers an improved ABC met heuristic (iABC). It is based on the first student cPDF and DE-inspired better search equation ABC/rand-to-opt/1. Ghassan Samara and co-workers [23] suggest an Efficient, Energy-Aware, Least Cost (ECQSR) quality of service routing protocol for sensor networks that can function effectively with best-effort traffic processing. Its ability to find the shortest route helps lower costs and power consumption, which helps the network last longer. According to Dr. S. Smys, among others [24], "big data" generation has resulted from the dense deployment of wireless sensor networks, which has generated a large amount of data flow. It becomes vital to alter the routing protocol to make it easier for routing to handle the big-data scenario in order to permit continuous transmission of the enormous volume of data packets. The three stages of the proposed routing protocol are path identification, data transmission, and updating the routing information table. The first step is to add up the merits of each node based on its energy, bandwidth, distance from the sink, and delay.Others include Xu Xuan.[25] Huge numbers of sensor nodes are densely deployed in a hostile environment as the sensor layer of the Internet of Things (IOT) to monitor and sense changes in the physical space. It is highly difficult and expensive for wireless sensor networks (WSNs) to increase network lifetime since sensor nodes are powered by batteries with limited power. We have discussed energy balance and minimising energy use in WSN in this essay. In the research by Mohammed Al-Hubaishi and colleagues [26], The fundamental feature of our model is that the suggested architecture can alter the current path while data is being transmitted, and this is made possible by using the SDN technique. For a more accurate performance assessment, the proposed system's algorithms and parts are all modelled and simulated using the Riverbed Modeller programme. Simulation results show that the proposed system finds the best route when working in situations that change. This paper [27] provides a novel clustering algorithm that chooses CHs by employing the grey wolf optimizer (GWO). A novel swarm intelligence programme called GWO that mimics the behaviour of grey wolves exhibits amazing qualities and is very competitive. It has been demonstrated that the proposed protocol can produce outcomes that are competitive with a few other recent methods that are similar to it. However, According to Jayarajan and co-workers [28], the strategy is to increase network lifetime and prevent data packet drops due to buffer overflow by making buffers aware. Lifetime and data loss are big issues because preconfigured sensor nodes can never expand the buffer size. The method also stops packets from getting lost across the whole network and from being sent over and over again, which wastes energy. In this research [29], Dawne Ruan et al. propose a PSO (Particle Swarm Optimization)-based uneven dynamic clustering multi-hop routing protocol (PUDCRP). When some nodes fail in the PUDCRP protocol, the distribution of the clusters will vary dynamically. The suggested approach enhances the formation of clusters in wireless sensor networks. To make sure that energy use is spread out more evenly, the main idea is to divide the network area into different clusters that change based on where the nodes are. A thorough investigation of the energy-efficient approach in static Wireless Sensor Networks (WSNs) without any energy harvesting modules was carried out. This paper first analyses the energy consumption characteristics in terms of each individual sensor node and the entire network. At first, a new generic mathematical definition of energy efficiency was proposed. This definition took into account both the rate at which valid data was collected and the total amount of energy used. One of them is Rajendra Prasad P. [31]. He is one of them. Energy protocols with shortest path routing techniques are common in networking environments. Creating an energy-efficient network that maximises network performance is a difficult challenge when creating the routing protocols for a mobile ad hoc network (MANET). With the information in this article, a node can keep track of its surroundings and choose the shortest route while keeping its maximum energy capacity in mind. Among others, Sachi Nandan Mohanty [32] said this research provides a distributed data mining (DDM) model based on deep learning in order to optimise energy efficiency and ideal load balancing at the fusion centre of WSN. A long-term short-term memory (LMTM) based recurrent neural network (RNN) is part of the DMM model that has been presented. At the same time, the RNN-LSTM model's transmission of processed data uses far less energy than the transmission of raw data. Here, the findings are verified using various hidden layer node counts and signalling intervals. Amit Sarkar and others [33] suggest choosing the optimum cluster head. Firefly with cyclic randomization is suggested in this research. When compared to other traditional