Energy Efficient Data Communication Process Of Shortest Path Using Artificial Bee Colony (ABC) Optimization Algorithm For Wireless Sensor Network

Dr.S.Gayathri[1,] Dr.C. Sasikala[2] and Dr.J.Kolangiappan[3]

[1]Assistant Professor, Dept. of CS & CA,A.E.T, College,Attur.

[2]Assistant Professor, *Department of Computer Science*, Bharathi Women's arts and science college, Kallakurichi

[3]Head & Assistant Professor, Department of CS, Tirukkoilur College of Arts and Science,Tirukkoilur

ABSTRACT

The Energy Consumption in sensor node is a very difficult task in Wireless Sensor Network (WSN) Environments. The Dijkstra's shortest Path using Artificial Bee Colony (SPABC) Optimization algorithm have been develop to find the optimal solution node and shortest path from source nodes to destination node.ABC optimization is used to search the information such as number of nodes, execution time of the neighboring nodes and optimal solution node in the cluster environment.In this research work, not only find out the shortest path to send the information. But also after calculating the sensor nodes weight and then the information send to destination. Because, if the distance is short, when the node weight is high received in the data, the data will send to take excess of the time. So, it has to find out some other way to send the data. The proposed shortest path using ABCOptimization (SPABC) Algorithm can successfully reduce the data transmission delay, energy wastage, improve the data gathering process, network reliability and extends the lifetime of the network.

Keywords: Sensor nodes, head nodeelection, dijkstra's algorithm, Artificial Bee colony Optimization, Base station, WSN.

I.INTRODUCTION

Wireless sensor networks (WSNs) generally consist of considerable sensor nodes with limited energy. A sensor is small electronic device that is used to senses the information and processing them than passing these information to the base station. It is used to measure more of thinks like the change in physical environmental parameters such as temperature, pressure, humidity, sound. Sensor Nodes are randomly deployed in a particular region to acquire various types of environmental parameters and transmit information to the base station (BS) for monitoring and detecting applications. They have been widely applied in forest fire detection, surveillance, military, human health detection[1][2]. The optimal energy management is an involves routing the collected data from sensors to the base station, while minimizing the energy consumption [3].Many researchers have found that clustered based routing play an important role in reducing energy depletion and increasing the network lifetime [4].Cluster head selection plays a crucial stage in a WSN architecture which mainly focuses on the minimization of network energy consumption. Intra cluster communication; the duration of time slot is adjusted to reduce consumption of energy. In Inter cluster communication, the Dijkstra's algorithm is applied to construct the shortest path between CHs, and the consumption of CHs' energy is reduced. The dead node count is reduced significantly so that the network longevity is increased [5] [6].The shortest distance is based on, and calculates the weighted average of them By this, it was confirmed that it was possible to search for an optimal route with a light load, although not the shortest distance, but the distance was rather short [7].Selecting an efficient path from the source link or edge weight decides the selection of the optimal path comprising consecutive edges for which the overall cost is minimized. Several algorithms are used in this regard such as Floyd–Warshall, Dijkstra's, and Bellman–Ford techniques[8].Optimization is a field of research with large number of applications in almost each and every area of science, management and engineering, where mathematical modeling is used[9] .To effectively solve optimization problems, intelligent optimization methods have been presented. Some representative algorithms are Ant Colony Optimization (ACO), Particle Swarm Optimization (PSO), Artificial Bee Colony (ABC), Firefly Optimization, Bee Colony Optimization, cuckoo search, pigeon inspired optimization, bat algorithm and social network optimization[10].

The suggestion of this research work is classified as follows**Section II** characterizes the relevant research of this paper. **Section III** described the shortest path finding and Optimization based data collection process of the WSN. **Section IV** justifies the principle of the ABC optimization and dijkstra's weight based shortest path problem of the network reliability. Present the mathematical calculation and optimization steps for WSN data collection. **Section V** analysis the data transmission parameter setting and network simulation results which an evaluate the performance of the proposed system. **Section VI**provides the conclusion of the research work.

