Bio-Inspired Approach for Mobile Sink in Wireless Sensor Networks

Kajal Snehdil, Harshdeep Trehan, Dr. Naveen Dhillon
[1]*Research Scholar, Ramgarhia Institute of Engineering and Technology, Phagwara*
[2]*Assistant Professor, Ramgarhia Institute of Engineering and Technology, Phagwara*
[3]*Principal, Ramgarhia Institute of Engineering and Technology, Phagwara*

Abstract - The WSN is the decentralized kind of a network that is capable of sensing information and transmitting it to the sink. The whole network is split into clusters and the selection of each CH is done in each cluster. The distance and energy consumption are utilized for choosing the Cluster Head in every cluster. The sensor nodes available in each cluster are utilized for aggregating the data to CH. The bio-inspired method is applied on the base station which can move from one location to another for the data collection. The proposed model is deployed in NS2 and the analysis of results is performedon the basis of certain metrics. It is analyzed that network throughput of the network is improved; energy consumption and packet loss is reduced in the research work.

Keywords - Mobile Sink, WSN, Bio-Inspired, NS2

I. INTRODUCTION

WSN is a kind of huge and distributed network in which low-cost and battery-constrained sensor nodes, that are less expensive and limited battery, have comprised. The employment of these sensors is done in the target regions randomly for monitoring the physical attributes of thesurroundings namely temperature, humidity, and pressure. A cooperative technique called multi-hop is utilized to transmit themonitored data to the data. This data is relayedto a remote server using thecollector to analyze the data [1].The energy-constrained batteries are utilized to give power to the sensors. These batteries are not replaced as sensors are available in huge amount and its cost is very high. Therefore, EERPs are implemented in WSN to deal with the issue ofenergy shortage. Moreover, the energy utilized by sensor is not balanced. Every sensor has its monitoring range and fade zones will appear and the performance of the network will be diminished after the death of node [2]. The issue ofunbalanced energy and the energy holes are akin to each other as these issues are occurred due tohot-spots issue. The static sink and fixed network topologyis the major reason ofhot-spots problem in WSNs. There is pressure ofbusier traffic on nodes which are present around the sink as the transmission of datapackages is required fromthe outer layer to the sink. The energy is also exhausted quickly due to this [3]. The major intend of this work is to deal with the issue ofenergy efficiency and energy balance and to attain promising outcomes. In Clustering technology, thesensors are separated into clusters based on some special rules to minimize the consumption of energy in WSN. Every cluster selects one or more CHs (cluster heads) to make them relay nodes for its members [4].Clustering assists the network in simplifying the topology structure and avoiding the direct communication amid sensors and the base station (BS). Moreover, theredundant data is filtered using data fusion in cluster heads so that the burden of CHsis reduced. LEACH is the traditional routing algorithm. But this approach is not suitable to choose the cluster head. Thus, much work is required to be carried out on LEACH.Sink mobility technology is an effective technique which can tackle the unbalanced energy in Wireless Sensor Network. In WSN based on MS (mobile sink), the intelligent vehicles or robots carry the sink and the sink is facilitated to movearound the sensing field. The travelling tour of mobile sink can be reduced by lessening the delay that is occurred when data is collected. Few nodes are considered as Rendezvous Points and the tour is made over them [5]. The Rendezvous Points are utilized to collect thesensed data under the field and for delivering them to the mobile sink. The clustering method is put together with the issue of constructing a tour so as energy depletion can be diminished. These algorithms emphasize on dividing the nodes intoclusters at which the CHs are taken as Rendezvous Points.