techniques, this strategy improves network performance. As a result, the FCR protocol has saved the network's energy, reduced the distance between nodes, and increased the number of active nodes. In general, the standard algorithms for choosing cluster heads have not done as well as the FCR approach. Smriti Sachan and co-workers [34] In order to examine network connectivity, this study introduces a new probabilistic technique that takes into account variables such as network probability, detection area, individual node radius, overall detection area, etc. When mobile nodes make the distance and location of nearby nodes change in unpredictable ways, it is harder to keep the network connected. [35] Quan Wang, et al In addition, a third duty of Backup Cluster Head (BCH) as well as the corresponding mechanism to rotate the roles between the CH and BCH were proposed to alleviate the "Hot Spot Problem" and reduce the energy consumption derived from the rotation of CHs. The clustering technique was then combined with the CS theory in this paper to lower the energy consumption caused by the spatial-temporal correlation. Besides, Teekaraman and others [36] Considering environmental conditions, data transmission rate, transmission efficiency, energy consumption rate, E-ED, and propagation delay, the review of localization-free protocols was explored and examined in this study. The protocols are put into groups and categories based on a problem statement that talks about node mobility, energy balance, avoiding the Void Problem, energy use, and reducing the effects of channel properties. In this study, L.-L. Hung et al. [37] propose an energy-efficient cooperative routing scheme for heterogeneous wireless sensor networks, where multiple WSNs deployed in the same geographic environment form a heterogeneous sensor network and sensors relay packets for their own WSN as well as for other WSNs. Sensors of type A can relay packets of type B along the transmission routes. When a sensor, such as sj's neighbours, receives a packet, such as P, it assists in transmitting P. Due to an increase in the number of sensors that can relay packets for an individual WSN's events, this could save energy while sending P to its sink. Khalid Haseeb and coworkers [38] In order to extend the network lifespan and improve the reliability of the data, this research proposes to design an energy-efficient and secure routing protocol (ESR) for the IoT based on WSN intrusion avoidance. The suggested protocol first builds various energy-efficient clusters depending on the inherent characteristics of nodes. This enabled data protection against malicious threats from the nodes to the cluster leaders and then to the BS. In future work, the suggested protocol will be expanded to take into account both mobility requirements and the need for network communication to take place over more than one hop. Among others, Liangrui Tang [39] Low energy consumption and imbalanced energy distribution have a significant impact on the performance of wireless sensor networks that are energy-constrained. Because of this, effective and appropriate routing algorithms are required to attain greater quality, and the entropy weight method is used to dynamically decide each index's weight. By combining the two of these, the BPA function may be obtained. Next, the DS Pratik Goswami and coworkers [40]. This research proposes a dynamic cluster generation method that is energy efficient. Any wireless sensor network's first and top priority is cluster creation (WSN). In our work, the suggested method combines the Firefly algorithm with enhancing intra-cluster communication. An energy-efficient OWSN is created with improved source-to-sink node communication. Among others, Biswa Mohan Sahoo [41] the cluster head selection problem and the sink mobility problem are both addressed in this research using a particle swarm optimization (PSO) algorithm integrated with an energy efficient clustering and sink mobility (PSO-ECSM) algorithm. The integration of the fitness function in terms of the five parameters of residual energy, distance, node degree, average energy, and energy consumption rate was done using a multi-objective Particle Swarm Optimization (PSO) (ECR). Mohamed Elhoseny and others (42). The K-Madrid Clustering model is presented in this research to cluster the vehicle nodes, and then energy-efficient nodes are found for effective communication. Together with optimization, clustering algorithms like the K-medic algorithm were used to reach the goal of energy-efficient communication. According to Sandeep Sharma and coworkers [43], the deployment tactics, energy efficiency, and coverage of wireless sensor networks are the current and most active study fields. In addition to energy harvesting, lowering energy usage can lengthen the network lifetime of the sensors. This study looked at different strategies and problems that still need to be solved in wireless sensor networks. These strategies and problems were based on sensors, deployment plans, sensing paradigms, energy efficiency, and coverage.

