

# Energy-efficient PEGASIS Clustering based multipath routing with Lion Swarm and Chicken swarm optimization (PEGA-LSCS) for Wireless Sensor Network

Binaya Kumar Patra

Assistant professor, Department of Computer Science Engineering and applications,  
Indira Gandhi Institute of Technology, Sarang, Dhenkanal, Odisha, 759146, India  
binaya.patra@gmail.com, www.igitsarang.ac.in.

Sarojananda Mishra

Professor, Department of Computer Science Engineering and applications,  
Indira Gandhi Institute of Technology, Sarang, Dhenkanal, Odisha, 759146, India  
sarose.mishra@gmail.com, www.igitsarang.ac.in.

Sanjay Kumar Patra

Assistant professor, Department of Computer Science Engineering and applications,  
Indira Gandhi Institute of Technology, Sarang, Dhenkanal, Odisha, 759146, India  
sanjay.patra@gmail.com, www.igitsarang.ac.in.

## Abstract

Due to the popularity gain in the wide research area in different field of application wireless sensor network (WSN) have been subject to deployed in the last decades. WSN due to use in harsh environment difficult to exchange batteries physically. For that reason Energy efficiency acts as a major factor to restoration of battery power in sensor network. The proposed algorithm prolong the lifetime of the sensor network by enhancing load distributions in the WSN. This work used the chain-based routing PEGASIS (Power Energy Gathering in sensor information system.) as basis. In this approach optimal path model Lion swarm and chicken swarm in PEGASIS based chain clustering (PEGA-LSCS) has been used. The optimal path is chosen by using Lion Swarm Optimization (LSO) and to reduce the energy consumption of the network the Enhanced Clustering approach is initiated using Chicken Swarm Optimization (CSO). As a result the noticeably improvement of lifetime in this approach has been showing. Other results like residual energy, packet delivery ratio and end to end delay are also considered.

**Key Words:** WSN, PEGASIS, LSO, CSO, Clustering.

## 1. Introduction about WSN

Wireless Sensor Networks (WSNs) are widely used for military purposes, health monitoring, and other purposes. The important circumstance, i.e., the precise positioning of sensor nodes, may arise in these types of applications. The sensor nodes can be found using localization techniques. Meta-heuristic methods can be recommended for optimising the current localisation solutions. The positioning of sensor nodes is made easier by using this optimization strategy [1]. Using reusable communication protocols in a generic WSN architecture, the sensors are efficiently arranged. These protocols are isolated from the protocols used at the top layers [2]. The sensors that are typically equipped with tiny batteries that cannot be recharged since they have been distributed more quickly and to unattended sites [3]. As a result, in networks with limited energy resources, lowering energy consumption is the most difficult challenge. Although there are several elements at play in this scenario, numerous studies have focused on routing methods for WSNs [4]. According to the gathered works, lifespan is defined as the amount of time left before the first sensor's node energy runs out [5].

WSN discusses a wide range of applications in real-world sectors, but it also face difficulties [3]. The current wireless sensor network-based healthcare systems include e-healthcare, M-healthcare, and remote healthcare systems. The stakeholders in the E-health care system can enhance the services and their information with the use of appropriate technology. It is an educational and cooperative healthcare system. In an electronic healthcare system, patients and medical assistants might meet and converse online. M-healthcare systems rely on mobile devices to collect personal health information from users. This approach aids in gathering data for researchers, patients, and health aides.

Here, real-time monitoring and telemedicine are included to enable direct patient care [4]. Education on physical computing, particularly with the aid of WSN, has made some progress. This may be due to a lack of knowledge

on how to configure such infrastructure. It has become challenging to integrate WSN at schools and test it out with software and hardware platforms [5]. The current Manet routing protocols may be used since they are designed to function well in completely mobile ad hoc networks. This may be as a result of similarities between MWSNs and Manet (Mobile Adhoc NETWORK) [6].

Maintaining the proper size and costing of sensor nodes in wireless sensor networks as low as possible could appreciate the use of WSNs in isolated and intricate access areas. This perception exposes that the computational resources, energy and memory sources of the sensor nodes are generally restricted in WSNs. Hence, modest design and low consumption of energy are the main restraints to be taken into consideration while designing any WSN protocols [7]. To advance network performance on specific QoS factors multiple access methods should be prudently measured for delay restraint WSNs. The three main categories of channel access methodologies-based protocols are contention-based, schedule-based and hybrid contention-schedule-based [8]. Wide use of WSNs for Structural health observation has been addressed in some studies that afford a broad outline of various topics assimilated from sensor characteristics, sensor location and data processing [9].

By enhancing the lifetime of the nodes, this issue can be rectified. For enhancing lifetime of the nodes, clustering is generally deployed. The hierarchical routing protocol distributes the network into clusters by having one cluster head and member nodes. The data from the existing nodes will be gathered by Cluster Heads (CH) in the cluster. Then the data will be transmitted to Base Station (BS). These functions will be accomplished only when the network is live in action. The network lifetime of the clusters directly relates with the battery proficiency. Saving nodes energy is another issue in WSN as energy is the basic requirement in cluster formation and CH selection. By adding WSN, which includes large sensor nodes relying on self-organization and multi hop, water quality of waterworks could be properly identified [10].

### 1.1 Clustering Approaches.

Several academics have started working on a cluster-based data aggregation scheme for reducing wireless sensor network latency and packet loss. Aggregation Tree Construction Phase and Slot Scheduling Algorithm are the two key processes that make up the processing time required for this approach.

The cluster head classifies its collected data into high priority and low priority data in the Slot scheduling method [11]. For effective intra-cluster communication in wireless sensor networks, a secure big data system is given. Here, a multi-hop path selection problem is addressed by a layer approach that is based on the energy density of the cluster. Relay nodes have a secure data transmission infrastructure in place to protect the privacy of the regular nodes. The outcome of this technique showed that EEICS could safely transmit massive amounts of data packets with little energy loss. More data is available with this strategy for upcoming big data applications [12],[13] Presents a thorough methodology that takes into account a number of variables related to the deployment of WSNs. These variables that are taken into account have an impact on real-world application characteristics including sensor dependability, unreliable connection, and imprecise sensor readings.

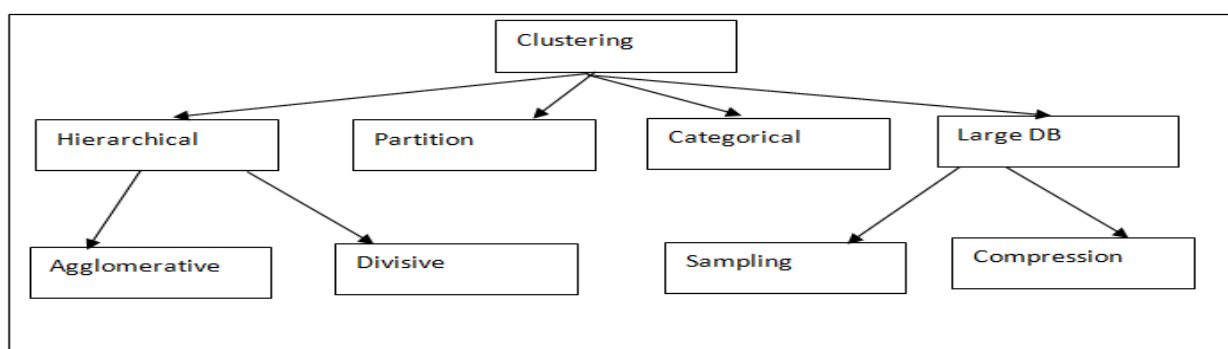


Fig. 1. Clustering Categories.

For WSNs, the RFPT cluster-based routing method is introduced. For LBCP resolution, RFPT uses an fpt-approximation algorithm with an approximation ratio of 1:1 and a temporal complexity of  $2O(M \log M) + O(n)$ , where  $M$  represents the number of gateways and  $n$  denotes the input size. A simulated grid substructure is well-defined in the event that RFPT might be determined practically for WSNs with more than 3000 sensor nodes and 100 gateways [14]. A routing protocol for wireless sensor networks (WSN) called NEAHC is suggested that focuses on increasing energy efficiency and extending network longevity. Cluster heads are chosen based on their low energy consumption, and certain CM nodes with low energy that alternates between active and sleep modes are also nominated [15]. In various WSN settings, the ABCO and LEACH algorithms' performance metrics are observed. This is accomplished by varying the number of rounds ( $r$ ) and sensor nodes ( $n$ ) ( $r_{max}$ ). The number of

packets sent to the base station (BS) every round, the number of living nodes per round, and the number of dead nodes per round are a few of the sophisticated metrics considered in this study [16]. For overcoming the conservation settings in monitoring submissions of wireless sensor networks in subversive coal mines, the ECRPW clustering routing protocol is introduced.

