International Conference on Advances in Materials, Computing and Communication Technologies
In Association with International Journal of Scientific Research in Science and Technology
Volume 9 | Issue 1 | Print ISSN: 2395-6011 | Online ISSN: 2395-602X (www.ijsrst.com)

Data Aggregation Using Squirrel Search Algorithm in Wireless Sensor Networks

K. Panimalar[1], S. Kanmani[2], V.Nithya[3], A.Subalakshmi[3], S.Vishvetha[3]
[1]Research scholar, Department of Computer Science and Engineering, Pondicherry Engineering College, Pondicherry, India
[2]Professor, Department of Information Technology, Pondicherry Engineering College, Pondicherry, India
[3]Department of Information Technology, Pondicherry Engineering College, Pondicherry, India

ABSTRACT
In a wireless sensor network (WSN), individual sensor nodes have limitations such as energy consumption, packet delivery, and delay and network lifetime. Data aggregation is an important method for lowering energy consumption of each sensor nodes in WSN. This helps in achieving increased network lifetime in WSN. Therefore, in order to improve the energy efficiency and lifespan of the network, Cluster-based data aggregation using Squirrel Search Algorithm is proposed in this paper.Cluster Head(CH) selection plays an important role for increasing the network lifetime. Criteria such as energy, distance are taken into consideration for selecting sensor nodes. For Cluster Head (CH) re-Electing, criteria such as its Residual energy and Received Signal Strength (RSS) are taken into consideration. Hence the sensor nodes with best CHs selected. Simulation results conducted in MATLAB shows that the Data Aggregation using Squirrel Search Algorithm (SSA) was able to improve the network lifetime, energy efficiency, delay compared with the Firefly Algorithm (FA) and Shuffled Frog Algorithm (SFA).

Keywords: WSN-Energy Consumption-Network Lifetime-Data Aggregation-Squirrel Search Algorithm

I. INTRODUCTION

to The networks are classified as wired or wireless, with the wired network having a higher level of complexity due to the increased number of connecting wires. As a result, the majority of networks are now wireless. WSNs are a form of network that consists of interconnected sensor nodes that communicate wirelessly to collect data about the environment. The Wireless Sensor Network (WSN) is an infrastructure-free wireless network[1] that uses a large number of wireless sensors to track device, physical, and environmental conditions in an ad-hoc manner. Wireless Sensor Networks (WSNs) are capable of delivering a wide range of services. It provides solution for data collection and transmission efficiency from any location. Tiny wireless sensors can be used to collect information from the physical environment in a variety of situations, ranging from wildfire detection[15] and animal surveillance to agriculture management and industrial monitoring. Micro wireless sensors can be used to gather data from the physical world in a number of circumstances, which led to the development of wireless sensor networks.

There are several types of nodes in a wireless sensor network: The source node/intermediate node collects the required amount of data from the environment in which it is deployed and sends it to another node on its way to the destination node.[13] Another type of node is the sink node, which is essentially a destination node that uses a forwarding node to collect data from the source node/intermediate node. Each sensor sends data to a base station via wireless transmission. Sensors work together to transmit data. As a result, WSNs have a wide variety of uses including air monitoring, remote assistance, health care, wildlife surveillance and so on. WSN uses sensor nodes in combination with an onboard processor to control and track the environment in a given region.

The important features of a WSN include Power consumption constraints for nodes using batteries are adaptability to node failures, Node versatility, Node homogeneity and heterogeneity, Capacity to withstand adverse weather conditions[1] and User-friendliness. The design complexity of a WSN depends on the particular application specifications such as the number of nodes, the power consumption, the life span of the sensors, information to be sensed and its timing, geography of where the sensors are located, the environment, and the context. A sink, also known as a base station, serves as a connection between users and the network. By collecting results from the sink, one can retrieve necessary information from the network. A wireless sensor network usually consists of hundreds of thousands of sensor nodes. Individual nodes in a wireless sensor network (WSN) have limitation[1]such as processing speed, storage space, reduced energy consumption and communication bandwidth. The network lifetime decreases as a result of the low battery power constraint. Clustering is considered as a feasible choice for reducing power consumption and extending network lifespan[10]. Since the wireless sensor network has a limited amount of resources, sensors cannot send data directly to the base station. All regular sensors can send data packets to a cluster head, which combines data from all regular sensors in its cluster which then sends to the base station. Due to the high node density, the same data is sensed by multiple nodes, resulting in redundancy.