III. Proposed Methodology

This paper proposed a novel hybrid GSO-FF algorithm is combination of GSO and firefly to resolve the issue of selection of optimal cluster head in each cluster. The define sensor network map each sensor node as glow-worm emitting a light substance called luciferin and intensity of the luciferin is dependent on the distance between sensor node and its neighbor of sensors. A sensor node is drawn to its neighbors who have lower levels of luciferin and chooses to travel in that direction. ACO has the benefits of being simple to search through in parallel, finding excellent solutions quickly, adapting to changes like additional distances, and ensuring convergence. The fact that GSO does not require centralized control makes it easily scalable, and it also has the potential to learn quickly and is suitable for non-linear modelling. The traditional algorithm only takes into account the global searching process, however the expert algorithms in this field take into account both the global and local searching processes in this study. Furthermore, we have hybridized in a way that allows the global and local searching capabilities to be used as necessary. This refines and coarsens the CHS selection process. The traits might also be felt in the outcomes. The processing of firefly and GSO algorithm describes here.

Glow-worm swarm optimization (GSO)

The process of algorithm used the concept of local sharing information and update the feature set of parameters.

The process of algorithms defines following parameters

1. Luciferin update: - the value of luciferin update depends on fitness value and pervious value of luciferin [15,16]

$$l_i(t+1) = (1-\rho)l_i(t) + \gamma fitness(xi(t+1)$$

$$here\ li(t)\ \ denotes\ the\ luciferin\ value\ of\ \ glowworm\ i\ at\ time\ t$$

2. Neighbourhood selection

The selection of neighbourhood Ni(t) as

$$N_i(t) = \{J: d_{ij}(t) < r_d^i(t); l_i(t) < l_j(t)\}$$

$$here\ dij(t) euclidean\ distance\ between\ glowworm\ i\ and\ j\ at\ time\ t$$

3. Compute probability

Glow-worm applied function of probability to measure the movements of glow-worm

$$P_{ij}(t) = \frac{l_j(t) - l_i(t)}{\sum_{k \in Ni(t)} l_k(t) - l_i(t)}$$

4. Movement process

$$x_i(t+1) = x_i(t) + s(\frac{x_j(t) - x_i(t)}{|\ \ x_j(t) - x_i(t)|})$$

5. Decision rule update

$$r_d^i(t+1) = \min\{r_{s,max}\{0, r_d^i(t) + \beta(n_t - |N_i(t)|\ \ )\}\}$$

Here β is constant, $r_{s,}$ shows radius of glowworm

Firefly Algorithm

Firefly algorithm is meta-heuristic optimization algorithm based on the flashing behaviors of fireflies in environment. Firefly algorithm resolve the problem of NP-hard problem and manage the dynamic behaviors of data. It's a random algorithm, to put it another way, a random search is utilized to locate a collection of solutions. The FA, at its most basic, focuses on producing solutions inside a search area and selecting the greatest surviving option. A random search avoids being stuck in local optimums. Exploration in metaheuristic algorithms refers to discovering multiple solutions inside the search space, whereas exploitation refers to the search process focusing on the best neighboring solutions. The firefly algorithm has three basic features are (1) the firefly becomes a.The firefly becomes brighter and more attractive when it moves randomly, and all fireflies are of the same sex. (2) The attractiveness of the fireflies is proportional to the brightness of the light and the distance from it. The light absorption coefficient γ calculates the reduction in light intensity. The value of the objective function also determines the luminance of the firefly. (3) the distance between fireflies is obtained form equation (1) so that Xi,k is the kth part of the spatial coordination and ith firefly

$$r_{i,j=} \sqrt{(xi - xj)^2 + \ (yi - yj)^2 \dots \dots \dots \dots \dots \dots .(1)}$$

The movement of firefly and attracted fireflies measured as

$$X_i = X_i + B0^{erij}\ \ (Xj - Xi) + a\left(rand - \frac{1}{2}\right) \dots \dots \dots \dots .(2)$$

A is a randomizer variable, rand is a random integer between [0, 1], and B is the attractiveness of the light source. The parameter is determined by variations in attraction.