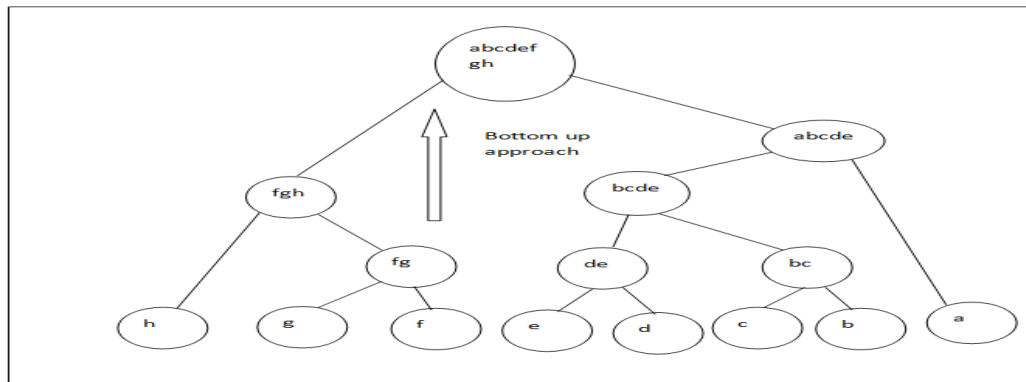


Fig. 2. Clustering Categories.

This protocol operates using the network's standard energy as well as the remaining energy of the nodes. The network lifespan is extended by taking into account the gain of characteristic of different energy in heterogeneous nodes. Additionally, the cluster formation's distance constriction is well specified in order to avoid further energy loss due to electromagnetic wave interference [17].

In a hexagonally clustered wireless sensor network, debility of cluster's inclusive transmission power is addressed. The cluster uses a variety of sub-cluster heads to carry out the fundamental task of sensor data accretion. The majority of nodes send data to a cluster subhead that is closer than the original head [18]. An energy-efficient clustering algorithm has been introduced that extends network lifetime and reduces energy usage [19]. It is based on the K-means algorithm technique. The ideal number of cluster heads based on node density is first computed after investigating the energy consumption of the whole network. The sensor nodes are distributed across many groups by the creative K-means clustering method [20].

## 2. Related Works

### 2.1 Lion Swarm Optimization Approaches

LSO algorithm explores for the most relevant optimized values for the objective function [21]. Maziar Yazdani in 2016 introduced nature-inspired meta-heuristic Lion Optimization Algorithm (LOA). Usually lions hunt all together with other fellows of their pride. In and around the specific solution space LOA procures an actual thought-out approach for clasping the prey and catching it from any extensively produced inhabitants. By constant cooperation of all lionesses they surround the prey from alternate positions and opt to catch the prey in an active manner [22].

A novel congestion management method was proposed in the origin of rearranging stratagem. This particular approach aimed in minimizing the congestion with condensed cost of rescheduling. The ultimate supremacy of the advanced system is examined and evaluated particularly by means of cost analysis. By lowering congestion with the least amount of rescheduling, the proposed rescheduling-based congestion management model Improved Lion Algorithm performs better than the other likely approaches [23].

The way the LSO algorithm is presented may be changed in numerous ways. However, the aim of this study is to compare the performance and reliability of the standard LSO method with other cutting-edge meta-heuristic optimization procedures [24].

The Lion Optimization technique is widely used in Software Defined Networks to enhance the network control systems. Decoupling the control plane from the data plane allows for this to happen. These networks develop greater heterogeneity. This heterogeneity is reported by the many applications running on networks that span both wired and wireless sensor networks with infrastructure. Numerous sensors will be connected in a wireless sensor network based on the applications and transfer appropriate data transmission [25].

The Lion Optimization technique is used to generate an efficient SDN-based routing architecture for WSN. The main goal of this particular research project is to increase network lifespan and QoS while achieving adequate energy efficiency. Cluster creation, route establishment, and effective data transmission are the three main processes that were started in order to achieve the main goal. The sensor nodes were gathered and instructions were written to convey certain sorts of data with the help of the LO algorithm [26].

To elucidate the routing problems of VANETs, recently familiarized Lion Algorithm (LA) [27] is extensively recommended. The LA algorithm is used in this research to address the path selection issues since it has the capacity to control obstacles in vast geographic areas.

Also, the wide-ranging actions of LA are not relevant for managing the routing problem outline [28]. VANETs are a major sub-domain of MANETs which takes proper responsibility in Intelligent Transportation System (ITS) for achieving road security. In VANET domain, several researches have been conducted for attaining enhanced routing process. An optimization approach is adopted in this research study to minimize the routing cost. The method used is Lion algorithm. This research compares the proposed technique with other techniques such as GA and results proved the reliable routing with reduction in cost and complexity [29].

Quite a few operators were anticipated and scientifically exhibited for furnishing the ALO algorithm with high qualitative exploration and exploitation [30]. This research projected the multiple objective limits essential for resolving a vehicle routing problem for VANET. For achieving this, a vehicle routing problem prototypical model had been recommended that primarily depends on the collision, congestion, travel, and QoS cost. The QoS based cost function had been derived by means of the fuzzy inference system. LA has been subjugated for unraveling the routing model. The computational time period is calculated along with the cost and convergence [31]. "ASPBT—adaptive scheduled partitioning and broadcasting technique" is envisioned as a reliable and efficient broadcasting method. This ASPBT is used for trustworthy vehicular data transmission with least delay. In case of pure flooding and unicast and multi-hop transmission, the apportioning systems are more suitable. In VANET, the adopted system is been scheduled for safety correlated performance [32]. With the actions of social activities of lions, a population based meta-heuristic algorithm is presented, Lion optimization algorithm. This algorithm is proficient of producing numerous results. The lion is the strongest creature in the world because it exhibits predictable social behaviors [33].

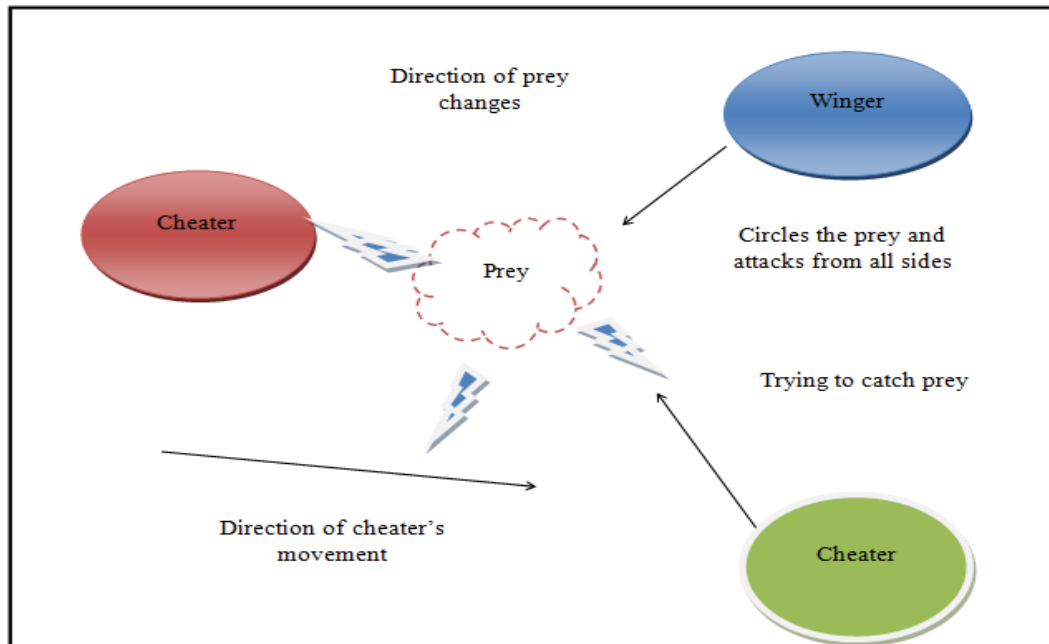


Fig. 3. Lion optimization Approach [33].