II. RELATED WORKS

Yang Liu et.al[2019]The proposedenergy-efficient LEACH (IEE-LEACH) protocol can optimize the number of CHs and their distributions, which can effectively reduce the energy consumption and overall communication cost. **Jbcesu Baghdad Iraq [2019]**The Proposed Weight based clustering algorithm select cluster head in such a way that cluster head always has highest residual energy. Residual energy is energy left in a node after performing its processing and data transferring functions and improves the life time of wireless sensor network. **Feriel Khanouche et.al[2019]**Energy efficient Multi-hops Routing protocol based on Clusters Reorganization (EMRCR) is proposed to overcome the limitations of random election of head sensor node, unequal distribution of clusters and the single hop communication between head sensor nodes and the base station. The proposed EMRCRtechnique gives the better energy consumption, reduce transmission distances and provide a high network lifetime. **Meenakshi Tripathi,R.B et.al[2013]**Introduces a novel cluster based routing protocol is leads to efficient transmission of data packets with less energy and therefore increases the network longevity as compared to LEACH-C and LEACH. **Jagan.G.C et.al [2022]** Propose a novel fully connected energy efficient clustering (FCEEC) mechanism is fully connected network with shortest path routing from sensor nodes to cluster head in a multi-hop environment. The proposed technique gets the results as energy efficiency, dead node count, packet delivery, and network latency compared to certain conventional approach. **XuHuibin et.al[2022]**The Propose ECOR algorithm makes the distribution of CHs more even. The Dijkstra's algorithm is used to construct the shortest path among CHs, in order to shorten the path of transmitting data. The aim of the ECOR algorithm is to reduce energy consumption of node and make CHs' distribution even. **Madiha Razzaq et.al[2019]**Fuzzy-Logic Dijkstra-Based an energy-efficient and delay tolerant routing scheme, which not only considers the remaining energy, minimizes the intra-cluster communication cost and it can improve the network lifetime. **Sandeep Kumaret.al[2014]** improved algorithm of Randomized Memetic ABC (RMABC) is new solutions are generated nearby the best so far solution and it helps to increase the exploitation capability of Memetic ABC. Proposed strategy in the memetic ABC improves the reliability, efficiency andaccuracy. **Songyi Xiaoet.al[2019]**developed an ABC-ESDL, there are two modifications: elite strategy (ES) and dimension learning (DL). The elite strategy is used to guide the search. Good solutions are selected into the elite set. These elite solutions are used to modify the search model. This complexity will increase the computational time. **MrunaliUmale [2015]** Modified Floyd-Warshall's algorithm is obtains better throughput, packet delivery ratio and minimized energy consumption. The new Modified Floyd-Warshall's algorithm calculates the shortest path from node to node by adding an acknowledgment mechanism. **Aruna Pathak[2020]**propose proficient bee colony-clustering protocol (PBC-CP) is an important factors for selection of heads such as node's energy, degree of node, and distance from base station to node. For transmitting the data from cluster head to base station, it chooses the energy-efficient path which further minimizes the energy consumption of sensor network. **YinggaoYue et.al** [2016] improved an Optimization-Based Artificial Bee Colony has three aspects: data collection maximization, mobile path length

minimization, and network reliability optimization. The proposed algorithm can effectively reduce data transmission, save energy, improve network data collection efficiency and reliability, and extend the network lifetime.

.III.SYSTEM MODEL

3.1 Network Model

In WSNs, sensor node is a small and low power devices, it generally comprises of four essential parts: a sensing, processing, Data communication and a power supply. The WSN has sensor node to take the environmental monitoring, like it gives spatial information whether forecasting, magnetic and information retrieval. Each sensor nodes are known its location by using GPS.
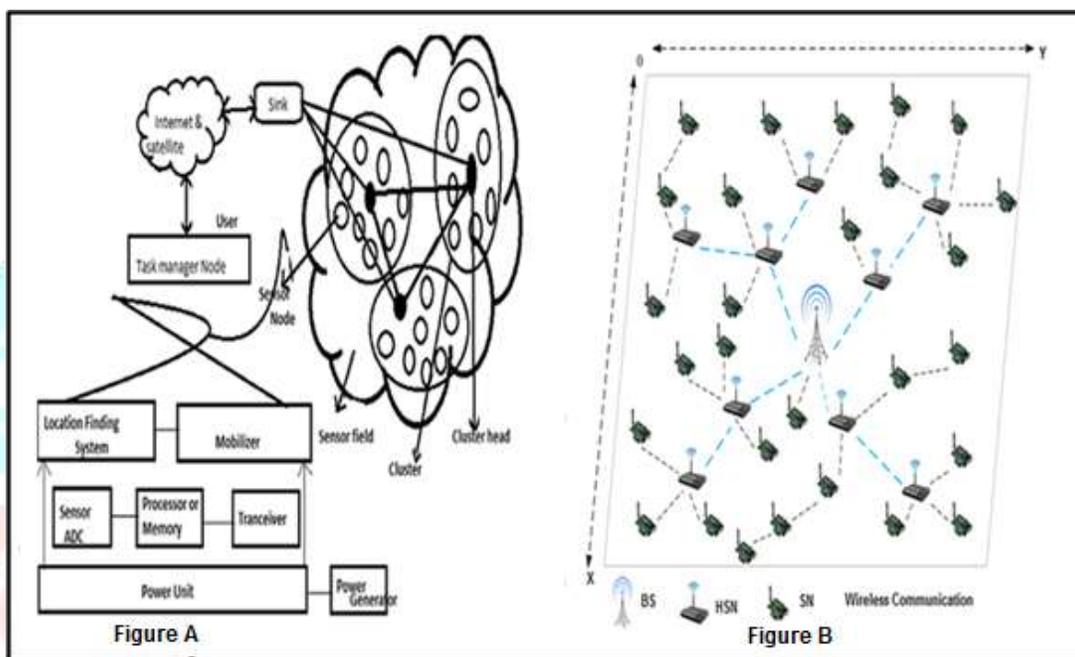