The process of stock price optimization

The firefly algorithm (FA) employed in stock data as initial population and set the value of parameters as α, γ, β min $and\ t = 0$ and Fes=0; the factors of brightness of data is Ii at Xi is measured by f(Xi). Define light absorption coefficient γ;

While (not meet the stop conditions)
For i=1: N all N fireflies
For j=1: N all N fireflies
If Ij > Ii Then
Move firefly i towards j in all dimensions according to Equation (2);
End If
Attractiveness varies with distance
Evaluate the new solution and update its brightness; Fes=Fes+1;
End For
End For
Rank the fireflies and find the current best;
t=t+1;
End While
End

Hybrid Algorithm

1. Define number of dimension as X
2. Define number of worm as Y
3. Size of sensor network as Si
4. Deploy randomly the sensor network nodes
5. Estimare $D_{(P_t,k)}$ and $k - disimarilty(p_t)$
6. for all $DP \in GSO_{(f_t,k)}$ do
7. estimate local function$-Lp(f_t, DP)$
8. end for
9. $W_{\text{update}} \leftarrow GSO\ \{the\ set\ of\ glows\}$
10. for all $DP \in W_{\text{update}}$ and $FP \in M_{(DG,K)}$ do
11. Update $k - disimarilty(DP)$ and $cluester - ds(GSO, FF)$
12. if $DP_{(FP,k)}$ then
13. $W_{\text{update}} \leftarrow W_{\text{update}} \cup \{DP\}$
14. end if
15. end for
16. for all $DP \in W_{\text{update}}$ do
17. Update $FD(DP)$ and $FD(\{GSO_{o,k}\})$
18. end for
19. return $FD(optimal\ cluester\ Head)$
20. if value of difference is near about zero.
21. The process cluester head is selected

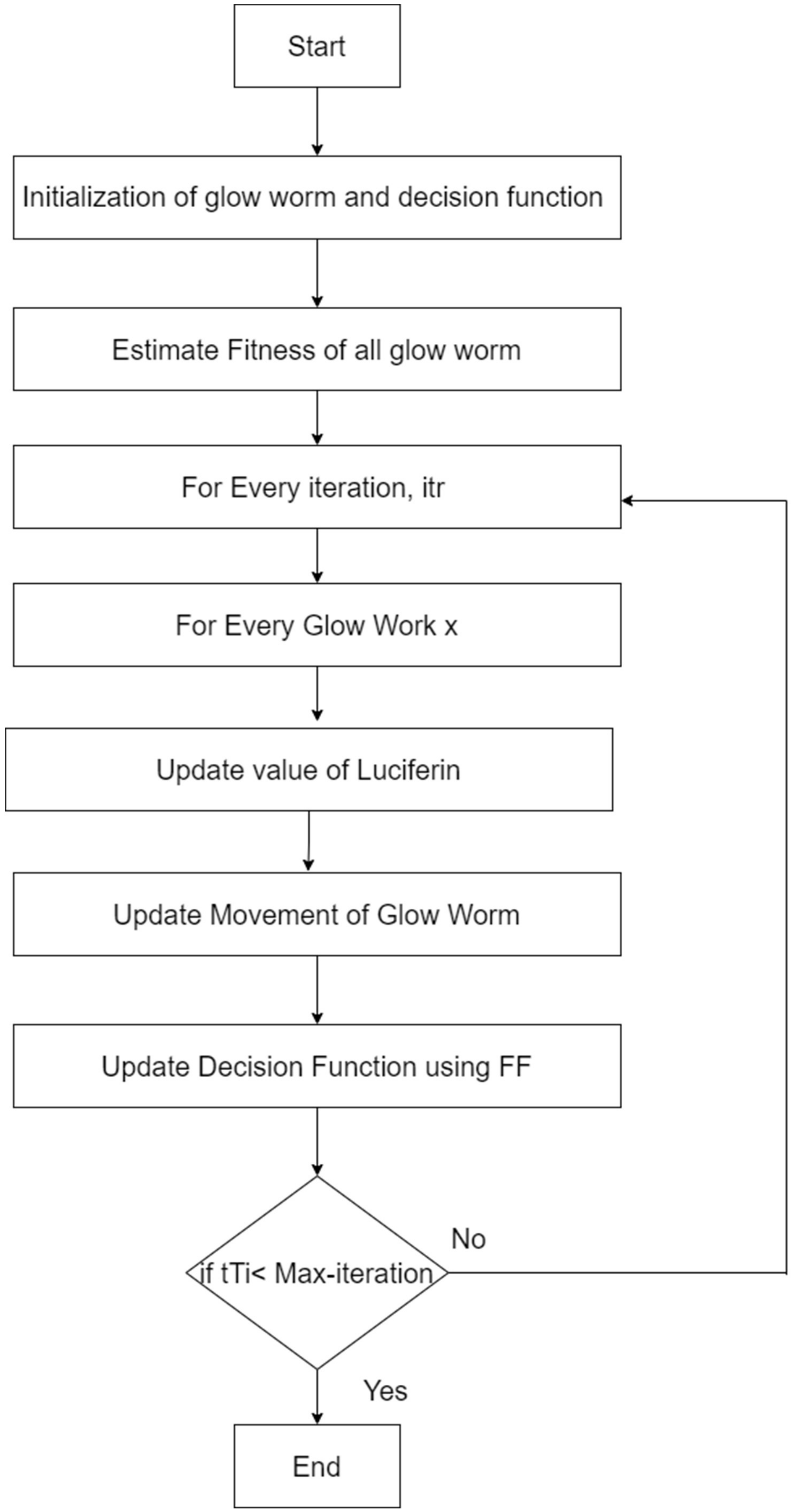
Start
Initialization of glow worm and decision function
Estimate Fitness of all glow worm
For Every iteration, itr
For Every Glow Work x
Update value of Luciferin
Update Movement of Glow Worm
Update Decision Function using FF
if tTi< Max-iteration
No
Yes
End