## 2.2 Chicken Swarm Optimization Approaches

The bio-inspired meta-heuristic optimization technique known as "chicken swarm optimization" (CSO) is expected to imitate the hierarchical structure of a swarm of chickens and the behaviour of the individual chickens. A chicken swarm's hierarchical organisation is divided into many groups, each of which consists of a single rooster and a large number of hens and chicks [37]. Different rules of signs are observed by each kind of chicken. In the social life of chickens, a hierarchical structure clearly plays a significant role. In a flock, the stronger chickens will control the weaker ones. Both the more dominant hens and roosters that remain close to the head roosters and the more submissive hens and roosters who stay at the outside of the cluster are present [38].

For tracking and solving optimization related problems, meta-heuristic kind of approaches are mainly used. By means of tracking an optimal point or the adjacent optimal solution among the available feasible solutions the meta-heuristic algorithms provides the enriched performance metrics [39]. The bio-inspired algorithms, in which every mathematical model offered for such algorithms is based on any biological evolution phenomena, are major types of meta-heuristic approaches. Grey-Wolf Optimizer (GWO), Chicken Swarm Optimization (CSO), and Crow Search Algorithm are a few of the current algorithms (CSA). While in CSO, the categorised form of order in the chicken swarm is imitated, GWO replicates the hunting behaviour of grey wolves. The Water Wave Optimization technique follows the perception of water wave flow, whereas the CSA adopts the behaviour of the Crow's Process [34].

In industrial viewpoint, several kinds of optimization concerns such as transportation and environment are found to be multidimensional in nature. A multi objective CSO algorithm approach is been introduced by researchers for solving huge optimization related issues inclusive of numerous objective functions. In accordance with the population diversity and convergence a vigorous and multi-objective algorithm is been thought-out [40]. An aggregation function is been suggested for the purpose of defining the social hierarchy within the population of chicken's. The multi-criteria search space has been discovered by adapting chickens' movement. The epsilon-distance has been established [35] in order to successfully achieve the archive population, which calls for the best non-dominated solutions during the exploration phase.

A type of stochastic optimization method is the CSO algorithm. It is primarily based on the hierarchy and search behaviour of a flock of chickens that is further subdivided into many communities. Each chicken in a certain neighbourhood receives a different rating. This community has a variety of mobility laws, and each community competes with the others. The moving rules of CSO are mentioned as follows:

- Flocks are initially divided into many sub-flocks which include roosters, hens and chicks.
- Chickens are gathered and assigned to different levels in the hierarchy based on their individual fitness levels and functional values.
- The "Rooster" is the chicken with the highest level of fitness, while the "Hens" are the other chickens. The Hens randomly choose "chicks" to "parent" before changing into "mother hens."
- The relationships and the hierarchy in the flocks are maintained in the same round and the round is rationalized at definite intervals.
- All of the flock's hens follow their roosters as they look for "meal." Additionally, they defend their own food source from other chickens. Each chicken randomly steals better food from other chickens when it is available, as is assumed [36].

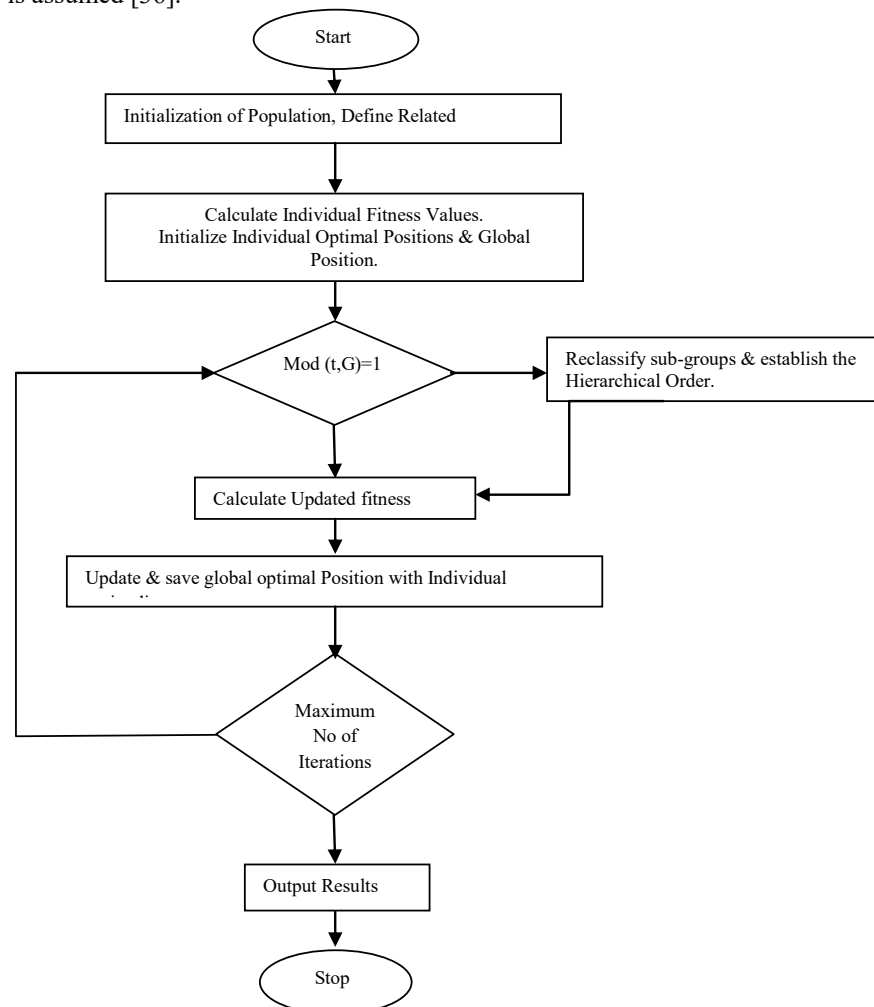


Fig. 4. Flow control of CSO algorithm.

### 3. Overview of the research:

One of the main goals of the project is to develop a wireless sensor network routing model that offers the optimal paths for a source to get to a destination while also being energy efficient to lower the network's energy consumption. Finding an ideal path that may be used in a network with a lot of sensor nodes has been a current difficulty for our network. Additionally, the energy consumption during the transition is quite high, which shortens the network's lifetime. This study established the efficient routing model Lion Swarm Chicken Swarm in PEGASIS based Clustering Approach (PEGA-LSCS), which offers the best route while conserving the network's energy. The optimal path is chosen by using Lion Swarm Optimization (LSO). As so to reduce the energy consumption of the network the Enhanced Clustering Approach is initiated using Chicken Swarm Optimization (CSO).

Our idea is sub-divided into two main sections. They are optimal path selection using LSO algorithm and Cluster head selection using CSO algorithm. While sending the data from source to destination multiple paths are present. Using LSO algorithm the optimal path is selected using three sections which are path creation, trust calculation and shortest path selection. On the other side Cluster Head (CH) selection is done using LSO algorithm which consists of three sections those are CH selection, cluster formation and data aggregation. The detailed analysis is given in the following sub sections.

#### 3.1 Optimal Path Selection Using LSO Algorithm:

##### 3.1.1 Path Selection:

Path selection is the initial stage of the work and it is modeled using the basic AODV routing protocol which generates the entire possible path from the source to the destination using flooding concept. AODV protocol consists of four steps for data transmission. They are hello message, error message, route request (RREQ), and route reply (RREP). All nodes will first use RREQ to make requests to every other node within that coverage region. Secondly the nodes which are present in that coverage area will receive the request and send a reply using the RREP. Path loss during the transmission is monitored by the error message. Finally hello message is to locate the address of the node localization at the earlier stage of the network formation. These are the process which is involved in the AODV protocol for path finding between the senders to receiver.

##### 3.1.2 Trust Calculation:

Trust value of the node is calculated using the following parameters namely location of the node, energy utilization, rate of data received and its throughput. The core parameter among those is energy utilization. The node which has more energy is preferred for path because if the node with less energy is selected as the path then there is a possibility for link failure. Which leads to increase the network delay and congestion? Hence the energy is considered as a primary trust parameter.

Next we considered rate of data received as trust parameter which is the rate of sending and receiving data of each node. If the amount of data sent is equal to the amount of data received then that node is a trust node. When the path consists of more number of such reliable nodes then the path is considered for optimal route. Finally network throughput is considered. Node which is selected in all this parameters and in which path those reliable nodes present in large number that path is selected as a shortest path to send the data. By using all these parameters the shortest path is chosen and these parameters are only used for shortest path selected. When the path is chosen the transmission begins. The process of trust calculation is detailed below.