Figure 1: WSN Architecture

The above figure A referred to WSN Architecture and figure B referred to connect and communication with data transmission process in X and Y radius of particular network Environment.This research studies a Cluster based WSN with size x andy. The equipment deployed includesHead sensor node(HSN), SensorNode (SN) and one sink node (BS), as shown in Figure B. All Sensor Nodes have the sameinitial energy of the WSN and Head sensor Nodes only forward without collecting information and it is assumedthat their energy is unlimited. SNs and HSNs follow the data communication model.The condition for any two devices to communicate with each other is that their Euclideandistance be less than or equal to the communication distance. SNs can send informationto Neighboring SNs, HSNs or the BS, while HSNs can only send information to other HSNs or the BS [11][12][13].

3.2 Bee Colony Model

Bee Colony optimization is the motivated by intelligent foraging behavior of honey bees. Bee colony has three groups of bees, namely, worker bees, onlooker bees, and scout bees. Probable solution to the optimization problem is represented by the location of a food source, whereas the fitness of the associated solution corresponds to the nectar amount. Here, the size of the colony is the same as the number of worker bees and also equal to the onlooker bees.
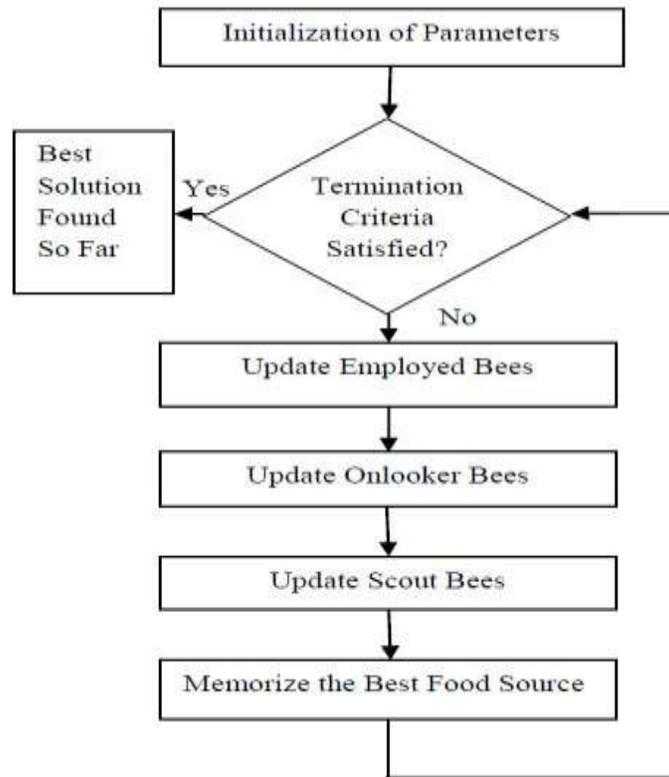

Figure 2: ABC Optimization Flow Diagram

The initial locations of food sources are randomly generated, and every worker bee is appointed to a food source. After that, each worker bee finds a new food source in all iteration and computes its quality. Worker bee travels to the new foodsource if the nectar quantity of the new food source is higher than the earlier one or else it persists with the older one. The capability of searching process of Artificial Bee Colony optimization can be boosted by using a heuristic function.

Algorithm of ABC Optimization

Produce initial population xi, i = 1...M;

Calculate the population

Set value of Round to 1

Repeat

i) For every employed bee

Create new solutions Vi by $V_{ij} = x_{ij} + \tau(x_{ij} - x_{kj})$

Where α is an arbitrary number between [-1,1], vi is candidate solution, xi is present solution and xk is neighbor solution, j = {1, 2...N}

Evaluate the cost function

Execute the greedy selection process

ii) For every onlooker bee

Select a solution xi on the basis of $P_i = \frac{F_i}{\sum_{L=1}^{m} F_i}$ PF$_k$

Where PF$_k$ is cost function of solution i, M = number of food source = number of employed bee.

iii) Create new solutions Vi by $x_{ij} = x_{ij} + rand(0,1)(x_j \max - x_j \min$

Evaluate the cost function

Execute the greedy selection process. If an isolated solution is there then, substitute this result with another result determined by

iv) Scout $f_i = \text{Optimize}[k\{R_e(i) + N_D\} + (1-k)\{\frac{1}{E_u(i,b)}\}]$

N is the dimension of solution vector

V) Accumulate the best solution accomplished till.