Figure 1 proposed model of hybrid swarm intelligence algorithm (GSO-FF)

IV. Experimental Analysis

To validate the proposed algorithm for wireless sensor network simulates in MATLAB tools. The system configuration for simulation windows 10 operating system, 16 GB RAM, 1TB HDD. We consider homogeneous network model for the analysis of protocol. The applied energy model describes as the radio energy model requires an amplifier for sending message of k-bit over distance x between transmitter and receiver [45,46,47]

$$E_{TX} = \begin{cases} K\ x\ Ep + Kxdxd^2\ when\ d \leq d0 \\ K\ X\ dx + KXxdd^2\ when\ d \geq d0 \end{cases} \dots\dots\dots\dots\dots\dots\dots\dots..(4).$$

$$d0 = \sqrt{\frac{xd}{kx}} \dots\dots\dots\dots\dots\dots\dots\dots\dots\dots (5)$$

Where d0 is threshold of distance and xd is amount of energy for transmitter and receiver Simulation Parameters [18,19,20]. The performance of network estimated as packet delivery ratio, energy consumption, round of rotation and packet loss.

Parameters	**Value**
Area of sensor network	200 X 200
Total number of nodes	200
Initial energy of sensor node	10pJ/bit
Location of base station	100,100
Data packet	5000 bits
Aggregation energy	5pJ/bit
Cluster probability	0.08
Number of rounds	15000 and 30000
Normal distribution	101 m
Standard deviation	60m