The spiritual energy is introduced in the calculation of energy parameter. The node energy values are categorized into 5 different sections which are node with nil energy, quarter loaded, half loaded, and three by fourth loaded and fully loaded. Their values are given in the table 1.

Sl.No	EnergyValues	Node Categories.
1	0	Nil Spiritual Energy.
2	0.25	Quarter Spiritual Energy
3	0.5	Half Spiritual Energy
4	0.75	Three by fourth Spiritual Energy.
5	1	Full Spiritual Energy

Table. 1. Spiritual Energy Categories.

The node residual energy ranges from 0 to 1. The node which consists of fully filled energy is denoted as the value 1 and nil energy is denoted as 0. And the intermediate positions are quarter, half and three by fourth loaded.

Similarly for the next parameter rate of packets received, the number of packet sent and the number of packet received are calculated. As well as, if the node forwards each and every incoming packet subsequently that node is considered trusted. According to the percentage of received messages the malicious activities are determined. The node which consist of half of received ratio then the node is malicious one. The values are detailed in the Table 2.

Sl.No	Energy Values	Node Categories.
1	0	R=0
2	0.25	R=S/4
3	0.5	R=S/2
4	0.75	R=3S/4
5	1	R=S

Table. 2. Categories for rate of packet received

Based on the data transmission the values and the node category are defined. The values are in between 0 to 1 which shows the behavior of the node. The node with more received rate is chosen as the reliable node. Finally the node throughput is taken into the account. Network throughput is represented as the queue length of the node. It is described as being the sum of the packets in the queue and the nodes along the route. The evaluation is explained in the formula which is given below.

$$TH = \frac{D_T}{CN_p} \quad (1)$$

Where  $D_T$  is the total number of data in the queue and  $CN_p$  is the total count of nodes in the path. By the way, TH is the throughput value calculation of the network. Then the normalization of the network is calculated as follows.

$$N = \frac{(TH - p_l) * (n_u - n_l)}{(p_m - p_l)} \quad (2)$$

From the above derivation,  $p_l$  and  $p_m$  are considered as the least and most values from the previously defined values which are in the ranges from 0 to 5. The values of  $n_u$  and  $n_l$  are considered as the upper bound and lower bound limits of the normalization values which are in the ranges from 0 to 1. At the end the values of all the trust parameters are added together. And the paths which consist of highest trust value nodes are considered as the optimal path. The final trust parameter is calculated by using this following equation.

$$T_p = \sum_{i=1}^N \frac{SE + RPR + TH}{3} \quad (3)$$

Hence using the equation (3) the trust values of the nodes are calculated. Here SE, RPR and TH stands for spiritual energy, rate of packets received and network throughput. In addition to that N is represented as the transmission path node counts. After this calculation of trust values those values are applied to the LSO algorithm in order to calculate the hop counts which lead to find the optimal path for data transmission from source to the destination.

### 3.2 Optimal Path Finding.

There are N potential pathways in the network that may be used to transport data from source to destination. The best route from among those is chosen using the LSO algorithm. One bio-inspired programme uses lions' operating principles in order to function. The lions live communal lives and are collectively referred to as a pride. Both resident and migratory lions are included in this division. Typically, a pride consists of six to seven lions, including adults and pups. The baby lions will eventually mature into adults, at which point they will separate from the pride and become nomadic lions.

To keep the adult lions in the pride under control, some of the young nomadic lions will try to attack them. Lion numbers, which include both prides and migratory lions, are calculated in the algorithm's main part. The lions are divided into groups based on gender ratio, with lionesses focusing mostly on hunting. By controlling the nomadic lions using a fitness function, our programme tries to locate the optimum route. Only lions with the highest fitness function values are permitted to remain in the pride, while the others separate. If any migratory lions are around and in top physical condition, they can bond with the nearby pride. Iterations of this technique are carried out till the ideal conclusion is reached. The fitness function is calculated using the following equation.

$$F_f = \sum_{i=1}^N \frac{(T_{p1}, T_{p2}, \dots, T_{pN})}{N} \quad (4)$$

The fitness function is calculated using equation (4), and the LSO method is used to determine the best network path for each transmission. It is possible to increase network lifetime and dependability by determining the best route.

### 3.2.1 Path Selection Algorithm:

Input -> possible paths from sender to the receiver

Output -> optimal path choosing

Begin

For each resident lions

Do

Lioness selection → it hunts in the random manner;

Calculate the fitness function of lions using equation (4);

Arrange the fitness function in ascending order;

Neglect the lions which have minimum fitness function;

End do;

End for;

For each nomadic lion

Do

Lioness selection;

Fitness function calculation;

Sorting the values;

Neglect the non eligible values;

End do;

End for;

Compute  $F_f$ ;

If ( $F_f$  (nomadic lions) <  $F_f$  (resident lions))

The pride accepts the lion;

Remove the lion with low  $F_f$ ;

Compare the possibilities and do necessary swapping;

Save the optimal route;

End if;

End for;

End;

This process is used to find the optimal path from all possible path in the network and this method helps to find the best route compared to other shortest path algorithms. The major advantages in sending the data in the best path are that it leads to increase the network reliability and energy efficiency.

### 3.3 Chicken Swarm Algorithm (CSA) based clustering approach:

By the backing of chicken swarm algorithm (CSA) we designed a clustering approach in order to improve the network energy efficiency by reducing the power used in the network. In CSA model we introduced binary representation model. The binary value '0' represents the node without CH as well as '1' represents the node with CH. For the transformation of real value to the binary value in the algorithm we used sigmoid function to transform the real value of each chicken to binary value. The mathematical representation of transformation is given below.

$$b(x) = \begin{cases} 1, & \text{if } \text{sigmf}(x) \\ 0, & \text{otherwise} \end{cases} \quad (5)$$

Where,  $\text{sigmf}(x) = \frac{1}{1 + e^{-x}}$  is known as the sigmoid function.

#### 3.3.1 CSA Algorithm.

The CSA algorithm is a three segmental model that includes Selection of CH, Formation of CH and aggregation of data. All these segments are detailed below.

##### 1) Selection of CH:

This section consists of three parts which are initialization, choosing and results. In the network the Base Station (BS) is responsible for this process and it is briefly explained in algorithm 2.

A) Initialization: The core contribution of this process are parameter selection, measure the CH (M) counts and selecting other supporting parameters of CSA. The primary CSA parameters are population count



(popCount), roosters count ( $R_c$ ), hens count ( $H_c$ ), chicks count ( $C_c$ ), Updated network frequency ( $F$ ) and the iteration count ( $I_{count}$ ).

- B) Choosing: In this process, the group of nodes which consists of CH and consumes very low energy for transmission is chosen using CSA algorithm.

Step 1 – Population matrix  $P$  is initiated.

Step 2 – In the  $P$  matrix each row values are calculated for the fitness function.

Step 3 – Sort the fitness function in the descending order.

Step 4 – Based on the fitness function the population matrix  $P$  is sub-divided into three groups (rooster, hens and chicks).

Step 5 – Fitness function updating for population matrix.

Step 6 – Transformation of the population matrix to its binary form using the **Equation (5)**.

- o Fix the infeasible problems which are the absence of CHs ( $M$ ).
- o For each individual's the ones count is compared with the  $M$  values, according to the output it arbitrarily selects or rejects the items which maintain  $M$  items with ones.

Step 7- Evaluate the fitness function on each row in the population matrix  $P$  in order to find the best solution bestP.

Step 8 – The process from step 2 to 7 are repeated until reaching the best iteration count  $I_{count}$ .

- C) Results: At last the results of CH are provided in the binary form which includes the position of nodes and a CH.

## 2) Formation of CH:

Some group of nodes ( $G$ ) is chosen to work as CHs which are determined by BS, it sends message to each and every node in the group ( $G$ ) to become a CH. All the nodes will receive the message and the eligible candidate will send a reply message. And some nodes which did not belong to the group but till received the message since those nodes are also having low communication costs they sends message to join the group. The nodes that are present in that communication coverage region are finally selected as the CH, and they will then become the Child Nodes (CN) of that CH.

## 3) Aggregation of Data:

At this point, every CN node will transmit data to the CH throughout the allotted predetermined time period. Additional data, such as the node ID and details on the leftover energy are included in the broadcast packets. The network will be able to recognise the details of the following round and the location with the use of this information. Once the CH has received the data from the child node, the BS will get it.