It's possible that data transmitted by neighbouring nodes is duplicated and redundant. Furthermore, the amount of data generated by large WSNs can be too much for the sink to handle. As a result, it's essential to use data combination methods in sensor nodes to produce high-quality data while reducing the number and size of transmitted packets. As a result, there is a reduction in the amount of energy and bandwidth used. When routing packets from source nodes to base station, this redundancy can be reduced by using a data aggregation[4] approach. When data from several sensor nodes enters the same routing node on the way back to the sink, it is aggregated as if it were around the same feature of the phenomenon. Data gathering refers to the method of collecting data from a network's source node/intermediate node. Since the gathered data contains redundant information, it wastes bandwidth if it is moved to the sink node in its current state. Furthermore, it increases the nodes' energy intake.

As a result[10], it is necessary to minimize node energy consumption by reducing the number of packets transmitted, thus extending the network lifetime. Data aggregation is the term for this procedure. Therefore in WSNs, data aggregation is an energy-saving technique. The method of gathering and aggregating useful data is known as data aggregation. Data aggregation is one of the most important processing procedures for energy efficiency. Data aggregation is an effective way to conserve limited resources in WSNs. The importance of data aggregation: Data aggregation aids in lowering traffic load and pre-serving capacity, as well as improving network robustness and reducing redundancy. One of the characteristics of a good data aggregation algorithm is that it reduces node energy consumption while also increasing network lifetime.

The main purpose of data aggregation algorithms is to collect and combine data in an energy efficient manner, thus increasing[26] network lifespan. To solve this optimization problems meta-heuristic algorithm such as Nature inspired algorithm is used. Meta-heuristics are a popular way to use trial and error to come up with suitable solutions to a complicated problem in a reasonable amount of time. Because of the complexity of a problem, it is difficult to find any possible solution or combination; the aim is to find good and feasible solutions in a reasonable period of time. For the solution of global optimization problems, there have been numerous algorithms created. A vital role is played by the nature inspired algorithm. [3]To develop stochastic optimization algorithms, the majority of nature inspired optimization algorithms simulate the group behaviour of certain species in nature. In this paper, data aggregation approach based on the Squirrel Search Algorithm (SSA). This approach avoids transmitting additional and redundant packets in the network, improving efficiency and network lifetime.

II. RELATED WORK

For Wireless Sensor Networks, Saleem et al [1] proposed a biologically inspired self-optimized routing mechanism. The delay, energy, and velocity models are used to create this mechanism. This model introduces a very energy- efficient solution while also taking velocity under consideration. This velocity parameter will also keep maintaining real-time applications .An additional factor that influences the best decision is the reinforcement learning (RL) technique. Finally, the throughput rate of this autonomic routing mechanism will improve. The author also designed and worked on an ant-based autonomous routing method for wireless sensor networks, which is presented in this paper. When making a decision, certain factors such as energy level, link quality, and velocity are taken into account. These choices will determine the most efficient way to send data to its final destination. The given bio-inspired self-optimizing mechanism will increase traffic throughput while decreasing network end-to-end delay. Breza et al [2] presented one example algorithm that used this knowledge to manage multiple managerial parameters efficiently. After that, simulations were used to test the algorithm (a standard practice for the field). However, when they put the algorithm to the test on real devices, they got some unexpected results.

They discuss the phenomenon and speculate on one is an existing protocol known as DIR or compass routing protocol, and the other is a new proposal called BeeRP- (BeeRoutingProtocol) that was inspired by bee communication. The results of this study show that both algorithms are similar, with the same fundamental principle of routing based on direction to the destination, but their tools are different. Possible causes, with the goal of demonstrating that current WSN bio-inspired research simulations are only marginally useful in the real world. Through a case study of two algorithms, Aksa et al [3] attempted to compare geometric field and bio-inspired system. One is an existing protocol known as DIR or compass routing protocol, and the other is a new proposal called BeeRP-(BeeRoutingProtocol) that was inspired by bee communication. The results of this study show that both algorithms are similar, with the same fundamental principle of routing based on direction to the destination, but their tools are different.In