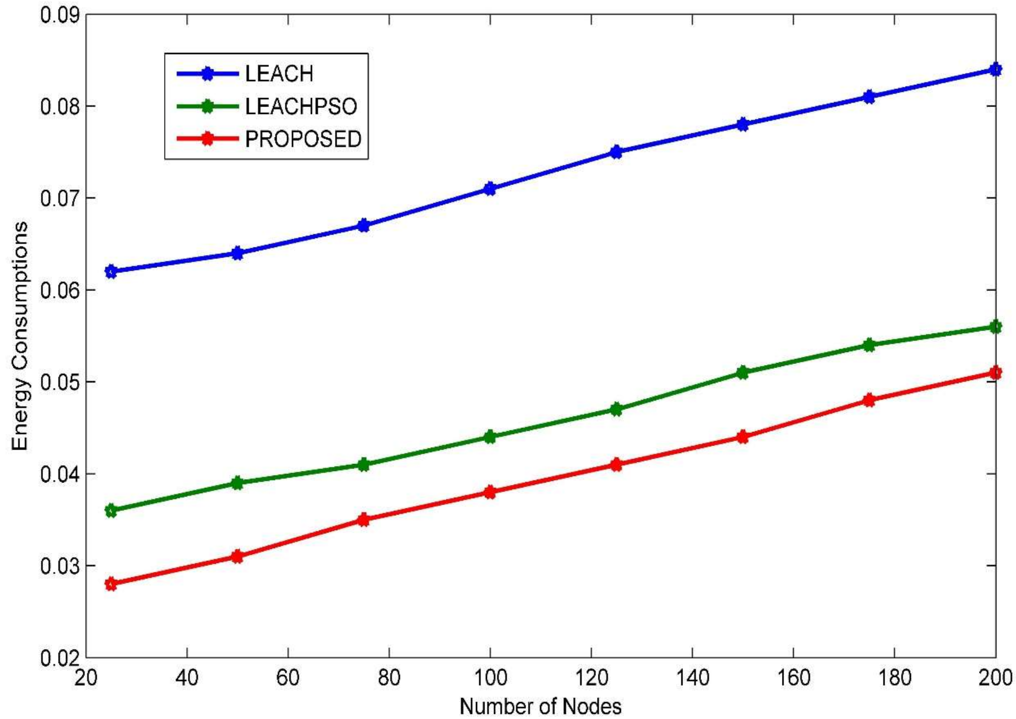

Figure 2 performance analysis of energy consumption of sensor nodes using LEACH, PEACH-PSO & proposed algorithm.

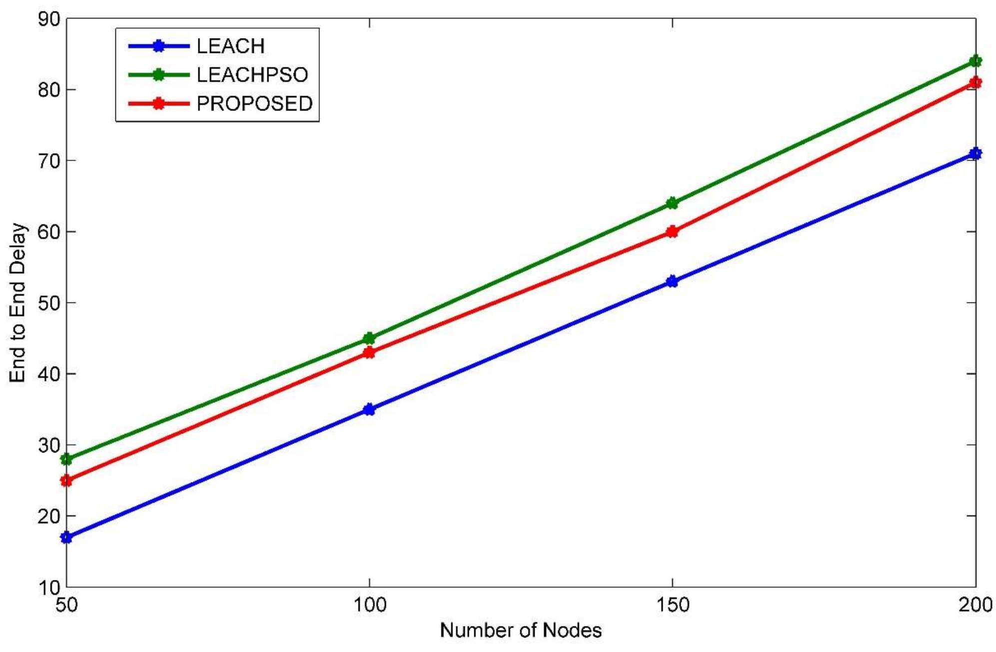

Figure 3 performance analysis of end-to-end delay of network using LEACH, PEACH-PSO & proposed algorithm.