## 4. Simulation parameters:

For the simulation evaluation purpose of our research work we are going for network simulation 2 (NS2). NS2 is basically a discrete event simulator mainly developed for networking oriented research works. This simulator supports for the analysis of TCP, routing and multicast protocols for both wired and wireless communication. Network simulation 2 structural designs are object oriented and it is the combination of C++ and Otc languages. By the use of this simulator the scalability of the network is improvised [41]. NS2 is operated in UNIX platform for multitasking, multi-user computer operating systems as well as virtually supports windows. For network construction we used ns2 allinone version 2.34. It has the predefined functions to store load details as well as the outputs are generated using trace files and NAM (Network Animator) file. Trace file is used to calculate all the numerical values and the NAM file is used to visualize the network. And other supporting output languages are AWK files and Perl files.

Energy efficiency, packet loss, energy consumption, routing overhead, packet delivery ratio, end-to-end latency, and network throughput are the main variables considered in this research. Additionally, the PEGA-GA, PEGA-ACO, and PEGA-ACOGA procedures are compared to our suggested technique. The essential concept of these older protocols, which are reactive routing protocols that use both single hop and multi hop broadcasts in the network, is based on the AODV protocol (Adhoc On-demand Vector Routing) protocol. In Table 1, the values of the main simulation parameters are discussed.

Parameters	Values
Simulator	NS-2.34
Simulation Period	100ms
Coverage Area	1000*1000
No of Nodes	100
Standard	IEEE 802.11
Propagation Model	Two Ray Propagation Model
Antenna	Omni-directional Antenna
Traffic Type	FTP/CBR
Traffic rate	0.01 sec to 0.50 sec
Agent Type	TCP/UDP
Routing Protocol	AODV
Initial power	100 J
Idle Power	0.1 J
Queue Type	Drop-Tail

Table. 3. Simulation parameters details for CEO-MAC protocol.

#### 4.1 Calculation of Energy Efficiency of the Network Vs Number of Nodes

Number of Nodes	PEGASIS-GA	PEGASIS -ACO	PEGA-ACOGA	PEGA-LSCS
0	0	0	0	0
20	9	11	14	18
40	15	17	23	27
60	23	28	33	42
80	35	38	42	51
100	44	49	56	68

Table. 4. Energy efficiency Values.

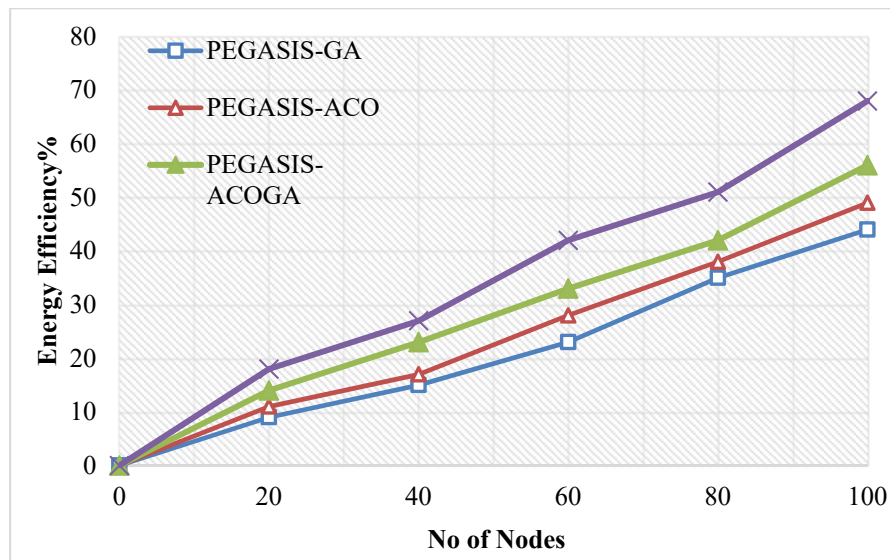


Fig. 5. Energy Efficiency Calculation.

The table shows the values for the parameter of energy efficiency. The results are calculated and it is compared with the earlier methods PEGASIS-GA, PEGASIS-ACO, PEGASIS-ACOGA. From the graph it's showed clearly. The number of nodes is shown on the x-axis in this graph, while the network's energy efficiency is shown on the y-axis. 100 nodes are used to run this simulation. PEGASIS-LSCS has an energy efficiency study of 68 percent. Additionally, our previous model PEGASIS-ACOGA generates 56%. While the figures for the current

protocols are shown above, PEGASIS-GA yields 44% and PEGASIS-ACO produces 49%. When compared to other current protocols, simulation results indicate that the PEGASIS-LSCS protocol performs better.

#### 4.2 Calculation of Energy consumption of the Network Vs Number of Nodes

Number of Nodes	PEGASIS-GA	PEGASIS-ACO	PEGA-ACOGA	PEGA-LSCS
0	0	0	0	0
20	9	10	5	3
40	17	15	12	9
60	24	23	21	18
80	38	35	32	21
100	56	52	44	32

Table 5 – Energy Consumption Values

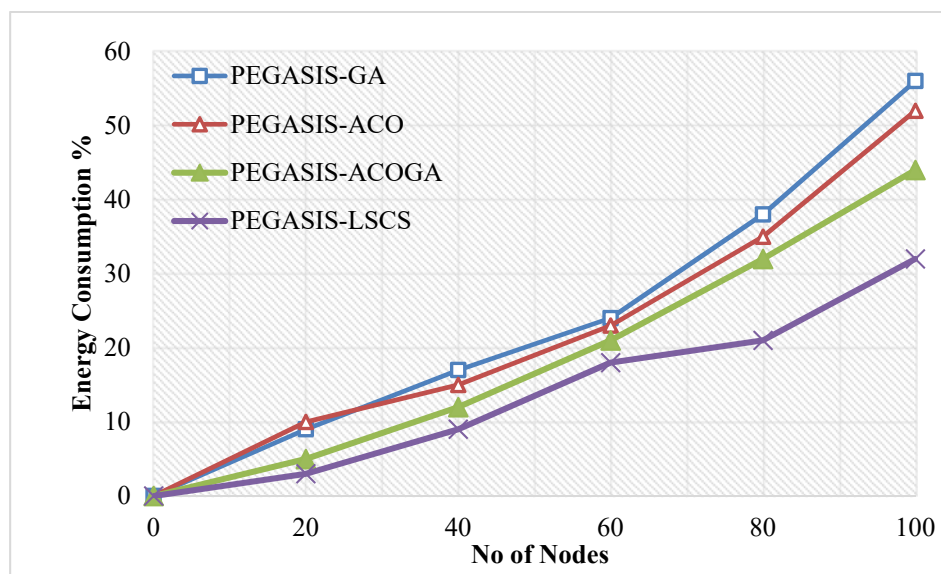


Fig. 6. Energy Consumption Calculation.

The table shows the values for the parameter of energy consumption calculation of the network at the end of the simulation. The results are calculated and it is compared with the earlier methods PEGASIS-GA, PEGASIS-ACO and PEGASIS-ACOGA. From the graph it's showed clearly. The number of nodes is shown on the x-axis in this graph, while the network's energy use is shown on the y-axis. The PEGASIS-LSCS energy usage analysis is 32%. And 44% comes from our prior study, PEGASIS-ACOGA. The figures for the older protocols are shown here, while PEGASIS-GA yields 56% and PEGASIS-ACO produces 52%. Analysis of the data reveals that the suggested procedure uses little energy during transmission.

#### 4.3 Calculation of Packet Loss of the Network Vs Number of Nodes

Number of Nodes	PEGASIS-GA	PEGASIS-ACO	PEGA-ACOGA	PEGA-LSCS
0	0	0	0	0
20	25	21	9	6
40	48	45	15	11
60	65	60	29	18
80	85	75	42	27
100	106	89	50	36

Table. 6. Packet Loss Values.

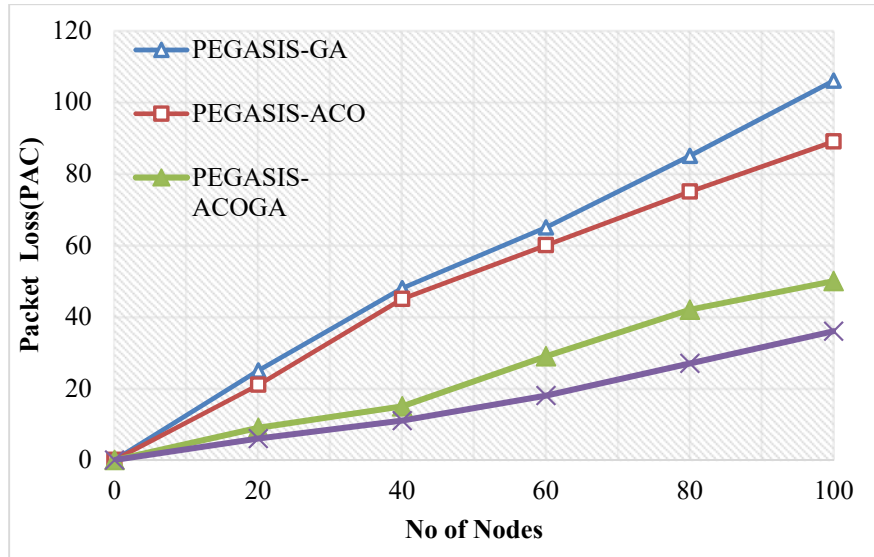


Fig.7. Packet Loss Calculation.