WSNs [4], data aggregation is essential, and sensing data is coordinated in space and time by stationing sensor nodes in a specific region. As a result, the nodes accumulate data of a smaller scale, and several analysis methods have been developed to measure distinct data aggregation proportions. The data packets are sent to nodes, nodes never receive any data during the data transmission process. Various converge-cast algorithms have been developed for WSNs (wireless sensor networks) [5,6]. Data magnitude of packets is escalated during data transmission from source to sink node with uninterrupted data aggregation flow. Aggregation of multiple packets is needed to reduce the number of data packets.Reference [7] applied particle swarm optimization to group the sensors into clusters, with each particle representing a line. The clusters were considered in the proposed decoding procedure as the product of the intersection of the lines. LEACH [8] is commonly used cluster-based routing algorithm. It uses clustering to spread the energy load equally among the sensor nodes using a randomization approach [9]. The LEACH protocol is divided into four stages.

The first step involves calculating the residual energy and the number of neighbour nodes before votig for cluster heads. In the second step, the chosen cluster head broadcasts its knowledge to other neighbour nodes, allowing them to join its cluster. When nodes receive information, they join the cluster as cluster members based on the received signal power. To avoid conflicts caused by overlapped transmission, the cluster head makes a decision and notifies its member nodes by the third step. As a result, the cluster members relay data in the appropriate time slots on a regular basis. Finally, the cluster head's aggregated data is sent to the sink node in a single hop. The cluster head expends more energy during aggregation and forwarding data to the sink node, as seen in the preceding phase. In that case, nodes will fail and the network's lifespan will be shortened. A periodic cluster heads voting framework was implemented in this method to increase overall efficiency and avoid energy consumption imbalances. It's done by measuring the node's residual energy at each round. Further, it is compared to a fixed threshold to manage the aggregation and forwarding process; if it is less than that, a new cluster head is picked, causing a disturbance in the energy consumption of all nodes. As a result, the network lifespan is extended. LEACH-C, a centralised clustering algorithm, and LEACH-F, a LEACH with fixed cluster, were proposed [10] in a similar manner. The creation of chains at each sensor node is done decentralized using a greedy algorithm [11] and the network's global awareness. The chain is constructed from the sink node's farthest node to the sink node's closest node.

The chain is rebuilt to bypass the dead node when nodes die. The data from the farthest node in the chain is received and aggregated in this chain-based method. This aggregation process is repeated until the chain leader receives the aggregated data and sends it directly to the sink node. Each round of communication will have a different leader, which is necessary for the sensor network to be resilient to node failures. Zaire et al. proposed cluster-based routing protocol (CBRP) [12], a distributed and energy efficient routing algorithm. It is defined as a hybrid protocol architecture that combines cluster and tree architectures.First and foremost, a cluster with a cluster head is created using certain novel factors. Second, a spanning tree is built to transmit aggregated data from the cluster head to the base station. CBRP uses a single hop method to send data to the base station from the root node of this tree. The main disadvantage is that it necessitates the exchange of multiple non-data messages between sensor nodes, resulting in a high communication overhead. Based on the actions of real ants, the ACO featured Ant Net based protocol for routing was first discussed and used in 1997

[13]. Researchers gained interest in 2009 and implemented the Cuckoo Search optimization algorithm, a bio-inspired technique (CS). The CS algorithm can be used to solve problems that are multimodal in nature [14]. In [15,16], CS is used to solve WSN localization problems. Using the CS algorithm, an emotional chaotic CS is implemented in solving with a key criterion dependent on more than one goal. The SFLA (shuffled frog leaping algorithm) is a new heuristic algorithm. Eusuff et al. [17, 18] is the first to suggest and implement it in a water delivery network.

This algorithm combines the benefits of particle swarm optimization (PSO) and the shuffled complex evolution (SCE) algorithms, and it has been shown to perform well in terms of convergence speed and precision [19, 21]. Many real-world problems, such as work shop scheduling and cloud computing resource allocation, were solved using it [22–23]. Hussain et al. use a heuristic-based approach to improve the HCR protocol in [24]. They use a GA to figure out how many clusters there are, who the cluster heads are, who the cluster members are, and what the transmission schedules are. Their findings are compared to those of HCR and LEACH. The findings show that using GA-based hierarchical clusters increases the network's lifespan.A data aggregation method based on the firefly algorithm [25] is proposed in this paper. The nodes belonging to the related cluster head within each cluster are periodically activated and deactivated in the proposed model based on their energy level and distance; This approach prevents the network from transmitting unnecessary and redundant packets, resulting in substantial energy savings and increased network lifespan.