Round = Round + 1

Unless Round = maximum Round number.

3.3 Shortest Path

The Dijkstra's algorithm makes use of Yen's model to find *k* shortest paths between communicating end nodes. That is, it finds a shortest path, second shortest path, etc. up to the Kth shortest path. More details can be found here. The below figure is attempts to solve the *k* shortest path routing problem for a Number of sensor nodes in network containing a combination of unidirectional and bidirectional links. The Dijktra's k shortest path algorithm is pecifies the mechanism of data transmission. It is used to determine the optimal route as well as the path node and its weight. The data transfer will not be interrupted as a result of this computation.

Dijkstra's Shortest Path Algorithm

k = number of paths to find, n = paths found so far,
s = source node, t = destination node,
$G[i,j]$ = network connectivity matrix,
$C[i,j]$ = network capacity matrix,
$H[u]$ = cost of a node,
Inf = a constant larger than the greatest possible path length

1. Initialize $G[i,j]$ and $C[i,j]$ with network values
2. Remove the span between s and t, to emulate a failure
3. $G[s,t] = inf$, $C[s,t] = 0$
4. Call k-Dijkstra (k, n, s, t, G, C)
5. k-Dijkstra (k, n, s, t, G, C) {
6.　while $(n < k)$ {
7.　　Dijkstra (s, t, G, C)
8.　　Record the path by tracing the predecessor vector
9.　　Subtract every entry in $G[i,j]$ that appears in the path
10.　n++
11.　}
12. }

In this Algorithm is used to find the solution to the single source shortest path. For given vertex called sources, in a weighted connected graph it finds the shortest path to all other vertices. It has two major limitations; first it does a unsighted search for all nodes. Thus, with more nodes it becomes computationally expensive. Second, it cannot handle negative weight.

IV.PROPOSED METHODOLOGY

Shortest path using Artificial Bee Colony optimization is a meta-heuristic bio inspired Scheme for converging on the exploration and exploitation of the search space during the process of head sensor nodes selection. In this cluster based data transmission process, the whole sensing region is partitioned into small regions.
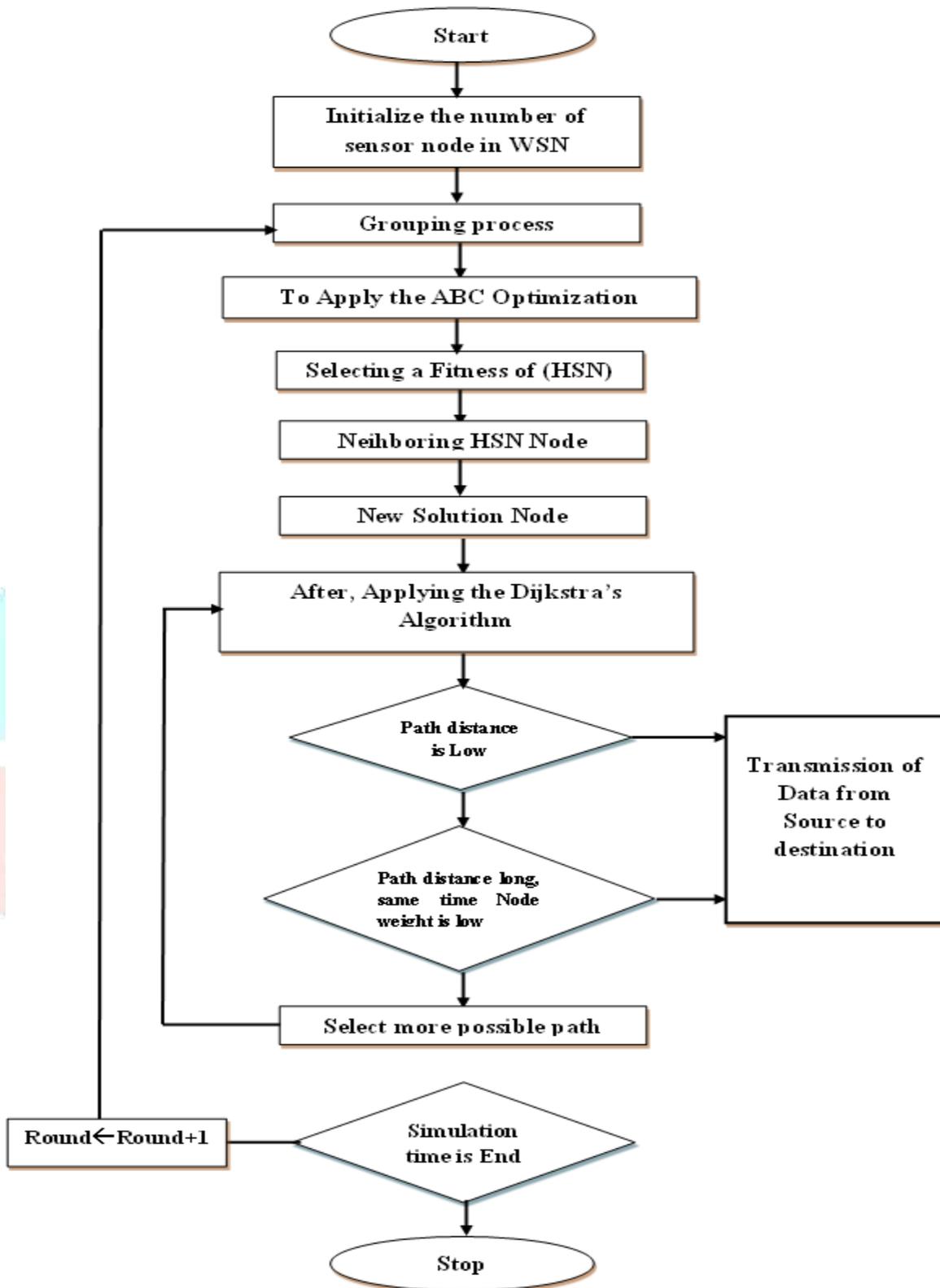
Proposed Flow Diagram of SPABC

