Enhanced Data Gathering Efficiency in WSNs with Mobile Sink via MST-Based Clustering and Plane Sweep Algorithm

Pragati Taneja*, Abhishek Bajpai§
*§Computer Science and Engineering, Rajkiya Engineering College Kannauj, India
Corresponding email:tanejapragti787@gmail.com

***Abstract*—In current years, power efficient data transmission is one of the greatest applications in wireless sensor networks (WSNs). Therefore various routing protocols are used to mitigate the energy consumption and maximize the lifetime of the connection to find the shortest path in WSNs . it faces many problems due to deferment and energy expenditure.so this research has determined a Minimum Spanning tree (MST) based clustering with Plane sweep algorithm (MSTCPSA) to overcome these issues. The clustering helps to find a optimal data gathering route by concluding the expected routes. Due to slow speed of Mobile sink base station (MSBS) , data delivery latency is high. When MSBS moves with maximum speed , there is an extra delay at few points .this problem is minimized by plane sweep algorithm . commonly utilized is for improving data aggregating time. We proposed this work to search optimal visiting points , optimal data aggregating route and improve data aggregating time. This mechanism maximize the data aggregating accomplishment as well as prolong the lifetime of the connection. The proposed prototype is build and experimented in MATLAB atmosphere. After that, the cultivated prototype are operated in terms of efficient energy consumption and connection lifetime. Moreover the effectiveness of this mechanism is validated.**

***Index Terms*—Energy Consumption, Wireless sensor networks, Connection Lifetime, Mobile sink .**

I. Introduction

A wireless sensor network (WSNs) [1], [2]is a connection , which collected of geographically dispersed autonomous sensors to observe physical or environmental situations , such as temperature, sound, pressure, etc., and to pass their information through the connection to a target location. WSNs usually made up of a hundreds and thousands of sensor nodes, each equipped with a sensing unit, a processing unit, a communication interface, and a power source (generally a battery). These devices perform three common tasks: sample a physical quantity from the atmospheric environment, process the acquired the information , and then transfer it to a Mobile sink base station[3]. The initially utilise of wireless sensor networks in the real environment is for monitoring and aggregating information in many observations .it consist : environmental monitoring , industrial monitoring and control , healthcare , smart agriculture ,structural health monitoring , wildlife tracking , smart home observations and so on[4]–[6]. In several conditions sensor nodes are supposed to be fixed. Every node employs on restricted battery power, where most of the part of the energy is exhausted on information communication and reception procedure . Battery power is an essential problem for sensor nodes since it is complicate to replace batteries with new ones in large-scale networks because it has limited battery power life, uneven energy depletion and self rechargeability. In straight communication strategy , sensor nodes transmit their information to the base station precisely . However, their battery power is expeditiously exhausted, when they communicate their information over long route[3] . In multi-hop communication, information are communicated by one sensor node to a centre sensor node, after that information is delivered to the mobile sink base station. When the sensing atmosphere is enormous or a base station is away from the sensor region, various nodes required countless hops to arrive the base station. This re-communication procedure is the origin of greatest node exhaustion. To conquered unequal energy utilization among the sensor nodes, clustering approach is suggested [5], [6]. DBSCAN (Density-Based Spatial Clustering of Applications with Noise) is a popular clustering mechanism utilized in machine learning and data mining to distribute a set of data points into clusters based on their density in a multi-dimensional feature space. DBSCAN can reduce energy over expenditure by assembling the sensor nodes into clusters to decrease the amount of communications and it also confine the straight transmission between the sensor nodes and the base station. However, DBSCAN advances localized data processing and collection within every cluster. Instead of communicating raw sensor information over long route to a cluster head, nodes within the same cluster can transfer collected data .it minimizes the required for incessant long-distance transmission[7], [8] and information addressing , thus preserving power .currently , as solution for data aggregating in WSN to maintain the energy expenditure environmentally among the sensors throughout the connection and covenant with secluded areas[9], [10]. In a Wireless Sensor Network (WSN), a mobile sink refers to a mobile node or external device that is eligible of operating within the connections inclusion region to aggregate information from sensor nodes. It is utilize to minimize the energy expenditure for the activity and motion of the mobile sink does not response on the lifetime connections. Systematically the mobile sink rebound to the base station to transfer aggregated information to proceeding and revitalize its battery-power to create upcoming journey [9]. In above mechanisms , prejudiced power utilizes among sensor nodes, it can be noticed as one of imperfections and it affects to connection operations. It is essential to minimize prejudiced power consumption among the sensor nodes. To improve data gathering time used plane sweep algorithm . the sake of contradiction that the MSBS does not finish the data aggregating process in minimum duration MSBS travels with its high velocity throughout the route avoid at few last -points. So, it takes, there is an extra delay at few last-points. Extra delay for collecting information from a sensor member is necessary only when the MS waits at some location , but for few sub-route of area[11]–[14] , the MSBS travels without collecting information from any sensor node or collect information from a sensor node , whose last -point appears after , i.e.one location is less than or equal to next location . This is because the sensor nodes, whose last-points appear after single location ,can transmit information beyond both locations and it may improve the waiting time at last point. In This paper , we proposes on the power utilize of sensor connections and to prolong the connection lifetime of the sensor nodes by using the clustering[9], [10] and the traverse route of a mobile sink. We could be use a mobile robot or a vehicle equipped with powerful batteries, long range transceivers, large memory units and GPS devices as a mobile sink. Commonly , information are aggregated at low rate and they are not time sensitive. The sensor nodes protect their information in their memory and transfer them to the mobile sink when the mobile sink a searches nodes. As an expansion of some previous work in this area, the contributions of this work could be summarized as follows:

- We determine optimal visiting points and a data aggregation route for a mobile sink to balance wireless sensor networks precisely in power aspect. We utilize a midpoint of every cluster as data aggregating point. It is known as cluster head. To address the optimal data aggregating point and build clusters, DBSCAN [4], [6]algorithm is utilized. It creates to minimize the intra-cluster transmission and for achieving energy accurately for sensor nodes.
- To decrease data aggregating period, we choose an optimal journey route for a mobile sink before each data aggregating path.
- To address the path, we utilize the Minimum Spanning tree solution and to improve the data aggregating time , use Plane sweep algorithm. Plane sweep based on-line data aggregating mechanism is suggest to aggregate information from the cluster member by balancing the information collecting events from the cluster members and velocity of the MSBS node.

systematic flowchart of the proposed approach is represent in given figure1

The paper is systematize as follows. In Section 2, various approaches related to the suggested approach are explained . In Section 3, Network Model ,Energy Models utilized in this study and assumptions are explained . Section 4 described

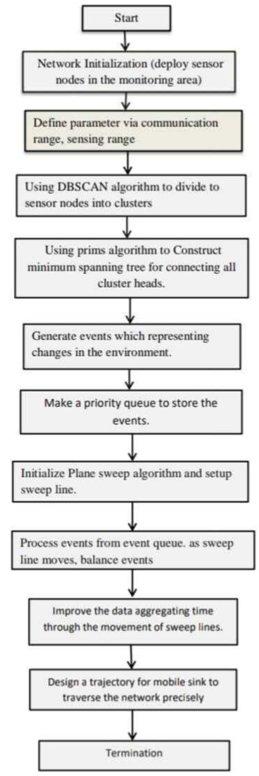

Fig. 1. flow chart of the proposed approach to prolong the lifetime of the network

the proposed method. In this section, clustering and creating precise route for the mobile sink and data aggregating in clusters are provided briefly . Simulation outcomes and comparison to other works are given in Section 5. Finally, Section 6 concludes this study .