The proposed approach uses the firefly algorithm to distribute sensor nodes within each cluster. In addition, the combination of the firefly algorithm and the LEACH model [26] is used for cluster head selection.Mohit et al. proposed the squirrel search algorithm (SSA) in 2018, which is a modern and efficient global optimization algorithm inspired by flying squirrels' natural dynamic foraging behaviour [27]. Since SSA incorporates a seasonal monitoring condition, it has the advantage of better and more effective search space exploration as compared to Other swarm intelligence optimization algorithms. Further rmore, the forest area contains three types of trees (normal tree, oak tree, and hickory tree), maintaining population diversity and thus enhancing algorithm exploration.The supremacy of SSA over other well-known algorithms such as GA , PSO, FA(firefly algorithm) [28] and BA (bat algorithm) is demonstrated by test results from 33 benchmark functions and a real-time controller design problem.However, when solving highly complex problems, SSA always suffers from premature convergence and is quickly stuck in a local optimal solution. Like other swarm intelligence algorithms, the rate of convergence of SSA is determined by the balance of exploration and exploitation capabilities.

III. SQUIRREL SEARCH ALGORITHM

Jain M. proposed the squirrel search algorithm[27] (SSA) in 2018. The algorithm imitates the gliding characters of flying squirrels. The key components of the mathematical model are the location of a food source and the presence of predators. The optimization process includes the summer phase and the winter phase. When flying squirrels start foraging, the search process starts. Squirrels search for food resources by gliding from one tree to the next during the warm season (autumn). They switch locations and explore various parts of the forest when doing so. Since the climatic conditions are hot enough, they can fulfil their regular energy needs more easily by consuming acorns, which are abundant, and they consume acorns as soon as they find them. They begin looking[27] for the best food source for the winter after they have met their daily energy requirements (hickory nuts). Storage of hickory nuts would aid them in maintaining their energy needs in severe weather, reducing the need for expensive foraging trips and thereby increasing their chances of survival. In deciduous forests, a lack of leaf cover during the winter raises the risk of predation, so they become less active but do not hibernate. Flying squirrels become involved again at the end of the winter season. This is a continuous mechanism that lasts the entire lifetime of a flying squirrel[27] and is the basis of SSA. The following assumptions are taken into account when simplifying the mathematical model:

3.1 3.1Initializing the Squirrel Search Algorithm

Parameters

Maximum number of iterations$Itermax$, Population size

NP, Number of decision variables n, Predator presence probability Pdp, Scaling factor sf, Gliding constant Gc , and Upper and lower bounds for decision variable $FSUFsL$are the main parameters of SSA. These parameters are set in

the beginning of the SSA procedure.

Initialize the locations and sorting of Flying Squirrels. The locations of flying squirrels are randomly initialized in the search apace as follows:

FSi,j = FSL + rand(0,1) ∗ (FS∪ − FSL) (1) i = 1,2 … . , NP,

j = 1,2, . . , n

Where rand() is a uniformly distributed random number in the range [0 1]. The fitness value f = f1f2,……..,fNP of an individual flying squirrel's location is calculated by substituting the value of decision variables into a fitness function:

fi=f(FSi,1,FSi,2, … … , FSi,n) (2) i = 1,2, … … NP

The quality of food sources is then sorted in ascending order based on the fitness value of the flying squirrels' locations:

[sorted_f,sorted_index]=sort(f) (3)

Three types of trees are classified after sorting the food sources of each flying squirrel's location, hickory tree

source), and normal tree. The best food source (i.e., minimum fitness value) is thought to be the hickory nut tree(NSht), the next three food sources are thought to be the

acorn nuts trees (NSat), and the rest are thought to be normal trees (NSnt):

FSht = FS(sorte index(1)) (4)

FSat(1: 3) = FS(sortindex(2:4)) (5)

FSnt(1: SP − 4) = FS(sorteindex(5:NP) (6)

3.2 Generate New Locations through Gliding

Following the dynamic gliding process of flying squirrels, three scenarios can emerge.