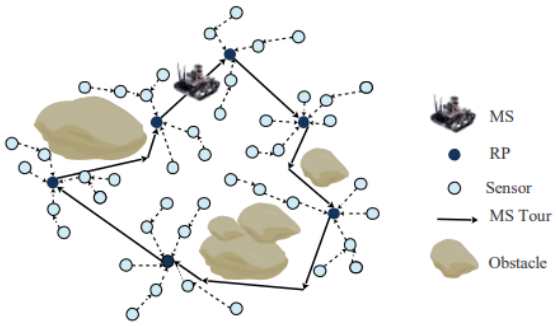

Fig. 1 Data Collection based on Mobile Sink during the obstacles

The availability of obstacles makes the issue ofcluster and tour construction more complex. The figure 1 represents that the mobile sinktour should avoid the hindrances [6]. Additionally, the clustering method is affected when the obstacles are present. A number of techniques are utilized to deal with the issue related to collect theobstacle-aware MS-based data.TheLEACH algorithm is utilized to develop the cluster.A heuristic approach is utilized so that the tour is generated over the cellswithout any obstacles on the basis of spanning graphafter generating avirtual grid over the sensor field. But, clustering based obstacle-aware algorithms face serious problems due to which their performance is constricted. To illustrate, all the sensors are visited by the mobile sink. Consequently, the tour becomes longer and data delivery delay becomes higher [7]. DGOB is an effective technique to be implemented to gather the data based on MS in WSN. DGOB algorithm divides the original problem in two stages. These stages are executed using AI (artificial intelligence) techniques. The initial stage implements OCC in initial stage and OCU in next stage. The cluster is constructed with the help ofk-melodies,HAC (hierarchical agglomerative clustering) and ACO (ant colony optimization). This technique provides the clusters of higher quality. Thus, these clusters are updated through OCU for preserving thequality of clusters in the next rounds. For this purpose, GA (Genetic Algorithm) is exploited [8]. The second stage includes the utilization of OMTC (Obstacle-aware MS Tour Construction). TheGenetic Algorithm-Multi-Agent Reinforcement Learning algorithm is expanded in this approach in which GA is utilized with MARL (Multi-Agent Reinforcement Learning) for constructing theMS tour when obstacles are present. These obstacles are considered to describe the distance amid each pair of cluster heads (CHs). The GA-MARL algorithm employs the resultant distances [9]. The DGOB is efficient for alleviating theusage of energy and preserving the delay requirement. The availability of obstacles leads to maximize thehop count of some sensors from the cluster heads present in the correspondence position. Moreover, when these obstacles are skirted, the length of tour is extended. Thus, the hop count and tour length metrics are considered inObstacleare Cluster Construction (OCC) for determining theproper cluster heads and clusters. Additionally, this technique is capable to balancethe size of the clusters so that the duration of network can be increased. The energy-aware metrics are utilized inObstacle-aware Cluster Updating so that cluster is updated. The RE of Cluster Heads and the hop count amid the cluster members and Cluster Heads are comprised in this technique [10]. The clusters are shifted using OCU.Theaverage hop count of the nodes from their Cluster Heads does not change its level over time. Consequently, the life span of network is prolonged. In the end,the affect of obstacles,due to which distances of the cluster heads are disturbed, is taken in account and the short travelling tours are constructed in OMTC.

II. LITERATURE REVIEW

Samad Najjar-Ghabel, et.al (2020) presented a novel algorithm forDGOB [11]. Two techniques were put forward in the initial stage. The first technique was utilized in the first round in which high-quality clusters were developed when the obstacles were present. For this,hierarchical agglomerative clustering and ACO (ant colony optimization) were employed.The second technique was executed in succeeding rounds made the deployment of GA (Genetic Algorithm) for updating the present clusters. The second phase of presented approach employed an efficient scheme on the basis of Genetic Algorithmand MARL. The outcomes of simulation depicted that the presented algorithm was capable of enhancing theenergy consumption up to 34% and prolonging the duration of network up to 80% in comparison with traditional techniques.

GuangqianXie, et.al (2016) investigated an effective system on the basis ofspanning graphs [12].A heuristic TP modelwas introduced for the MS with the objective of discovering the obstacle-avoiding shortest route. MATLAB was applied to carry out the experiments. The experimental outcomes revealed the feasibility of the investigated approach for the dispatch of MS. This approach was adaptable to determine theobstacle-avoiding for MS and maximize the duration of network.