II. Related Work

Various data aggregating algorithms have been suggested in the literature utilizing mobile sink node where the route of the MS is controllable or static . Depending on observations , dissimilar objectives achieved such as enhancing connection lifetime, reducing the whole power consumption, decrease whole route length, etc. In this portion , we categorize the literature depend upon whether the route of the MS is controllable or static. below is the existing work which to overcome these issues with various approaches. Ilkyu Ha et al.[3] expressed their idea regarding to save the energy In wsns , power is one of the most prime natural resources since each node aggregates, proceeds and communicates information to its base station. In this , Most of the conventional experiments in WSNs are existed of fixed nodes and one base station. Currently, some mobile information aggregating procedures are suggested to extend the working time of sensor connections. There are some mobile collectors are utilized to aggregate the sensed information from sensor nodes at short communication ranges. The author proposed this paper to search optimal visiting points and data gathering route for a mobile sink within clusters. With experimenting an optimal clustering and data gathering route, this approach enhances the information gathering performance as well as the network lifetime extension of sensor connections . By this approach , The network lifetime is enhanced to 20 percent when sensor nodes are categorized into from 4 clusters to 15 clusters. Jian Zhang et al.[4] proposed their work to consume the energy . Power Consumption or power balance in the procedure of information aggregating has always been a major problem for increasing the processing time of WSNs, exceptionally on the hypothesis of the overview of mobile morphemes to manage with the rare occurrence of hot spots or power spaces. In this research, they suggested optimal cluster-based techniques by a enhanced multi-hop layered model for load compensating with several mobile sinks for these issues. Furthermore, under the condition of a delay-tolerant application, rendezvous points (RPs) and rendezvous nodes (RNs) are used to appreciate the aim of desirable power consumption in the sense of power communication model through a inquiring algorithm in a mathematical way . Quantisation techniques are exploited to decrease the consumption of connection power. As a outcome, they analysed the cluster operation time in different environment and bring to successful balance to rescue significant power. Areej Alsaafin et al.[5] experimented their experiment to rescue the power. In this paper highlighted the many works have displayed the profits of utilizing a mobile sink (MS) to decrease the energy expenditure resulting from multi-hop information aggregation utilizing a fixed sink in WSNs. However, the utilizing MS may enhance the data delivery latency as it requirement to visit every sensor node in the network to gather information . This is a fault finding problem in delay-sensitive real time utilization where entire sensed information must be collected within a given real-time constraint. In this work, they suggested a distributed data gathering protocol using MS for WSNs. The suggested protocol architects a trajectory for the MS, which consumes power consumption and delay. Their protocol performs in four predominant stages : information sensing, rendezvous point (RP) election, trajectory prototype , and information aggregating . In information sensing, a number of positioned sensor nodes keep sensing the objective area for a particular period of time to seizure actions . after that , utilizing a cluster-based RP election algorithm, few sensor nodes are elected to become RPs based on local facts . The elected RPs are then utilized to describe a trajectory for the MS. For that , they project three trajectory prototype algorithms that support several categories of utilizations, this is to say reduced energy path (REP), reduced delay path (RDP), and delay bound path (DBP). The MS movements through the created route to attain its information aggregating according to an effective scheduling approach that was announced in their work. They certify the suggested protocol via comprehensive imitations over many metrics such as power, delay, and time complexity. Hong Zhang et al.[6] suggested the work to minimize the hot spot issue and maximize the network lifetime, information aggregating with mobile sink is an efficient amount to increase the system accomplishment . However, the traversing technique of sink node can be covered as traveling salesman problem, which can hardly achieve the analysis with polynomial running time. To mitigate above issue , an energy-aware information aggregating approach for mobile sink in wireless sensor networks utilising particle swarm optimization is recognized . initially , the geometrical model is developed according to the whole power consumption and delay constraints for mobile sink's information aggregation . after that , the optimal rendezvous points are elected to collected information generated from the source nodes via multi-hop relay, and the collection tree will be designed for information communication. The spanning tree is encrypted into particles, and the incidental approach is prototyped to originate the information aggregation spanning tree with constrain of tree height restrict . Furthermore, a particle swarm optimization algorithm with adaptive elite mutation is created to enhance the population diversity and restrict falling into the local optimal analysis prematurely. Simulation outcomes represent that the suggested approach can join the delay needs and decrease the whole power consumption of the connection. Nami Susan Kurian et al.[1] recommended the work , Although there are various issues connected with the sensor networks, the energy-hole issue is one of the serious problems linked to WSN. To overcome this problem, a mobile sink is systematically moved to determine information from the sensor nodes , which is redistributed in the field by custody all other nodes in the network as fixed. Rather than traversing all the nodes, which may result in delay, a mobile sink is sanctioned to traverse only the rendezvous points. in this , the head node and the rest of the nodes transmit information to the closest head node. The two necessary objections in this method are: searching the precise rendezvous nodes at dissimilar areas in the connection and also searching the route in which the mobile node necessary to be visited. Excellent rendezvous points not only the data enhance the data collection but also prolong the lifetime of the network. This paper proposed a new-fangled optimization technique called the P-AACO, Power-Aware Scheduling and clustering algorithm based on AACO, where an advanced ant colony optimization to decide the excellent mobile sink route for wireless sensor networks. To accomplish the appropriate the aims of upgrading network lifetime and decreasing latency, this technique consolidating an persuasive approach to search the optimal aggregation of rendezvous points. Reelection of RP is enforced after every step of communication to protect power utilization and maintain the network load. The suggested protocol is distinguished with LEACH and WRP by taking the achievement metrics such as delay, throughput, and energy into deliberation . The examination was enforced using the ns2 simulator and the from the outcomes achieved, it is conspicuous that the compensations of P-AACO are assorted and it exceeds the usual protocols. Zhou Wu et al.