Case1: Flying squirrels on acorn nut trees appear to shift towards hickory nut trees in case1 the new locations can be generated as follows:

FSnew = {FSold + dgGc(FSold − FSold),ifR1 ⩾ Pdp}(7)

Random locations otherwise

Where dg is random gliding distance R1, is a function which returns a value from the uniform distribution on the interval [0, 1], and Gcis a gliding constant.

Case 2: Some squirrels on normal trees can migrate to an acorn nut tree to meet their daily energy requirements. The following is how new locations can be created:

FSnew = {FSold + d G (FSold − FSold), ifR ⩾ P

} (8)

at at

g c at at

2 dp

Random location otherwise

Where R2 is a function which returns a value from the uniform distribution on the interval [0, 1].

Case 3: If some flying squirrels on normal trees have met their regular energy requirements, they may migrate to the hickory nut tree. The following is how a new squirrel position can be created in this scenario:

FSnew = {FSold + dgGc(FSold − FSold), ifR3 ⩾ Pdp}
(9)
at at

at at
Where R3 is a function which returns a value from the uniform distribution on the interval [0,1].

3.3 Check the Status of Seasonal Monitoring

Seasonal differences have an important effect on the foraging behaviour of flying squirrels.
First, a seasonal constant Sc and its minimum value are determined:
t n
c k=1
S

t at,k
10E−6

– NS

ht,k

)2,t=1,2,3 (10)
(11)

Iter/(Itermax)

/2.5
(hickory nuts food source), oak tree (acorn nuts food Following that, the seasonal monitoring situation is examined. The winter is over, and the flying squirrels who have lost their ability to explore the forest will spontaneously reposition themselves in search of food
FSnew = FSL + Levy(n) ∗ (FS∪ − FSL) (12)
Where Levy distribution is a powerful mathematical method that most optimization algorithms can use to improve their global exploration capability.

3.4 Stopping Criterion

If the maximum number of iterations is reached, then the algorithm ends. Otherwise, the habits of creating new locations and testing the status of seasonal monitoring are replicated. The location of squirrel on hickory nut tree is the final optimal solution

IV. NETWORK MODEL

Sensor networks are made up of a large number of sensor nodes that are dispersed across the environment. All of the sensor nodes in the network can be deployed using Cluster- based architecture. Clusters have been created in the network. A cluster-based [10] WSN has several benefits, according to several studies, including efficient energy management and improved scalability. A CH is assigned to each cluster and is in charge of collecting and aggregating sensing data from the cluster's nodes. The aggregated results are then sent to the BS by the CH. Therefore, there are two levels of each cluster: First level: This level consists of a set of sensor nodes that transmit data to the cluster- head. Second level: This level consists of cluster-heads, which collect data and communicate with the base station/sink directly. The cluster-based network topology
[13] is shown in the figure1.The distance between sensor nodes in each cluster is calculated according to the below equation.

$(i, j) = \sqrt{(xi - xj)2 - (yi - yj)2}$ (13)

The distance between base station and cluster heads is calculated according to below equation.

$$Mindist\text{–}to\text{–}sin = \surd (X - xj)2 + (Y - xj)2 \quad (14)$$

V. ENERGY MODEL:

The energy consumption by the nodes to transmit 'K' bit of data packet to the CH is proportional to d2 and is:

$$SN = A * Se + \{A * SSd2\ d \leqslant d0 \quad (15)$$

$$SN = A * Se + \{A * Sld4\ d \geqslant d0 \quad (16)$$

Where 'SS' and 'Slrepresents the energy consumed by nodes in the transmission[17] of data packets to CH or sink

i.e. the distance of nodes to its CH ($d2$) and sink ($d4$). 'Ee' is the energy dissipated per 'A' bits by the transmitter and receiver circuitry.The Threshold distance'$d0$' is a function of amplifier energy. Moreover the energy consumed to receive 'E' bit message includes the cost of aggregation.

$$SRC = A * (Se + SDA) \quad (17)$$

Where 'SDA' is the energy consumed in aggregation of data packets at CH. under the random distribution of nodes.