Chuan Zhu, et.al (2018) proposed a high-available and location predictive technique to gather the data using mobile sinks so that issue was tackled [13]. The sensor nodes had potential for computing the current location of MSs on the basis of timesynchronization. The network was able to work even in case of failure of some mobile sinks. The energy consumed by the nodes was considered to suggest themoving trajectory adjusting strategy so that the usage of energy was balanced among of nodes in the network. The outcomes of simulation depicted that the presented technique performed more effectively in contrast to other techniques.

Maryam Naghibi, et.al (2020) recommended a technique named EGRPM for splitting the network into some cells in a

geographically manner [14]. The cells nodes sensed some data which was collected usingtwo mobile sinks. The SCCs (single-hop communication cells) and MCCs (multi-hop communication cells) were two kinds of cells. The MCCs transmitted the data to MS using this technique. The NS2 simulator was utilized to simulate the recommended technique. The results of comparative analysis validated that the recommended technique leads to mitigate theaverage energy consumption and delay and maximize the PDR (packet delivery rate) and duration of network.

AreejAlsaafin, et.al (2018) suggested adistributed data gathering protocol with the help of MS for WSN [15]. Atrajectory was constructed for MS for alleviating theenergy consumption and delay. Three algorithms were put forward to assist various applications such as REP, RDP and DBP. The data was gathered on the basis ofan effective scheduling method when the mobile sink undergone the developed route. The simulation exhibited that the suggested technique was authentic with regard toenergy, delay, and time complexity.

Muhammad Faheem, et.al (2017) developed a newMQRP for WSN so thatSGI 4.0 was empowered [16].TheEstiNet9.0 tool was applied to conduct the simulation. The experimental outcomes indicated that the developed approach assisted in enhancing the QoS (Quality of Service)performance metrics including PDR (packet delivery ratio), overhead, duration of network andthroughput and lessening the error rate, E2E delay than the traditional techniques.

Praveen Kumar D., et.al (2018) intended a newmobile sink path determination onthe basis of ACO for WSN [17]. This approach emphasized on increasing the life span of network and reducing the delay during the collection of data from the sensor nodes. An effective system was put forward for discoveringa near-optimal set of Rendezvous Pointsand travelling path of the MS for fulfilling the desired objectives.The energy consumption was balanced among the sensors by re-selecting the rendezvous points. The simulation results demonstrated that the intended algorithm provided higher performance as compared to traditional algorithms.

III. RESEARCH METHODOLOGY

The proposed methodology will be planned on the basis of the relocation of nodes in WSN for maximizing the network duration. The partition of entire network is done intoclusters that have fixed size and the CHs are chosen in every cluster. The data of nodes available in cluster is utilized to aggregate the data to its CH. The suggested method is designed on the basis ofsome assumptions under first assumption. The location ofall sensor nodes is known to the base station. The base station will move to CH from at which the data is data is gathered by it and will able to attain that location from the stored location of CH. The location of BS is adjusted by itself in accordance with thesignal strength. The best position is attained by location in the presence ofmaximum numbers of CHs in the range of sink. An equation is suggested in this work for computing the signal strength and judging the numbers of CHs present in the range of sink. The BCO algorithm is implemented to decide the movement of sink. In this algorithm, an arrangement of operations,which are appeared aselements of the bumble bee conduct, is accepted inAnt Bee Colonycalculation. The sustenance source quality whose association is established with the nourishment's area is known as the fitness value. The process replicates the quest of honey beefor imperative sustenance sources. It provides the similar one forthe preparation to discover the ideal arrangement.The insignificant model for a bumble bee province comprises of three classes: employed various bees. The honey bees whose employment is done will be in charge of examining the honey bees sustenance sources and offering the data to select spectator honey bees.