[2] shared their idea regarding to increase the lifetime .By expediting the information transmission in wireless sensor networks, the activity of mobile sink can extend the network relativity and sensory analysis . However, the excellent way perseverance of mobile sink is a NP-hard escalation issue. By collectively contemplating the cluster-based routing and sink mobility, in their work proposed an enhanced ACO-based activity scheduling of mobile sink for data aggregating in wireless sensor networks. To connect the delay demands and maintain the energy consumption of the sensor nodes, in this a optimal cluster heads election is determined. Then, an enhanced ACO-based movement scheduling algorithm is suggested to achieve the optimal route of mobile sink by moving the connection . The experimental outcomes display that our suggested approach can provide a excellent performance in terms of decreasing data delivery latency and prolong the lifetime of the connection. Vishnuvarthan Rajagopal et al.[9] recommended their work to enhance the network lifetime . Due to the maximizing world population, request for food products have formulated the requirement to rejuvenate and aggravate cultivation operations through accuracy cultivation. The Internet of Things provides a wide diversity of resolution for accuracy cultivation , but simulating it in the cultivation areas dictates objections to hardware and information transmission in the network. Specifical , the sensor nodes have to be decisive for long duration with the restricted accessible battery power. In this network, the aim of this work is to present an adequate information aggregation method which prolongs the network lifetime of the wireless sensor network (WSN), reduces the power hole problems and minimizes the data aggregation delay. In the presented study , the rendezvous points (RPs) in the connection are elected depend upon the power level of the nodes, data packet frequency and the range to the RPs. Then the mobile sink (MS) traverses to the RPs in the optimal possible route to aggregate the information from the information -powered points. A hybrid meta-heuristic approach called WOAXGWO is presented to search the optimal route for the MS. To evaluate the accomplishment , the connection 's lifetime, power expenditure , and latency are examined. Experimentation searching display the persuasiveness of the presented approach and are approved on a coconut farm to determine its authenticity. Bala Gangadhara Gutam et al. [10] presented the work, in this , In wireless sensor networks (WSNs), the energy-hole or hot-spot issue is an essential , grandiose problem because it is detaches some nodes from the sink. The hotspot issue is overcome by representing a mobile sink, where the mobile sink moved in the WSN, aggregates the information from rendezvous points (RPs) instead of traversing each sensor node. But, electing the excellent set of RPs and mobile sink prototypes is grandiose in the WSNs. In this context, this study presents an optimal RP and trajectory construction (ORPSTC) for the mobile sink in WSNs for information aggregation . originally , they employ the minimum spanning tree-based clustering method for RP election. In this level, an RP is recognized from each partition, whereas other nodes can send the information to RP. Next, they design a prototype for mobile sink among all the RPs, consisting the sink node utilising a computational geometric approach . It outcomes in a near-optimal route with minimal computational resources. Further, we also employ the RP re-election and online RP selection technique to maintain the power among the SNs. We experiment and calculate the presented ORPSTC and existing techniques , and the presented study outperforms among them. Dinesh Dash et al. [15] shared their ideas to prolong the network lifetime and power consumption . in this work represent that Mobile sink node (MS) has been utilize for effective information aggregating in wireless sensor networks (WSNs) to enhance the accomplishment of power strained sensors in various respects, such as integrity, energy expenditure , lifetime, etc. In this experiment , information aggregating issue from power harvesting wireless sensor networks (EHWSNs) is experimented . A MS traverses along a route to gather information from the connection via the closer sensors. These closer sensors are called as sub-sinks. Due to the quiet acceleration of the MS, the data delivery latency is high. However, optimizing the information aggregating schedule of the MS can decrease the information aggregating latency further. They design two novel optimization issues to reduce the information aggregating time, considering the amount of sensed information and staying power of the energy harvesting sensors. Plane sweep based online approach for searching optimal information aggregating schedule of the MS and a plane sweep based effective data circulation design among the sub-sinks are presented . The accomplishes of the presented approaches are experimented via imitation. The imitation outcomes display that our combined solution enhance the data gathering time, idle time, throughput, and also balances power neutrality of the power harvesting sensors. Amar Deep Gupta et al. [16] shared their for efficient environmental impact analysis, a wireless sensor network (WSN) utilised a aggregation of independent sensor nodes (SNs) , which were circulated at arbitrary astride a given region. WSNs were used for several utilizations that have need of real-time information . While the SNs in a WSN were restricted in their capacity to produce power , the path searching procedure was displayed as a essential means of increasing the connection's capacity to protect resources and extend its beneficial animation . In this proposed experimental work, they proposed sink mobility-based energy-optimized routing (SMEOR) in energy harvesting (EH)-enabled WSN. While following the cluster-based routing, the selection of cluster head (CH) was simulated utilising their presented extended spotted hyena Lévy flight optimization (ESHLFO) algorithm. Furthermore, to overcome the energy-hole issue , four information aggregation energy-unrestricted nodes were utilized circumference the outskirts of the connection. The sink progresses from one EH-enabled node to different node to aggregate information. Further, protection in SMEOR was guaranteed by enciphering the information utilising a stream cipher and a scornfully produced protection key. It is apparent from the execution investigation that SMEOR transfers network durability and absolute accomplishment. Saranga Mohan et al. [11] proposed their work to save energy without Quality of service deterioration . The concurrence of wireless sensor network-assisted Internet of Things had various utilizations .