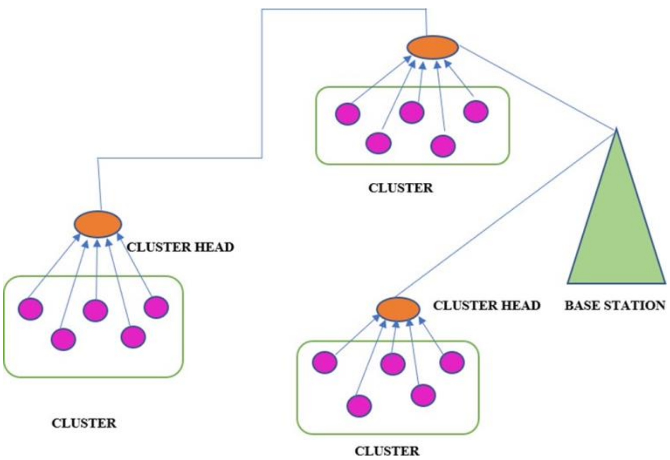

Figure 1. Cluster based Architecture for data aggregation

VI. DATA AGGREGATION USING SQUIRREL SEARCH ALGORITHM

Due to factors such as overlapping distribution, sensor nodes often transmit duplicate data when collecting data. Duplicate packets should be aggregated and translated into unified data throughout the network. For extracting duplicate data and transforming it into unified data, an aggregator should be used, which takes a lot of resources. The aggregator's lifespan, on the other hand, is limited by a number of rounds. As a result, the most complicated part of aggregation is eliminating redundant data while still minimizing energy consumption. Clustering is a well- known technique for eliminating duplicate data. In this paper, clustering-based Squirrel Search Algorithm was proposed. For data aggregating, CHs are elected specially based on distance, energy. And for CH re-election is based on its residual energy and received signal strength.Then, data aggregation process is carried out by using the optimal clustering of sensor nodes. In this model, position of the squirrel search algorithm is measured according to the below equation.

$$x(i) = \sum n\ 1(x(i)) + \sum n\ 1\ d(\ x(i), xi+1)\ n \quad (18)$$

Initial values of position of the squirrels are generated based on sensor nodes. Squirrels with more energy are selected for clustering. In case solutions are not optimal, squirrel will be updating their positions and new vector establishment processes are carried out.