Description of Flowchart

1. The WSN is executed with limited number of sensor nodes and the clustering based on location is utilized to split this network into fixed size clusters.

2. The LEACH protocol is deployed that can choose the CH in everyclustering. This protocol assists in choosing the node that has high maximum energy and less distance to the other nodes as the CH. Theother nodes present in the cluster are utilized for aggregating its data to the CH.

3. The coordinates of the BSrepresent the preliminary population to carry out the sink movement. Thesignal strength is checked; its location is changed based on the initial population and the data is aggregated at which it gets maximum data using the sink node.

4. This abovementioned is repeated till the aggregation of required data to the sink.

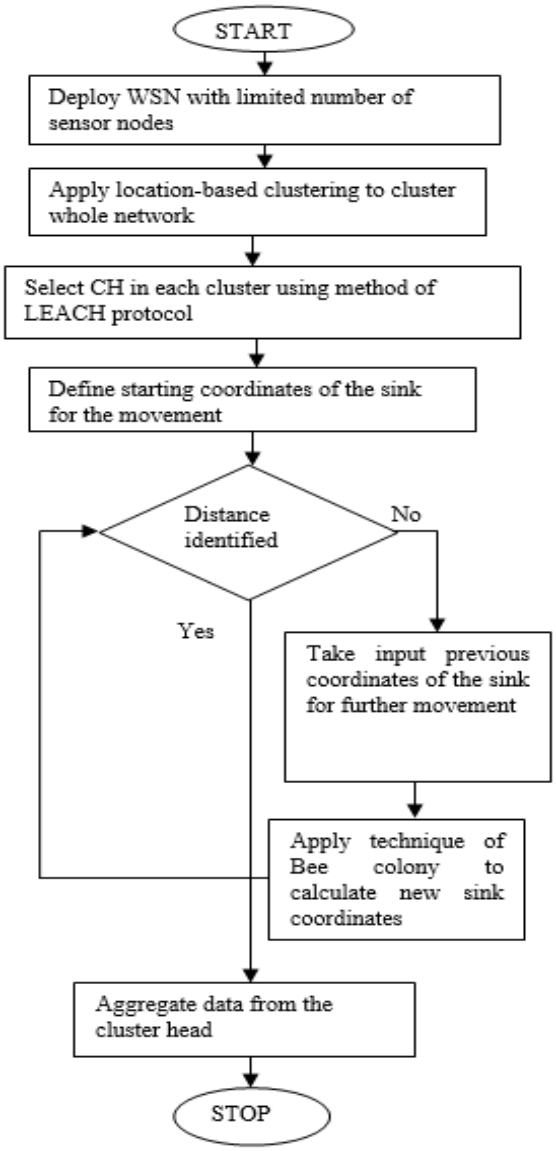

Fig. 1: Proposed Flowchart

IV. EXPERIMENTAL RESULTS

TheNS2 simulator is applied to deploy the suggested algorithm and the comparison of suggested algorithm is done with the existing approach to analyze the results with regard to various metrics includingenergy consumption, packet loss and throughput.

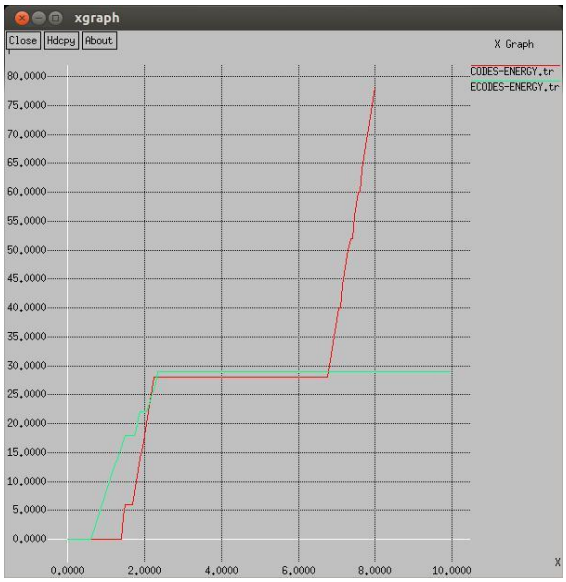

Fig 2 Energy Comparison

The figure 2shows that the suggested algorithm is compared with the state-of-art scenario with regard to the energy consumption. The energy graph depicted that energy consumed in the suggested scenario is lower by deploying multiple sink in the network.