The values for the network's parameter used to calculate packet loss at the conclusion of the simulation are displayed in the table. Calculated findings are compared to those obtained using the prior techniques PEGASIS-GA and PEGASIS-ACO. The graph makes it quite apparent. The number of nodes is shown on the x-axis in this graph, while the number of packets lost in the network is shown on the y-axis. 100 nodes are used to run this simulation. The PEGASIS-ACOGA packet loss study covers 50 packets. PEGASIS yields 243 packets, PEGASIS-GA produces 106 packets, and PEGASIS-ACO produces 89 packets, compared to the numbers for the older protocols listed above. When compared to the current methodologies, analysis shows that the suggested model yields reduced packet loss.

#### 4.4 Calculation of Routing Overhead of the Network Vs Number of Nodes

Number of Nodes	PEGASIS-GA	PEGASIS-ACO	PEGA-ACOGA	PEGA-LSCS
0	0	0	0	0
20	164	149	88	62
40	287	271	195	134
60	321	297	245	189
80	485	453	312	267
100	562	532	382	323

Table. 7. Routing Overhead Values.

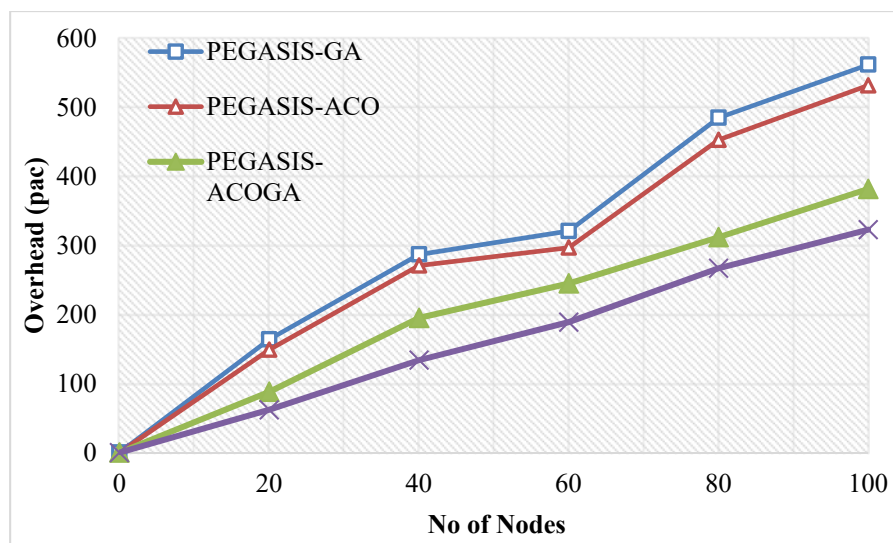


Fig. 8. Routing Overhead Calculation.

The table shows the values for the parameter of routing overhead calculation. The results are calculated and it is compared with the earlier methods PEGASIS, PEGASIS-GA and PEGASIS-ACO. The number of nodes is shown on the x-axis in this graph, while the network overhead (packets) is shown on the y-axis. 323 packets make up the PEGASIS-LSCS overhead study. And PEGA-ACOGA, our earlier effort, contains 382 packets. While the figures for the older protocols are shown below, PEGASIS-GA and PEGASIS-ACO each yield 562 and 532 packets, respectively. Analyzing it demonstrates that the suggested model has a reduced overhead when compared to the current approaches.

#### 4.5 Calculation of Packet Delivery Ratio of the Network Vs Number of Nodes.

Number of Nodes	PEGASIS-GA	PEGASIS-ACO	PEGA-ACOGA	PEGA-LSCS
0	0	0	0	0
20	22	24	28	34
40	34	37	41	48
60	48	51	54	63
80	71	73	78	83
100	86.33	89.762	95.87	97.583

Table. 8. Packet Delivery Ratio Values.

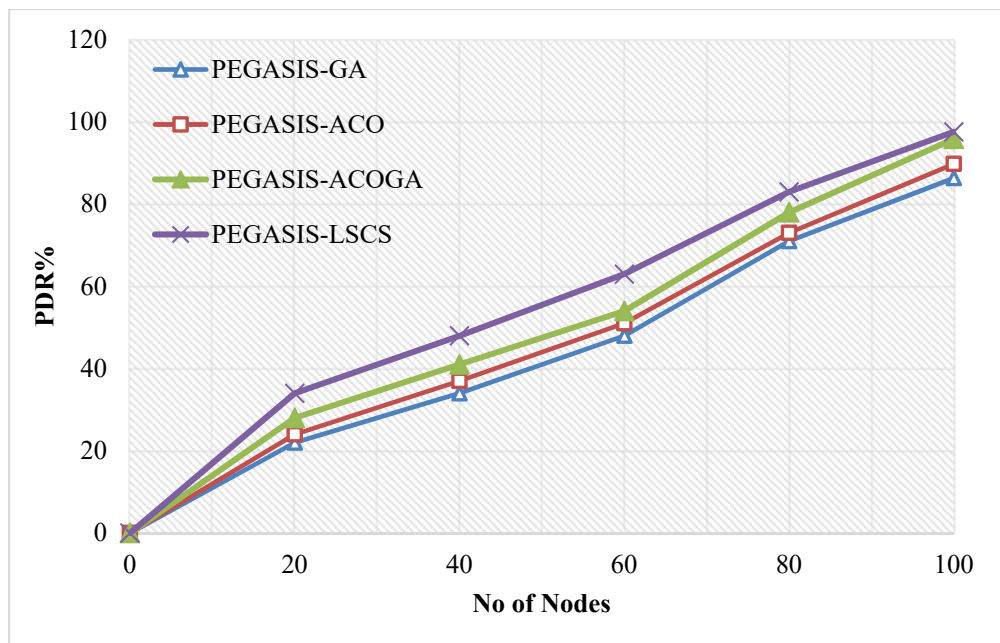


Fig. 9. Packet Delivery Ratio Calculation

The values for the parameter used to calculate the packet delivery ratio are displayed in the table. Calculated findings are compared to those of the prior techniques, PEGASIS-GA, PEGASIS-ACO, and PEGASIS-ACOGA. The number of nodes is shown on the x-axis in this graph, while the network's packet delivery ratio is shown on the y-axis. The PEGASIS-LSCS packet delivery ratio analysis is 97.583 percent. And 95.87 percent is what our older technique, PEGASIS-ACOGA, offers. The figures for the previous protocols are shown below, although PEGASIS-GA and PEGASIS-ACO both generate higher percentages. When compared to the current methodologies, analysis shows that the suggested model generates high packet delivery ratios.



#### 4.6 Calculation of End to End Delay of the Network Vs Number of Nodes.

Number of Nodes	PEGASIS-GA	PEGASIS-ACO	PEGA-ACOGA	PEGA-LSCS
0	0	0	0	0
20	19	17	5	3
40	32	29	9	9
60	48	41	12	11
80	69	61	16	14
100	87.437	75.734	20.912	18.535

Table. 9. End to End Delay Values.