In several utilizations, the sensors are battery-motorized and it is essential to utilize the power appropriately to enhance their working period efficiently . Mobile sinks-based information aggregation is utilized to increase the agedness of these connections . But furnishing a ascend-able and efficient result with deliberation for multi-criteria aspects of QoS and lifespan increment is still a objection. This experiment addresses this issue with a hybrid wireless sensor network-Long term progress assisted prototype. The issue of incrementing lifespan and giving multi-factor quality of service is executed as a two-stage optimization issue consisting clustering and information aggregating route scheduling. Hybrid meta-heuristics is utilized to determine the clustering optimization issue. Minimal Steiner tree-based graph theory is enforced to schedule the information aggregating route for sinks. Unlike extant research, the lifespan increment without QoS deterioration is addressed by hybridizing various techniques of multi-criteria optimal clustering, optimal path scheduling, and network adaptive traffic class-based data scheduling. This hybridization assists to increase the lifespan and increase the QoS regarding packet delivery within the suggested resolution . Through execution analysis, the recommended technique yields a noteworthy enhance of at least 6 percent and decrease packet delivery delay by 26 percent correlated to extant approaches . R. Saravanan et al.[12] recommended work to increase the lifespan of network . Wireless sensor network (WSN) transmissions captivate experimenters . WSN utilizes inexpensive sensor nodes to transmit information wirelessly to a base station, minimizing sensor node power and communication expenses . MWCSGA is well-proven, and NS-2 is utilized to appraise CSOGA's accomplishment . GA-LEACH and MW-LEACH measure experiment accomplishment alongside CSOGA. Simulating multiple encircling investigation the methodologies of TCL, C++, and Ns2. Live mode (NAM), energetic with trailing archive , analyses performance based on variables and principles. Power, latency, packet, quickness, and transfer ratio are metrics. This work displays how an IOT WSN can utilize a mobile agent and the multi-fold gravitational search method (MFGSA). The gravitational search algorithm (GSA) selects the cluster head (CH) and enhance the MA route to sensor nodes. Cluster head optimisation consisted node power , BS communication expenses, and adjacent nodes with crisis information. Clustering assigned MA source nodes, and GSA enhanced the route. Correlate the proposed approaches connection efficiency and increase lifespan to older ones. GSA-based MA itinerary planning is correlated to task power expenditure approaches. The innovative approach enhances MA achievement, connection establishment , and power utilize. Sunita Satish Patil et al. [13] recommended a work. In this , fuzzy based rendezvous points selection (FRPS) methodology for mobile information aggregating in wireless sensor networks is experimented. initially, the significance of diagnosed information is distributed into perilous and non-perilous based on the persistence and time restriction of information. Then two Sencars are build up: first for collecting perilous information by seeing consecutive to the analogous sensors, the second for collecting non-perilous information from other sensors. The rendezvous points (RPs) for seeing the Sen-cars are described by utilising fuzzy decision model based on the input variable power level, buffer occupancy level, and recent load. Based on the outcome of this prototype, each sensor is accredited a united utility value. After that the sensors with high utility values are elected as RPs and the analysis are transmit to the specific Sen cars. Lina Zhang et al. [14] proposed a study to prolong the lifetime of network. In this study, Wireless Sensor Networks (WSNs) collected of sensor nodes with location mobility, most wireless sensor nodes utilize batteries as their energy and have restricted power, therefore prototyping power -conserving routing protocols is essential for the long-term decisive experiment of mobile WSNs. In their work they proposed a method which is SPIN-PP . it is a simple power-conserving plat routing protocol, however, it is for static sensor nodes. To appease the need of protecting power for mobile WSN, this experiment is enforced. inclined the position of incidental movement of sensor nodes, depend upon the concept of plat routing protocol, this project embraces the approach of mobile sink node (sink) and utilizes the technique of vector projection to achieve the excellent trajectory of the sink node, so as to minimize the whole power consumption of transmission. The experimentation outcomes represent that, correlated with SPIN-PP protocol, the presented approach has great profits in conserving power and node runtime in a duration. Sai Srinivas Vellela et al. [17] recommended a experiment . in recent days , power-efficient information communication is one of the greatest objections in Wireless Sensor Networks (WSNs). so, several routing protocols were cultivated to reduce power consumption to search the optimal route in the WSN. However, they confront problems due to deferment and power consumption. Thus, this work has established a novel hybrid Chimp-based Clustering Flat Routing Protocol (CbCFRP) to conquered these disadvantages. The chimp fitness function in the prototyped miniature searches the shortest path for information communication . Therefore the power consumption and deferment are reduced. The clustering protocol supports to search the optimal path by concluding the expected paths. The suggested miniature is created and experimented in the MATLAB environment. Furthermore, the outcomes of the cultivated miniature are calculated in terms of throughput, delay, packet drop, and delivery rate. Moreover, the robustness of the approach is validated with a correlated experiment . The correlated experiment verifies that the cultivated miniature earned superior outcomes than the existing methods.