Figure 3: Flow diagram of SPABC

Algorithm of SPABC Technique

Step 1: Initialize the number of sensor nodes in WSN

Step 2: To form a cluster

Step 3: distance based clustering process using equation(1 and 2)

Step 4: Apply the ABC algorithm

Step 5: Select the fitness of HSN solution node

Step 6: Update the Neighboring HSN node

Step 7: Find the New solution node

Step 8: Transmission of packets between Fitness of the solution node to Base Station.

Step 9: After, applying the Dijkstra's Shortest path technique

Step 10: Shortest path to check two conditions

If Path distance is low (or) path distance is long, at the same time node weight is low

Transmission of data from source to destination

Else

Select more possible path

Step 11: To check Simulation Time

If Simulation time ends

Then, end process.

Else

Round$\rightarrow$Round + 1

Then, follow step 2 to..

Step 12: End Process

A single designated node called Head Sensor Node (HSN) is assigned to each of the divided sensors for energy optimization. The HSN selection is playing a most important character in the energy efficient data transmission process. In addition, the HSN are collecting the data from member sensor node into forwarding the data to the base station. Dijkstra's algorithm finds shortest paths source to destination node. It can also be used to generate a shortest path and fastest data transmission based on node weight calculation process. Dijkstra's algorithm takes into account the node weight in WSN and returns the path that has lowest weight to it between source nodes to destination node. This can means the shortest path might actually involves traversing more nodes, but the some of their nodes weight will be lower that the alternative paths.

V. Experimentations and Results

Table 4.2 Simulation Parameters and Values

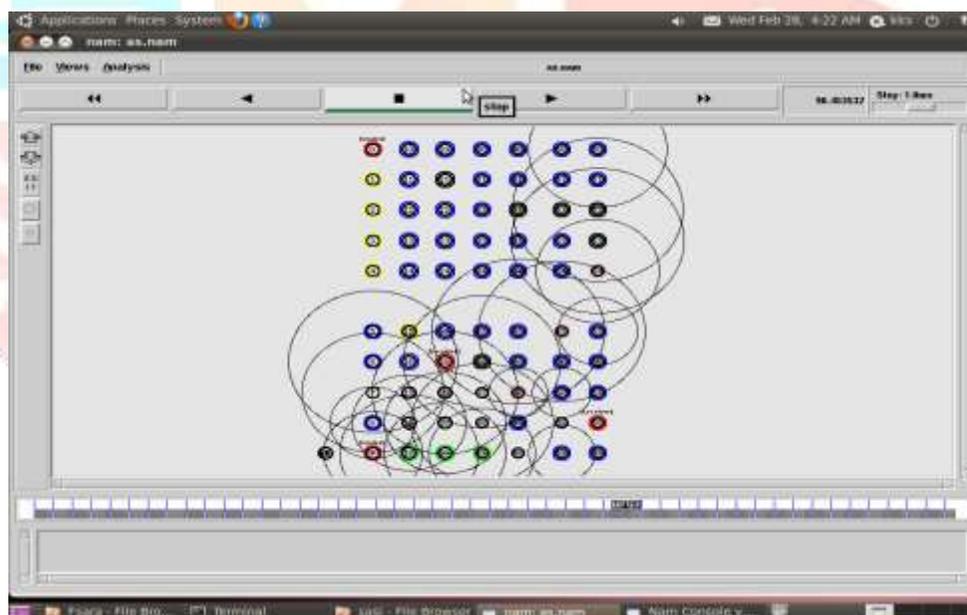| Parameters	Values
Number of Node	100
Area Dimension	800 * 400(Meter)
Routing Protocol	AODV
Total Energy	150 Joule
Initial Energy	1.5Joule
Packet Size	4000 bits
Simulation time	60 (seconds)
Type of the MAC	802.11
Simulation Tool	NS2.34