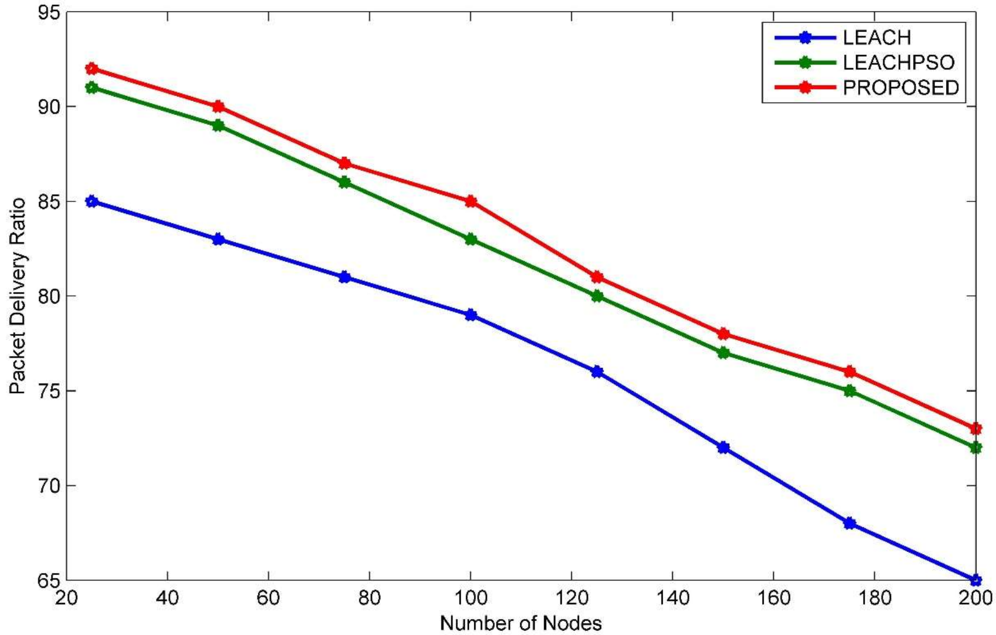

Figure 4 performance analysis of packet delivery Ratio of network using LEACH, PEACH-PSO & proposed algorithm.