The comparison among algorithm which is used for load balancing of power consumption, accurate data recovery and low computation based upon their metrics and drawbacks . which is shown in below Table I.

III. Network Model and Problem Formulation

In this section, the wireless sensor network model is explained in the section and then Problem formation is explained:

TABLE I
COMPARISON TABLE OF ALGORITHMS WITH EMPHASIS ON ADVANTAGES AND DRAWBACKS

Author	Approach	Advantages	Drawbacks
Ilkyu Ha etal [3]	Clustering	Energy efficiency , load balancing , scalability	overhead , cluster head failure,scalability limitations
Nami Susan Kurian et al. [1]	P-AACO	Energy Efficiency, Enhanced Data Collection,Reduced Latency.	Complexity,Communication Overhead,Security and Privacy Concerns.
Zhou Wo et al. [2]	Enhanced ACO	Optimized routing, Dynamic Adaptation,Energy efficiency	Complexity, Overhead, Limited Adaptability, Sensitive to Parameters.
Hamidreza Salarian et al. [18]	Weighted Rendezvous Planning (WRP)	Efficient Data Collection, Load Balancing , Energy Conversation	Sensitivity to weight, Communication overhead
Jian Zhang et al.[4]	Rendezvous Algorithm	Extended Network Lifetime, balanced energy load, scalability, adaptability	Latency Considerations,Vulnerability to RP Failure.
Areej Alsaafin at al. [5]	Distributed trajectory Design	Energy efficiency , Adaptability	Challenges in parallelization
Samad Najjar Ghabel et al. [19]	Clusters using Genetic Algorithm	Optimized Cluster Formation,Mobile Sink Integration	Computational Overhead, Convergence Time.
Anjula Mehto et al. [20]	squirrel search algorithm based rendezvous points selection (SSA-RPS)	Bio-inspired Optimization	Computational Overhead, Parameter tuning
Vishnuvarthan Rajagopal et al.[9]	Hybrid meta- heuristic (WOAXGWO) algorithm	Potential for Improved Performance, Exploration and Exploitation	Computational Overhead
Bala Gangadhara Gutam et al.[10]	ORPSTC	Network Efficiency, Reduced Latency	Computational Overhead, Limited Predictability
Dinesh Dash et al.[15]	Plane Sweep Algorithm	Energy efficiency, Balance load	Computational Overhead
Nusaiba N. Al-Salahat et al.[21]	Enhanced LEACH Protocol	Energy Efficiency , scalability	Computational Overhead, Trade-offs Between Objectives
Amar Deep Gupta et al.[16]	Enhanced Spotted Hyena Levy Flight Optimization ´ (ESHLFO) algorithm	Energy Efficiency,Balanced Load Distribution, Adaptability	Parameter Tuning, Mobile Sink Hardware
Saranga Mohan et al.[11]	Minimal Steiner tree based graph the	Reduced Transmission Distance, Flexibility	NP-Hardness, Static Network Assumption, Overhead of Steiner Points
R. Saravanan et al. [12]	GA-LEACH and MW-LEACH	Optimized Clustering,Mobile Sink Integration , Reduced Hop Count	Vulnerability to Node Failures, Limited Power for Multi-Hop
Sunita Satish Patil et al.[13]	fuzzy based rendezvous points selection (FRPS)	Adaptability,Flexibility, Scalability	Parameter Tuning, Computational Overhead
Lina Zhang et al. [14]	SPIN-PP	Power-Aware Negotiation,Reduced Communication Overhead	Latency Considerations,Complexity for Mobile Sink Integration
Sai Srinivas Vellela et al.[17]	Hybrid Chimp based clustering flat routing	Energy Efficiency	Flat Routing Challenges ,Computational Complexity
Muralitharan Krishnan et al. [22]	Q learning	Adaptability,Dynamic Optimization, Self-Learning	Exploration vs Exploitation,Sample Inefficiency
Hong Zhang et al.[4]	Particle Swarm Optimization	Mitigate hot-spot problem, Derivative-Free ,Efficiency	Early Convergence ,Limited Interpretability
Hassan Al-Mahdi et al. [23]	clustering with genetic algorithm	Efficiency ,Scalability	Computational Overhead, Convergence Time
Kongara Mahesh Chowdary et al. [24]	Dynamic Clustering with Ant Colony Optimization	Adaptability, Avoid Hot-spot Problem	Computational Cost
R. Ashween et al.[7]	Oppositional grey wolf optimization (OGWO) algorithm	Improved Exploration,Enhanced Convergence Speed	Potential for Noise,Parameter Tuning
Shima Pakdaman Tirani et al.[8]	Weighted data aggregation trees with optimal mobile sink(s) (WDAT-OMS)	Efficient Data Collection, Adaptability	Complexity, Overhead
Jau-Yang Chang et al.[25]	Greedy-based algorithms	Approximation for Hard Problems, Efficiency	No Guarantee of Optimality