NAM Window

Figure 4: Nam Window

All the mobile nodes are randomly distributed in an area with dimensions of the sensing region. In this above Figure 5 red color is Head sensor node, Blue color nodes are members of the sensor node. After best solution node selection, all the member nodes transfer their packets from there as a source to best solution node with effective communication path.

Packet Delivery Ratio

Figure 4 denotes that the existing method was overcome by SPABC. In this packet delivery ratio, the packets are transmitted from the sources to destination by proper routing path to evaluate the number of packets that are delivered in WSN like cluster using optimization approaches in WSN.
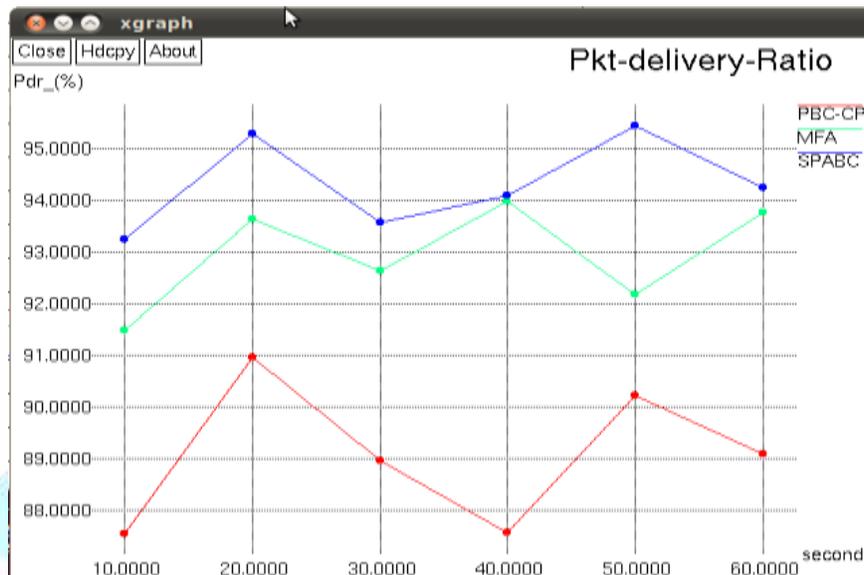

Figure 5: Packet Delivery Ratio

The Figure 5 shows the pictorial representation of the performance evaluated. By analyzing the obtained results of proposed SPABC technique, packet delivery ratio approach produced the best average values. Hence SPABC approach is an efficient one. When comparing with the existing method, the result of PBC-CP is 87.64% and FMA is 91.13%. Now the proposed work is much better than the existing work. So the packet delivery ratio is 94.85% with SPABC method.

End to End Delay Time

The measurement of cluster based congestion avoidance end to end delay time using three techniques such as proposed SPABC mechanism, PBC-CP and FMA approach is in Figure 6 and it clearly describes that in the proposed SPABC technique, the time delay for congestion aware packet delivery has becomes less than the other existing techniques. When compared to the existing method, the result of PBC-CP is Average of 89.54 Milli Second (ms) and FMA result is 78.67ms. Now the proposed work is much better than the existing work.
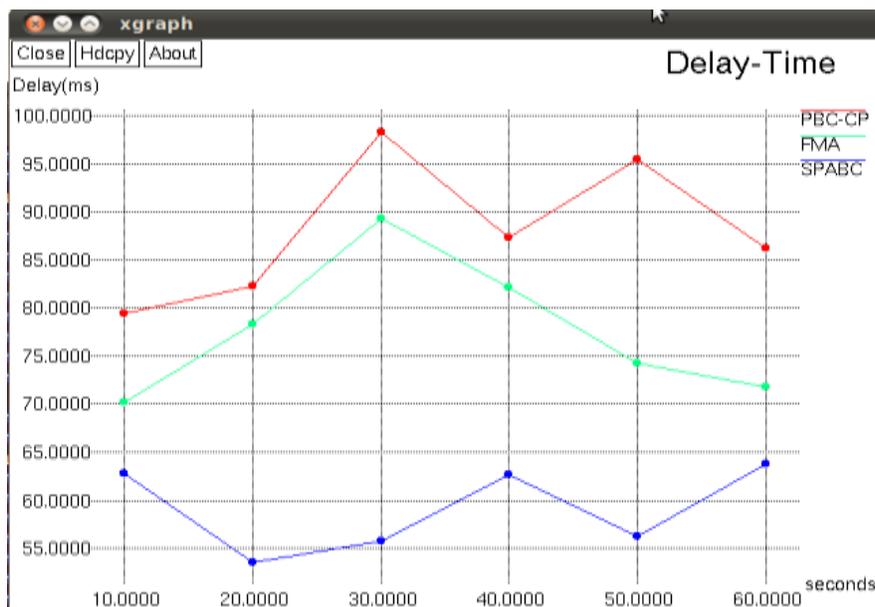
Figure 6: End to End Delay Time