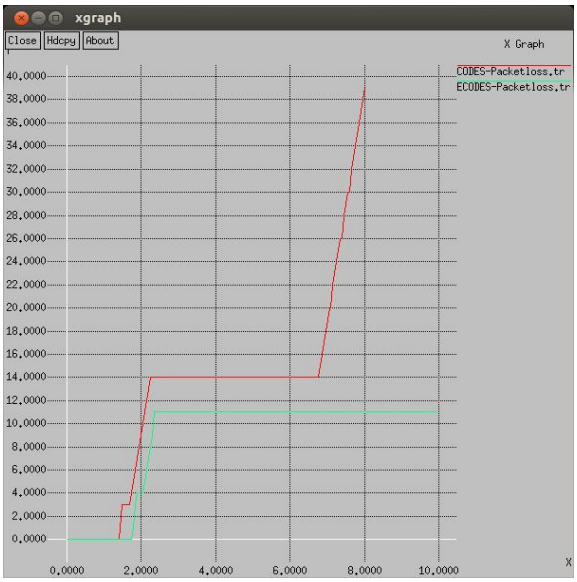

Fig 3 Packet loss Graph

The figure 3 represents the comparison of the suggested technique with the existing scenario concerning packet loss. The packet loss is more because of the sink and the mitigation of packet loss is found at steady rate in case of

implementation ofmultiple sinks are deployed in the network.

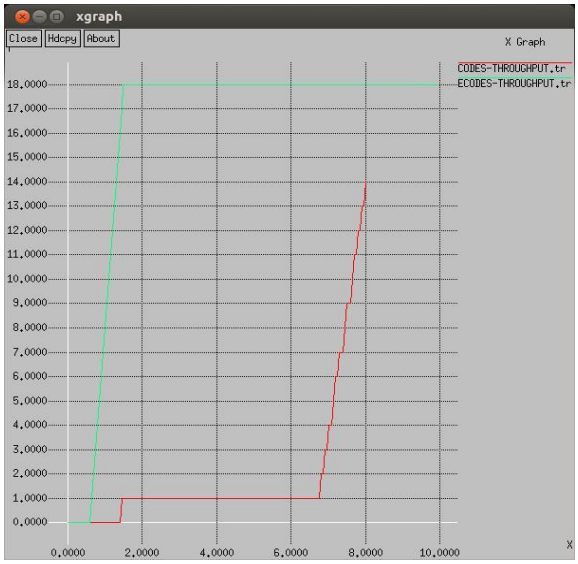

Fig 3 Throughput comparison

The figure 3 illustrates the comparison of throughput of suggested technique withthe existing algorithm. This demonstrated that when themultiple sinkis employed in the network, the maximization of throughput is found at steady rate.

V. CONCLUSION

This research paper concluded that the WSN is a self configuring network which assists in sensing theinformation through sensor nodes and transmitting it to the base station. The problem of energy consumption is often occurred in Wireless Sensor Network as the sensor nodes are small sized and they are deployed at far. This work suggested amobile sink method on the basis ofbio-inspired algorithm for prolonging the network duration. The NS2 simulator is utilized to analyze the performance of the suggested algorithm concerning various parameters.