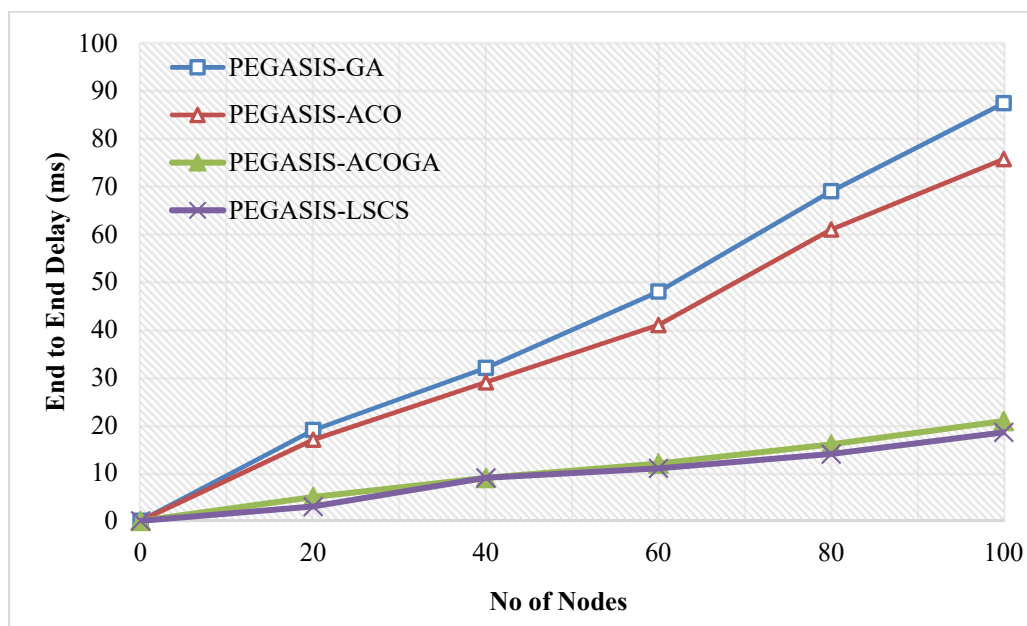


Fig. 10. End to End Delay Calculation.

The values for the End to End Delay calculation parameter are displayed in the table. Calculated findings are compared to those of the prior techniques, PEGASIS-GA, PEGASIS-ACO, and PEGASIS-ACOGA. The number of nodes is shown on the x-axis in this graph, while the network's end-to-end latency is shown on the y-axis in ms. End to end delay analysis of PEGASIS-LSCS is 18.535ms. The output of our prior study PEGASIS-ACOGA is 20.912. While the figures for the older protocols are listed here, PEGASIS-GA and PEGASIS-ACO also produce times that are longer than these values. Analysis shows that, when compared to the current approaches, the suggested model yields reduced end-to-end latency.

#### 4.7 Calculation of Throughput of the Network Vs Number of Nodes.

Number of Nodes	PEGASIS-GA	PEGASIS-ACO	PEGA-ACOGA	PEGA-LSCS
0	0	0	0	0
20	75	81	95	124
40	91	105	154	187
60	157	169	217	249
80	198	217	248	387
100	243.864	267.893	320.355	521.89

Table. 10 . Throughput Values.

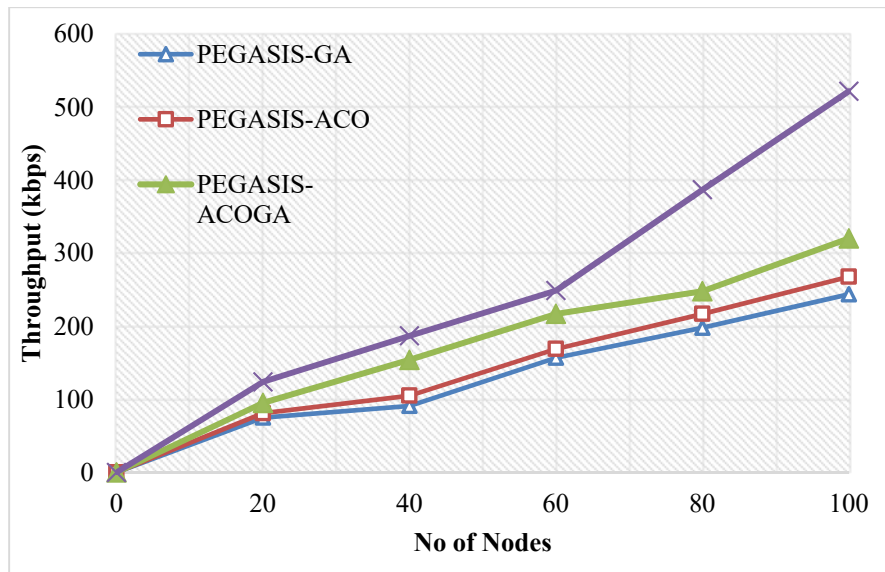


Fig. 11. Network Throughput Calculation.

The values for the parameter used to calculate network throughput are displayed in the table. Calculated findings are compared to those of the prior techniques, PEGASIS-GA, PEGASIS-ACO, and PEGASIS-ACOGA. The number of nodes is shown on the x-axis in this graph, while the network throughput is shown on the y-axis in kbps. The PEGASIS-LSCS throughput analysis is 521.89 kbps. Our previous model, PEGASIS-ACOGA, had a bitrate of 320.355 kbps. The figures for the previous protocols are shown below, although PEGASIS-GA and PEGASIS-ACO both output data at speeds of 243.864 and 267.893 kbps, respectively. After analysis, it is demonstrated that the suggested model outperforms the standard techniques in terms of throughput.

## 5. Conclusion:

This work introduced the PEGASIS-LSCS optimization protocol in an effort to increase the network's energy efficiency and lifespan. To increase the network's energy efficiency more effectively, the clustering model is paired with the chicken swarm optimization technique. On the opposing side, the network's ideal route is found through lion swarm optimization. Optimal path selection is also started to decrease network latency, which also helps to reduce energy consumption in a better way. Our focus is primarily to improve the lifetime of the network by lowering energy consumption in the network. In comparison to PEGASIS-GA, PEGASIS-ACO, and PEGASIS-ACOGA, the findings demonstrate that our PEGASIS-LSCS extends the network lifespan.

## CONFLICTS OF INTEREST

The authors declare that they have no known competing financial interests or personal relationships that could have appeared to influence the work reported in this paper.

## REFERENCES

- [1] Sharma, N.; Gupta, V. (2020): Meta-heuristic based optimization of WSNs Localisation Problem-a Survey, *Procedia Computer Science*, 173, pp. 36-45.
- [2] Hashish, S.; Tawalbeh, H. (2017): Quality of service requirements and challenges in generic WSN infrastructures, *Procedia Computer Science*, 109, pp. 1116-1121.
- [3] Alagarsamy, V.; Ranjan, P.V. (2019): Multi-Cluster Multi-Channel Scheduling (Mms) Algorithm for Maximum Data Collection with Delay Minimization in WSN, *International Journal of Computer Networks & Communications (IJCNC)*, Vol 11, No. 6, pp. 91-110.
- [4] Ravikiran, D.N.; Deth, C.G. (2018): Improvements in Routing Algorithms to Enhance Lifetime of Wireless Sensor Networks, *International Journal of Computer Networks & Communications (IJCNC)*, Vol. 10, No. 2, pp. 23-32.
- [5] El Assari, Y. (2020): Energy-efficient multi-hop routing with unequal clustering approach for wireless sensor networks, *International Journal of Computer Networks & Communications (IJCNC)*, Vol. 12, No. 3, pp. 55-73.
- [6] Rawat, P.; Singh, K. D.; Chaouchi, H.; Bonnini, J. M. (2014): Wireless sensor networks: a survey on recent developments and potential synergies. *The Journal of supercomputing*, 68(1), pp. 1-48.
- [7] Sharma, N.; Bhatt, R. (2018): Privacy preservation in WSN for healthcare application. *Procedia computer science*, 132, pp. 1243-1252.
- [8] Hloupisa, G.; Stavarakas, I.; Moutzouris, K.; Alexandridis, A.; Triantis, D. (2011): WSN open source development platform: application to green learning, *Procedia Engineering*, 25, pp. 1049-1052.
- [9] Rowaihy, H.; BinSahaq, A. (2016): Performance of GPSR and AOMDV in WSNs with Uncontrolled Mobility. *Procedia Computer Science*, 98, pp. 48-55.
- [10] Cano, C.; Bellalta, B.; Sfairpoulou, A.; Oliver, M. (2011): Low energy operation in WSNs: A survey of preamble sampling MAC protocols, *Computer Networks*, 55(15), pp. 3351-3363.
- [11] Cinar, H.; Cibuk, M.; Erturk, I. (2019): HMCASN: A hybrid multi-channel allocation method for erratic delay constraint WSN applications. *Computer Standards & Interfaces*, 65, pp. 92-102.