The measurement of cluster based congestion avoidance end to end delay time using three techniques such as proposed SPABC mechanism, PBC-CP and FMA approach is in Figure 4.7 and it clearly describes that in the proposed SPABC technique, the time delay for congestion aware packet delivery has becomes less than the other existing techniques. When compared to the existing method, the result of PBC-CP is Average of 89.54 Milli Second (ms) and FMA result is 78.67ms. Now the proposed work is much better than the existing work.

Remaining Energy

Figure 7 shows the remaining energy for both existing PBC-CP and MFA proposed SPABC technique. It shows remaining energy for different rounds of 0 to 60 seconds. Both existing and proposed technique applied for Millie seconds and energy values are mentioned. From the analysis, it is known that the proposed SPABC technique gets the high remaining energy than the existing PBC and MFA techniques.
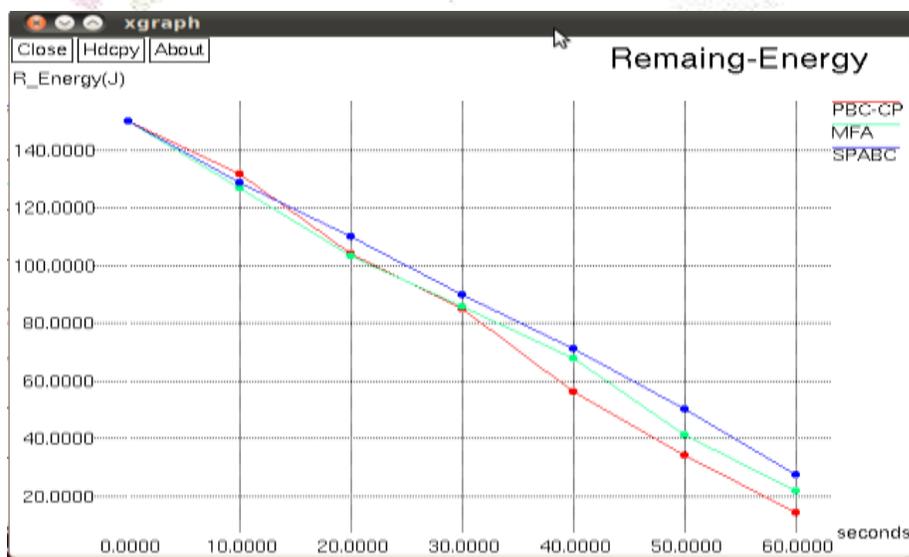

Figure 5: Remaining Energy

VI. Conclusion

In this paper, An Efficient shortest Path using Artificial Bee Colony Optimization motivated from the data collection principle of Sensor node(honey Bee) for wireless sensor networks. Where the objective is to increase the data collection ratio and network lifetime. We elects head sensor nodes of the group by exploiting the high speed data collection aspects of the bee colony optimization technique and transfer the data from sensor nodes to Base station by shortest path. The simulation outcomes prove that the SPABC technique better PBC-CP and MFA. The proposed technique as shortest path selection is much more important for maximum energy consumption and packet delivery ratio with particular time period. Using SPABC technique, the data from source to destination are transmitted efficiently to minimize energy consumption, avoid packet losses and extents lifetime of network.

References

1. Yang Liu , Qiong Wu , Ting Zhao , Yong Tie , FengshanBai and Minglu Jin "An Improved Energy-Efficient Routing Protocol forWireless Sensor Networks" pp(1-20), Sensors 2019. https://doi.org/10.3390/s19204579.

2. Jbcesu Baghdad Iraq "Clustering in Wireless Sensor Networks (WSNs)" Journal of Baghdad University College of economic sciences,2019.