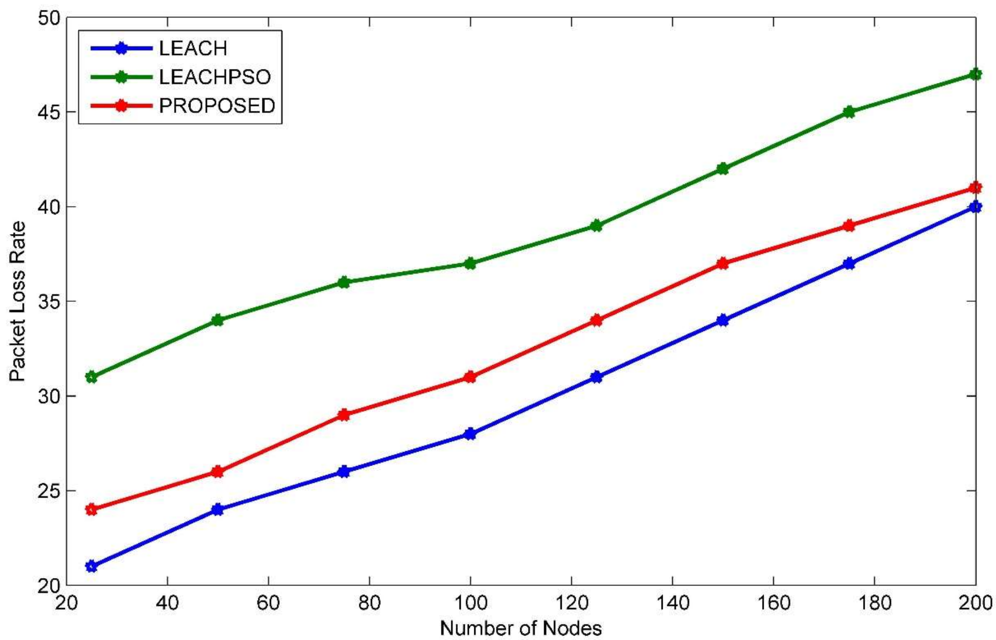

Figure 5 performance analysis of packet loss rate of network using LEACH, PEACH-PSO & proposed algorithm.

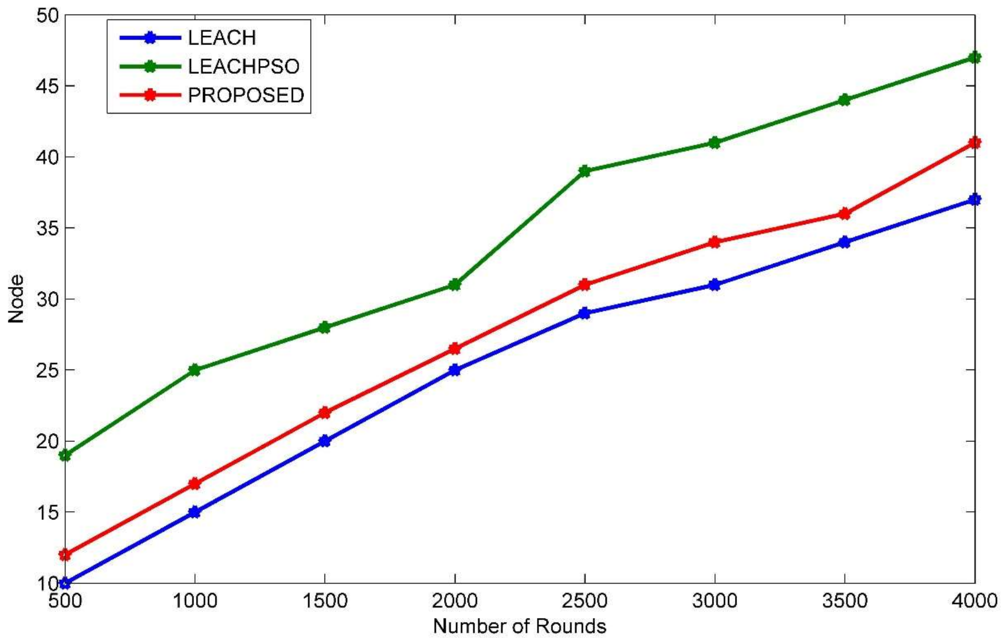

Figure 6 performance analysis of number of rounds using LEACH, PEACH-PSO & proposed algorithm

V. Conclusion & Future Scope

WSNs have a wide range of uses nowadays. As a result, it is difficult to provide routing algorithms with a dynamic topology and dispersed nature. Different routing techniques are used by WSNs to enhance network performance and lower energy usage. Because of the constraints of sensor nodes, routing poses one of the most significant issues in WSNs. The proposed algorithm encapsulates LEACH protocol with hybrid swarm intelligence algorithm. A fitness function based on three variables—the degree of a node, the residual energy of a node, and the separation between each node and its neighbours—was offered to assess CH nodes. Route finding was accomplished using a firefly method in the second phase. Three factors are used to construct the system: the traffic in nodes, the distance between CH nodes and the base station, and the energy level of CH nodes. Path maintenance was included in the third phase so that a path break would continue route finding. In terms of end-to-end latency, energy usage, and packet loss rate, the suggested technique was compared with LEACH [24] and LEACH-PSO [27]. Our approach works better than other ways, according to the results. In actuality, the suggested approach enhances network lifetime and end-to-end latency. Additionally, it results in a decrease in energy use and packet loss rate. In further studies, we want to enhance the clustering and routing procedures and assess the implications of these enhancements on the effectiveness of the suggested system.

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