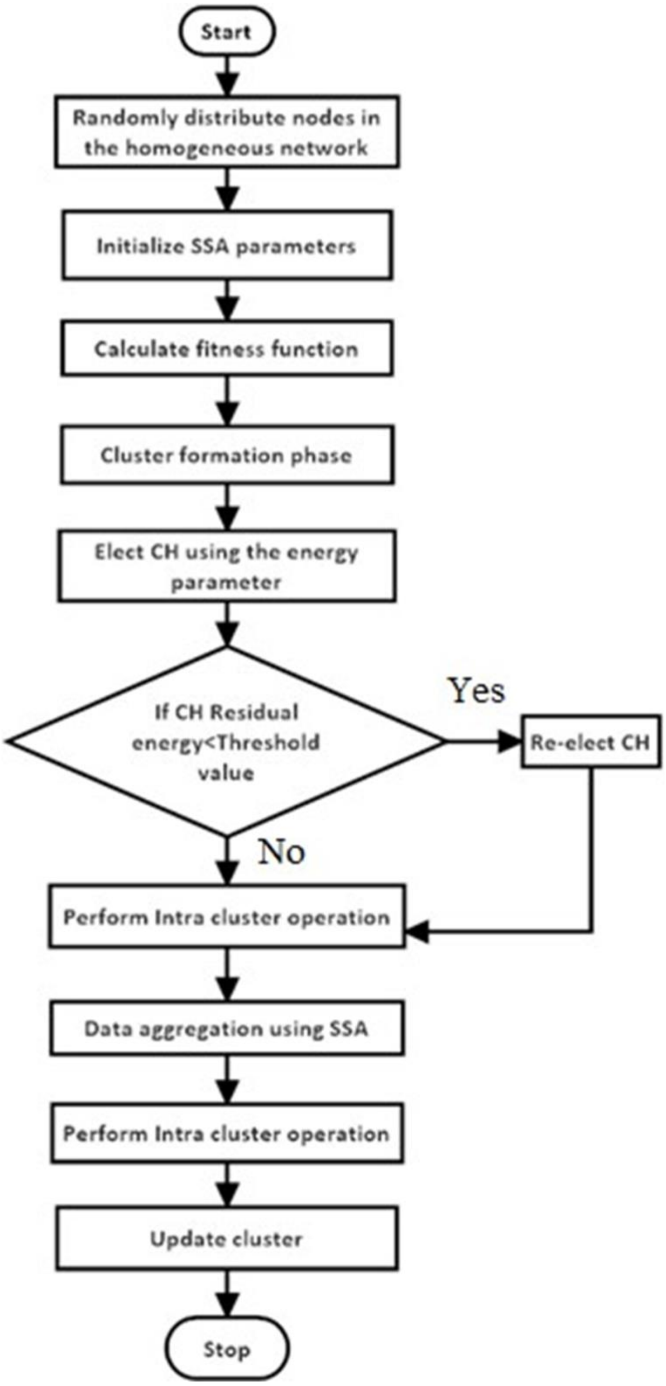

Figure 2 shows the flowchart of the Squirrel search algorithm for data aggregation.

VII. PERFORMACE EVALUATION

7.1 SIMULATION PARAMETERS

The proposed model was simulated and evaluated in MATLAB .The efficiency of the proposed model was compared with that of SFA[23] and FA[26] models.It was assumed that each sensor node has the initial energy of amount 0.05 J. The network area is taken as 100m x 100m (Xm,Ym).The simulation parameters and their values are given in the following table 1.

Table 1: Simulation parameters

Parameters	Symbol	Values
Number of nodes	N	100
X-value for plot area	Xm	100
Y-value for plot area	Ym	100
Initial energy of sens	Eo	0.05
Transmission Energy	$Etx()$	50*0.0000001
Data aggregation ene	EDA	05*0.0000001
Energy used	$Eadv$	50*0.0000001
Amplification energy	Efs	10*0.0000001
Receiving energy	$Erx()$	50*0.0000001
Residual Energy	R	0.0036
Received Signal Stre	T	0.04

7.2 PERFORMANCE METRICS

For performance evaluation of the proposed algorithm, SFA [23]and FA[26], we use the following metrics.

7.2.1 NUMBER OF DEATH NODES

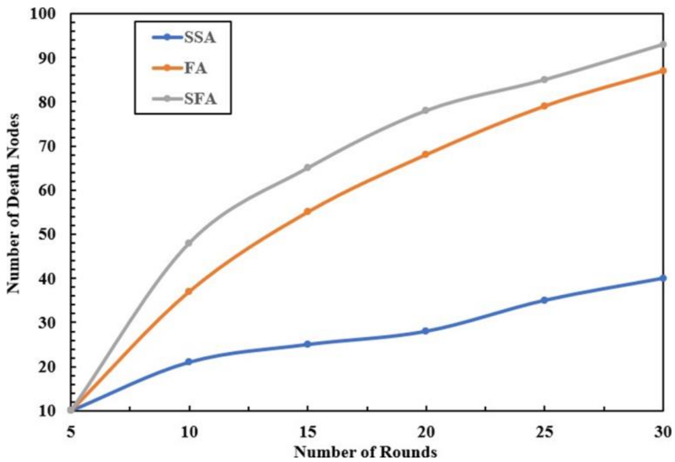

Figure 3: Number of Death Nodes

The SSA is compared with FA[26], SFA[23] in terms of the number dead nodes which is illustrated in the following figure. Also, as shown, in the proposed scheme SSA and SFA[23], FA[26]. The ratio of death node is higher in SFA, FA when compared with SSA. In SSA, the node is not really dead, because if the node energy decreases (when it comes to 40%), the cluster head will be re-elected which has maximum energy. The Cluster head will be re-elected with the cluster head selection criteria. Hence, not all nodes deal with the problem of energy shortage. Consequently, data exchange process between nodes is maintained. • For comparing the total number of dead nodes of the network area 100 m×100 m, As Figure 3 shows the number of dead nodes in proposed scheme (SSA)[23] are lesser than FA[26].