A. System model:

In WSNs , sensor nodes are distributed throughout the sensing area. Each sensor node is equipped with sensing, processing, and communication capabilities. Sensor nodes collect data from the environment and transmit it to the sink. This consist set of sensor nodes N= S1,S2,S3. . . . . . . .Sn. Categorize the sensing region into sectors using a DBSCAN algorithm. Form clusters within sector based on proximity .Every cluster selects a cluster head capable for coordinating data communication within the cluster. Construct an MST within every cluster. MST guarantees that there's a minimum total edge weight between all sensor nodes within the cluster. The cluster head coordinates the construction of the MST within its cluster. Mobile sink responsible for gathering data from sensor nodes. Mobile sink is utilized to overcome these energy conserving problems. It is improve the energy efficiency and improve network lifetime of the connection . In which all sensor nodes in cluster transmit their data to cluster head than cluster head communicate it to mobile sink. It reduce the energy consumption and prolong the connection lifespan. 2 in this set all sensor nodes are denoted by

$$S = \{\text{SensorNode}_i \mid i = 1, 2, \ldots, n\}$$

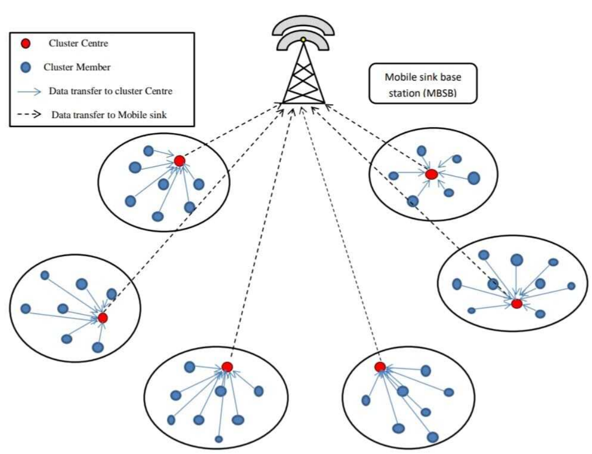

Fig. 2. System model: it represent the sensor deployed in the region

B. Energy Model:

To simulate the performance of the suggested approach, the prototype of the DBSCAN is utilized to correlate with the suggested approach[] and another experiments. Power Consumption for information forwarding to MBSB is proportional to the amount of hops and information transfers from origin to MBSB.

$$E = \sum_{i=1}^{n} \left(\alpha \cdot d_i \cdot p_i + \beta \cdot d_i^2 \right)$$

Where:

- E represents the total energy consumption.
- n is the number of sensor nodes.
- $\hat{d}_i$ is the distance from sensor node i to the mobile sink.
- $\hat{P}_i$ is the amount of data transmitted by sensor node i.
- α and β are coefficients representing the energy consumed per unit distance and per unit data transmitted, respectively.

Therefore, whole power consumption of the connection is calculated as the addition of the power consumption of all sensors . We suppose that if there is no data collection in the connection and the power consumption is not included.

C. Mobile Sink Base Station:

The mobile is used to minimize the energy consumption and maximize network lifespan. It travels along the predefined model and aggregates information from sensor nodes in single hop. When it ends data aggregating on predefined points , it returns to base station and transfers aggregated data to the base station . speed of mobile sink is constant. The mobile sink is take information of all the sensor node position. The mobile sink is connected with unrestricted power source, a powerful CPU with large storage, a long distance transceiver and a GPS.

D. Sensor Nodes:

In WSNs , consist hundreds and thousands of sensor nodes. All sensor nodes have the equal restricted power source . when sensor n odes are out of power these are described as dead node. And the base station and sensor node are static in location. Each sensor node is provided ID number. The location data and ID of sensor nodes are achieved during connection deployment duration. We suppose that aggregated information are not duration sensitive , they are protected in storage of sensor nodes. sensor nodes transmit their information when a mobile sink traverses them.