3. FerielKhanouche and Lydia MAOUCHE "Energy efficient Multi-hops Routing protocol based on Clusters Reorganization for wireless sensor networks" Association for Computing Machinery (ACM), 2019. https://doi.org/10.1145/3341325.3341994.

4. MeenakshiTripathi,R.B.Battula,M.S.Gaur and V.Laxmi "Energy Efficient Clustered Routing for Wireless Sensor Network" International Conference on Mobile Ad-hoc and Sensor Networks, pp(330-335), IEEE-2013.

5. Jagan.G.C and P. JesuJayarin "Wireless Sensor Network Cluster Head Selection and Short Routing Using Energy Efficient Electro Static Discharge Algorithm" Journal of Engineering,pp(1-10),2022. https://doi.org/10.1155/2022/8429285.

6. XuHuibinandZengMengjia "An Energy-Efficient Clustering Routing for Wireless Sensor Networks Based on Energy Consumption Optimization" International Journal of Digital Multimedia Broadcasting, pp(1-11), 2022. https://doi.org/10.1155/2022/5566365.

7. Kohei Arai "Routing Protocol based on Floyd-Warshall Algorithm Allowing Maximization of Throughput" International Journal of Advanced Computer Science and Applications(IJACSA), Vol. 11(6),pp(436 - 441),2020.

8. MadihaRazzaq and Seokjoo Shin "Fuzzy-Logic Dijkstra-Based Energy-Efficient Algorithm for Data Transmission in WSNs" pp(1-20), Sensors 2019.

9. Sandeep Kumar, Vivek Sharma and RajaniKumariPoonia "Randomized Memetic Artificial Bee Colony Algorithm" International Journal of Emerging Trends & Technology in Computer Science (IJETTCS), Vol.3(1), pp(52-62),2014.

10. Songyi Xiao, Wenjun Wang, Hui Wang, Dekun Tan, Yun Wang, Xiang Yu and Runxiu Wu "An Improved Artificial Bee Colony Algorithm Basedon Elite Strategy and Dimension Learning" pp(1-20),Mathematics - 2019.

11. MrunaliUmale and Dr.S.D.Markande "Energy Efficient Routing Algorithm on the Target Tracking in Wireless Sensor Network"International Conference on Information Processing (ICIP), pp(176-181),IEEE-2015.

12. AshaRawat and Dr.MukeshKalla "Clustering Algorithm for Energy Efficient Wireless Sensor Network" Turkish Journal of Computer and Mathematics Education(TJCME), Vol.12(5),pp(877-884),2023.

13. Wenjie Yu, Xiangmei Li, ZhiZeng and Miao Luo "Problem Characteristics and Dynamic Search Balance-Based Artificial Bee Colony for the Optimization of Two-Tiered WSN Lifetime with Relay Nodes Deployment"pp(1-17),Sensors 2022. https://doi.org/10.3390/s22228916.

14. ArunaPathak "A Proficient Bee Colony-Clustering Protocol to Prolong Lifetime of Wireless Sensor Networks" Journal of Computer Networks and Communications,pp(1-9),2020. https://doi.org/10.1155/2020/1236187.

15. YinggaoYue, Jianqing Li, Hehong Fan and Qin Qin "Optimization-Based Artificial Bee Colony Algorithm for Data Collection in Large-Scale Mobile Wireless Sensor Networks " Journal of Sensors-2016. http://doi.org/10.1155/2016/7057490.

16. Vijayashree.R and C. Suresh Ghana Dhas "Energy efficient data collection with multiple mobile sink using artificial bee colony algorithm in large-scale WSN"Automatika Journal for Control, Measurement, Electronics, Computing andCommunications,pp(1-10), 2019.https://doi.org/10.1080/00051144.2019.1666548.

17. Le Yang1, Damin Zhang1,*, Lun Li1,+, and Qing He "Energy Efficient Cluster-Based Routing Protocol forWSN using Multi-Strategy Fusion Snake Optimizer and Minimum Spanning Tree" Research Square, pp(1-24),2014.https://doi.org/10.21203/rs.3.rs-3901967/v1.

18. XuHuibinandZengMengjia "An Energy-Efficient Clustering Routing for Wireless Sensor Networks Based on Energy Consumption Optimization" International Journal of Digital Multimedia Broadcasting,pp(1-11),2022.https://doi.org/10.1155/2022/5566365.

19. AnkitGambhir,AshishPayal and Rajeev Arya " Performance analysis of artificial bee colony optimization based clustering protocol in various scenarios of WSN " International Conference on Computational Intelligence and Data Science (ICCIDS),pp(183-188),Elsevier-2018.

20. Sandrine Mukase ,Kewen Xia and Abubakar Umar "Optimal Base Station Location for Network Lifetime Maximization in Wireless Sensor Network" pp(1-20), Electronics -2021.