- [12] Lepage, F.; Docquier, T.; Lecuire, V.; Georges, J. P. (2018): TOMAC-WSN: A new WSN efficient protocol for monitoring big distributed mechanical systems. *IFAC-PapersOnLine*, 51(10), pp. 52-57.
- [13] Sheng, J.; Weixing, W.; Jieping, Y.; Zhongqiang, H. (2018): Design a WSN system for monitoring the safety of drinking water quality, *IFAC-PapersOnLine*, 51(17), pp. 752-757.
- [14] Devi, V. S.; Ravi, T.; Priya, S. B. (2020): Cluster Based Data Aggregation Scheme for Latency and Packet Loss Reduction in WSN, *Computer Communications*, 149, pp. 36-43.
- [15] Wang, A.; Shen, J.; Vijayakumar, P.; Zhu, Y.; Tian, L. (2019): Secure big data communication for energy efficient intra-cluster in WSNs, *Information Sciences*, 505, pp. 586-599.
- [16] Senouci, M. R.; Mellouk, A. (2019): A robust uncertainty-aware cluster-based deployment approach for WSNs: Coverage, connectivity, and lifespan. *Journal of Network and Computer Applications*, 146, pp. 102414.
- [17] Yarinezhad, R.; Hashemi, S. N. (2019): Solving the load balanced clustering and routing problems in WSNs with an fpt-approximation algorithm and a grid structure, *Pervasive and Mobile Computing*, 58, pp. 101033.
- [18] Yangrui Ke, W.; Hong, O.; Heli, J., Z.; Xi, L. (2016): Energy aware hierarchical cluster-based routing protocol for WSNs, *The Journal of China Universities of Posts and Telecommunications*, 23(4), pp. 46-52.
- [19] Gambhir, A.; Payal, A.; Arya, R. (2018): Performance analysis of artificial bee colony optimization based clustering protocol in various scenarios of WSN, *Procedia computer science*, 132, pp. 183-188.
- [20] Sun, Y.; He, Y.; Zhang, B.; Liu, X. (2011): An energy efficiency clustering routing protocol for WSNs in confined area, *Mining Science and Technology (China)*, 21(6), pp. 845-850.
- [21] Wang, D.; Lin, L.; Xu, L. (2011): A study of subdividing hexagon-clustered WSN for power saving: Analysis and simulation, *Ad Hoc Networks*, 9(7), pp. 1302-1311.
- [22] El Khediri, S.; Fakhri, W.; Moulahi, T.; Khan, R.; Thaljaoui, A.; Kachouri, A. (2020): Improved node localization using K-means clustering for Wireless Sensor Networks, *Computer Science Review*, 37, pp. 100284.
- [23] Peng, W.; Li, C.; Zhang, G.; Yi, J. (2020): Interval type-2 fuzzy logic based transmission power allocation strategy for lifetime maximization of WSNs. *Engineering Applications of Artificial Intelligence*, 87, pp. 103269.
- [24] Guo, Y.; Jiang, M. (2020): Power System Optimization Based on Multi-agent Structure and Lion Swarm Optimization, In *Journal of Physics: Conference Series*, IOP Publishing, Vol. 1575, No. 1, pp. 012222.
- [25] Gope, S.; Dawn, S.; Mitra, R.; Goswami, A. K.; Tiwari, P. K., (2019): Transmission congestion relief with integration of photovoltaic power using lion optimization algorithm. In *Soft Computing for Problem Solving*, Springer, Singapore, pp. 327-338.
- [26] Tapre, P. C.; Singh, D. K.; Paraskar, S. R.; Zadagaonkar, A. S. (2018): Implementation of Improved Lion Algorithm for Generator Scheduling in Deregulated Power System using IEEE-30 Bus System, In *2018 International Conference on Smart Electric Drives and Power System (ICSEDPS)*, IEEE, pp. 233-238.
- [27] Liu, J.; Li, D.; Wu, Y.; Liu, D. (2020): Lion swarm optimization algorithm for comparative study with application to optimal dispatch of cascade hydropower stations, *Applied Soft Computing*, 87, pp. 105974.
- [28] Akyildiz, I. F.; et al., (2002) Wireless sensor networks: a survey, *Computer Networks*, vol. 38, pp. 393- 422.
- [29] Ragavan, P. S.; Ramasamy, K., (2020): Software defined networking approach based efficient routing in multihop and relay surveillance using Lion Optimization algorithm, *Computer Communications*, 150, pp. 764-770.
- [30] Masadeh, R.; Mahafzah, B. A.; Sharieh, A. (2019): Sea Lion optimization algorithm. *Sea*, 10(5).
- [31] Rajakumar, B. R., (2012) The Lion's algorithm: a new nature-inspired search algorithm, in: *Second International Conference on Communication, Computing & Security*, pp. 126-135.
- [32] Wagh, M. B.; Gomathi, N. (2018): Route discovery for vehicular ad hoc networks using modified lion algorithm, *Alexandria engineering journal*, 57(4), pp. 3075-3087.
- [33] Mirjalili, S. (2015). The ant lion optimizer. *Advances in engineering software*, 83, pp. 80-98.
- [34] Wagh, M. B.; Gomathi, N. (2019): Optimal route selection for vehicular adhoc networks using lion algorithm, *Journal of Engineering Research*, 7(3).
- [35] Ramakrishnan B; Selvi M, (2015): Prioritized and secured data dissemination technique in VANET based on optimal blowfish algorithm and signcrypton method, *Int J Comput Netw Appl* 2(4), pp. 165-172
- [36] Selvi, M.; Ramakrishnan, B., (2020): Lion optimization algorithm (LOA)-based reliable emergency message broadcasting system in VANET, *Soft Computing*, 24(14), pp. 10415-10432.
- [37] Fouad, M. M.; Hafez, A. I.; Hassanien, A. E., (2019): Optimizing topologies in wireless sensor networks: A comparative analysis between the Grey Wolves and the Chicken Swarm Optimization algorithms, *Computer Networks*, 163, pp. 106882.
- [38] Zouache, D.; Arby, Y. O.; Nouioua, F.; Abdelaziz, F. B., (2019): Multi-objective chicken swarm optimization: A novel algorithm for solving multi-objective optimization problems, *Computers & Industrial Engineering*, 129, pp. 377-391.
- [39] Yu, X.; Zhou, L.; Li, X. (2019): A novel hybrid localization scheme for deep mine based on wheel graph and chicken swarm optimization, *Computer Networks*, 154, pp. 73-78.
- [40] Hafez, A. I.; Zawbaa, H. M.; Emary, E.; Mahmoud, H. A.; Hassanien, A. E., (2015): An innovative approach for feature selection based on chicken swarm optimization., In *2015 7th international conference of soft computing and pattern recognition (SoCPar)*, IEEE, pp. 19-24.
- [41] Moldovan, D.; Chifu, V.; Pop, C.; Cioara, T.; Anghel, I.; & Salomie, I., (2018)., Chicken swarm optimization and deep learning for manufacturing processes., In *2018 17th RoEduNet conference: networking in education and research (RoEduNet)*, IEEE, pp. 1-6 .
- [42] Qu, C.; Zhao, S. A.; Fu, Y.; He, W. (2017): Chicken swarm optimization based on elite opposition-based learning., *Mathematical Problems in Engineering*, vol. 11, pp. 1-20.
- [43] He, D.; Lu, G.; Yang, Y. (2019): Research on optimization of train energy-saving based on improved chicken swarm optimization., *IEEE Access*, 7, pp. 121675-121684.



## Authors Profile



**Mr. Binaya Kumar Patra** is pursuing his Ph.D in Computer Science Engineering, in Utkal University, Odisha, India. He is currently an Assistant Professor in the Department of CSE&A, IGIT, Sarang, (An Autonomous Institute of Govt. of Odisha) India. His research areas include WSN, IOT, MANET, VANET, AIML.

Education: M.Tech (CSE), Ph.D (Utkal University Continuing)



**Dr. Sarojananda Mishra** is serving as a professor in CSE&A Department of IGIT, Sarang, India. He has guided more than 10 Ph.D.s. He has guided several M.Tech and B.Tech thesis. His current research interest is on Fractals and Graphics, System Dynamics, MIS, Operation Research, Networking, Computer Programming, Soft Computing & Wireless Sensor Network.

Education: MCA (S.U), M.Tech (IIT Delhi), Ph.D (UU).



**Dr. Sanjay Kumar Patra** is serving as a Assistant professor in CSE&A Department of IGIT, Sarang, India. He has guided several M.Tech and B.Tech thesis. His current research interest is on IOT, WSN, Fractal network, AI&ML, Block chain and Data security.

Education: MCA , M.Tech (KIIT), Ph.D (UU).