7.2.2 THROUGHPUT

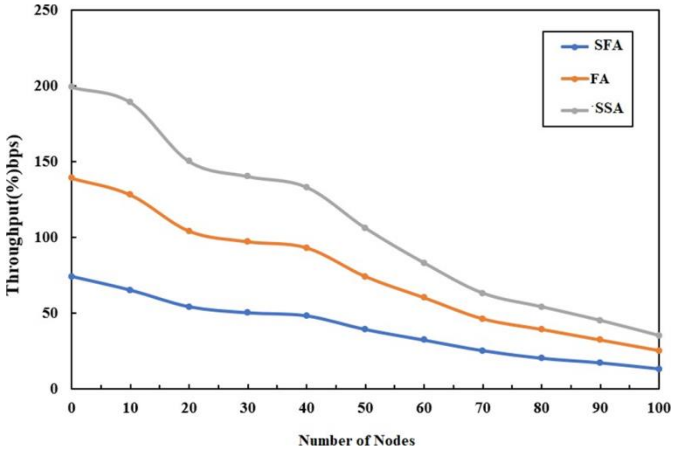

Figure 4: Throughput

The proposed scheme SSA is compared with FA[26], SFA[23] in terms of the message delivery from nodes to cluster head and cluster head to base stations/sink which is illustrated in the following figure 4. Also, as shown, in the proposed scheme (SSA), SFA[23] and FA[26]. The ratio of message delivery from nodes to cluster head and cluster head to base stations/sink increases in SSA when compared with SFA[23], FA[26]. Throughput is the average rate of successful message delivery over a communication channel. Throughput is usually measured in bits per second, and sometimes in data packets per second or data packets per time slot. High throughput is always desirable in a communication system. Hence, For comparing the message deliveries of the network area 100 m×100 m ,As Figure 4 shows of the message delivery from nodes to cluster head and cluster head to base stations/sink in proposed scheme(SSA) increased than SFA[23],FA[26] .

7.2.3 AVERAGE END-TO-END DELAY

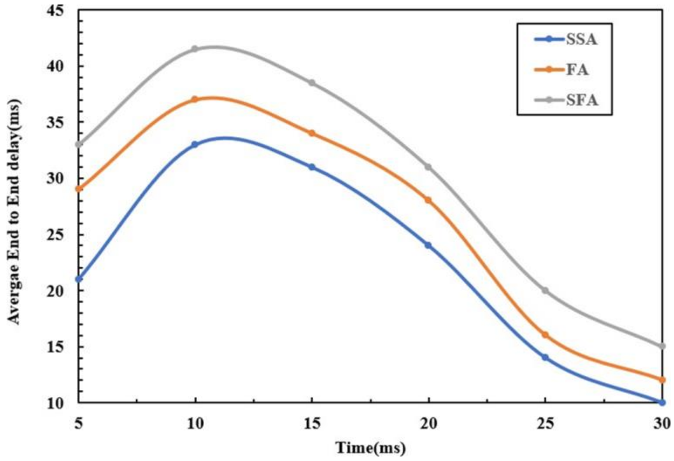

Figure 5: Average End-to-End Delay

The proposed scheme SSA is compared with SFA[23], FA
[26] in terms of the average values of delay which is illustrated in the following figure 5. Also, as shown, in the proposed scheme (SSA), SFA[23] and FA[26]. The ratio of
delay increases when compared with SSA. To compute the average values of delay. Let's define delay as the duration since a packet enters a queue of a beginning node until it arrives at the ending node. The definition of beginning and ending nodes depends on the type of delay under consideration as follows: Average delay is computed by, For comparing the total average values of delay of the network area 100 m×100 m . As Figure 5 shows the delay in proposed scheme(SSA) are lower than the SFA[23],FA[26].

Parameters	SSA	FA	SFA
No of Death Nodes	28	40	80
Throughput	350	230	140
Average End-to-End Delay	18.4	23.4.	40.1

Table 2: Simulation result comparison for SSA, FA,SFA

VIII. CONCLUSION

One of the most important drawbacks of large-scale wireless sensor networks is the logistics involved in selectively replacing sensors that have run out of power. Hence it's essential to use data aggregation in sensor nodes to produce high-quality data while reducing the number and size of transmitted packets. Since data transmission consumes the majority of energy, data aggregation becomes a significant issue that requires optimization. Efficient data aggregations not only save energy but also eliminate redundant data, resulting in only useful data. As a result, there is a reduction in the amount of energy and bandwidth used. In order to improve the energy efficiency and network lifetime, Data aggregation using squirrel search algorithm was proposed. Simulation results indicated that the proposed model was found to be more efficient than SFA[23] and FA[26].By improvising this, overall improvement will be shown in Data Aggregation which results in the improved Network lifetime and Energy efficiency. For further, we would intend to extend this work by hybriding Squirrel search algorithm to achieve better exploration results.

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