VI. REFERENCES

[1]Jau Yang Chang, JinTsongJeng, Yung Hoh Sheu, Z. Jie Jian and Wei Yeh Chang, "An efcient data collection path planning scheme for wireless sensor networks with mobile sinks", 2020, Eurasip Journal on Wireless Communications and Networking

[2] Jin Wang, Yu Gao, Wei Liu, Arun Kumar Sangaiah, and Hye-Jin Kim, "Energy Efficient Routing Algorithm with Mobile Sink Support for Wireless Sensor Networks", 2019, Sensors

[3] Yong Lu, Na Sun, Xiuqin Pan, "Mobile Sink-Based Path Optimization Strategy in Wireless Sensor Networks Using Artificial Bee Colony Algorithm", 2019, IEEE Access, Volume: 7

[4] Joohan Park, Soohyeong Kim, JiseungYoun, SeyoungAhn, and Sunghyun Cho, "Iterative Sensor Clustering and Mobile Sink Trajectory Optimization for Wireless Sensor Network with NonuniformDensity", 2020, Journal of Wireless Communications and Mobile Computing

[5] Santosh Soni and Manish Shrivastava, "Novel Learning Algorithms for Efficient Mobile Sink Data Collection Using Reinforcement Learning in Wireless Sensor Network", 2018, Journal of Wireless Communications and Mobile Computing

[6] Hong Zhang, Zhanming Li, Wanneng Shu and Jarong Chou, "Ant colony optimization algorithm based on mobile sink data collection in industrial wireless sensor networks", 2019, EURASIP Journal on Wireless Communications and Networking

[7] Rezoan Ahmed Nazib and SangmanMoh, "Sink-Type-Dependent Data-Gathering Frameworks in Wireless Sensor Networks: A Comparative Study", 2021, Sensors

[8] U.NilabarNIsha, S.Velmurugan, L.Raja, G.Shanthi, "A Survival Studyon Data Gatheringand Target Tracking Techniquesfor Energy Efficient RoutinginWSN", 2020, Journal of Critical Reviews, Vol. 7, No.4

[9] LaxmikantReddi, Najam-Al-Saher, "Routing for Sink Nodes with Obstacles in Cluster-Based WSN", 2017, International Journal of Engineering Research & Technology (IJERT), Vol. 6, No. 8

[10] Mr. Praveenkumar, Prabhakar Pawar, Mr. Umashankar M L, "Obstacle Avoiding Routing in Wireless Sensor Network using Mobile Sink", 2017, IJARIIE, Vol. 3, No. 3

[11] Samad Najjar-Ghabel, LeiliFarzinvash, Seyed Naser Razavi, "Mobile sink-based data gathering in wireless

sensor networks with obstacles using artificial intelligence algorithms", 2020, Ad Hoc Networks

[12] GuangqianXie, Feng Pan, "Cluster-Based Routing for the Mobile Sink in Wireless Sensor Networks with Obstacles", 2016, IEEE Access

[13] Chuan Zhu, Kangning Quan, Joel J. P. C. Rodrigues, "A high-available and location predictive data gathering scheme with mobile sinks for wireless sensor networks", 2018, Computer Networks

[14] Maryam Naghibi, Hamid Barati, "EGRPM: Energy efficient geographic routing protocol based on mobile sink in wireless sensor networks", 2020, Sustainable Computing: Informatics and Systems

[15] AreejAlsaafin, Ahmed M. Khedr, Zaher Al Aghbari, "Distributed trajectory design for data gathering using mobile sink in wireless sensor networks", 2018, AEU - International Journal of Electronics and Communications

[16] Muhammad Faheem, V. C. Gungor, "MQRP: Mobile sinks-based QoS-aware data gathering protocol for wireless sensor networks-based smart grid applications in the context of industry 4.0-based on internet of things", 2017, Future Generation Computer Systems

[17] Praveen Kumar D., Tarachand Amgoth, Chandra Sekhara Rao Annavarapu, "ACO-based mobile sink path determination for wireless sensor networks under non-uniform data constraints", 2018, Applied Soft Computing