IV. Optimal Clusters and Data aggregating routes:

To balance energy precisely this paper utilizes a mobile sink and a clustering with plane sweep algorithm. In WSNs , when mobile sink is applied , managing and traversing precise routes must be described. In this section , the optimal visiting points , data aggregating route and improve data gathering in minimum time for mobile sink are finalized in clusters.

A. Decision of traversing points:

After organization of sensor nodes in the sensing region, they are categorized into clusters. Clustering sensor nodes might minimize excessive information, minimize the amount of inter-node transmission by localizing information communication within the clusters and minimize the total quantity of communication to the base station. In this study , sensor nodes transfer only with the mobile sink precisely. DBSCAN clustering mechanism is utilized to create clustering . Few situations are studied for WSNs utilizing the DBSCAN mechanism . Clustering is accomplished by the mobile sink since it has sufficient calculating and communication energy which does not have any affect the lifetime of sensor connections. The input to DBSCAN would be the spatial coordinates of the sensor nodes. Every sensor node is represented as a point in the 2- dimensional space, where n is the number of dimensions . this approach accepts the set of dimensions

$$\mathcal{D} = \{d_1, d_2, \ldots, d_n\}$$

1) Selects n points incidentally in the sensor region and create them as inceptive centres . At this position, few situations are considered when select unsystematic points. Inceptive points required to be selected not outer area of the sensor region. the density of sensor nodes is great in few regions and nodes are very near to each other. In such areas , inceptive regions required to be selected more.
2) Compute and search the closest centre for every sensor node and consider it to the cluster connected with the closest centre. At this stage , first clusters are made depend upon the inceptive cluster points. The centre of every cluster is modernized depend upon the situation of sensor nodes , which belongs to this cluster. Periodically , the recent centre will be the mean situation point of all the sensor nodes situate in the cluster. For every node, re-figure the interval between the node and all cluster centre utilizing Euclidean distance formula and assign the nearest one.
3) This process is repeat until no point converts into clusters. Distance is calculated by given formula:

$$\sqrt{(x_2 - x_1)^2 + (y_2 - y_1)^2}$$

At figure 3, there are provided set of sensor nodes and their (x, y) location data and sensor nodes will be categorized into six clusters. At Fig. 1a, the sensor nodes and their location data are A(4,9), B(10,12), C(14,8), D(2,8), E(5,6), F(16,4), G(12,33), H(15,5), I(5,4), J(10,20),K(4,8),L(10,8),M(8,6) N(12,4) and O(8,10). These points are utilized to compute interval utilizing Euclidean distance formula. Then, six points are selected in dissimilar location . In this case, the density of nodes is not great and inceptive points should not be selected to close each other. In figure 3, these points are elected at P(9,12), Q(10,24) , R(30,15), S(12,16),T(8,15)and U(6,14). For every node, the interval between the node and inceptive cluster centre is computed. When the nearest one is achieved , the node is considered to this centre. figure 3 shows that nodes are considered to nearest centre. Nodes are considered to the nearest cluster centres. Six dissimilar clusters are bordered with line. At this point inceptive clusters are organized . As delineated above these computed are re-evaluated until no cluster centres or sensor nodes members convert the cluster. The last simulation of clustering is shown in Fig. 1b. oval shaped squares represents cluster centres. Those centres will be data aggregating points for the mobile sink in data aggregating stage .

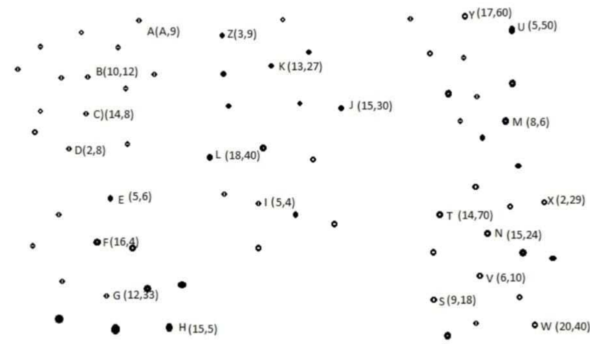

Fig. 3. Sensor nodes deployed in the sensing area

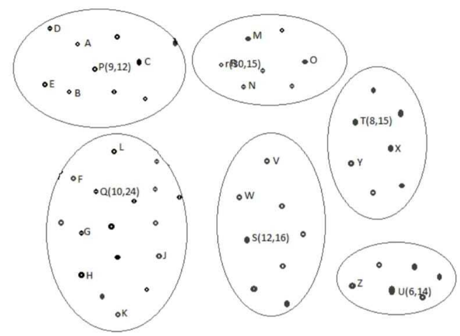

Fig. 4. sensor nodes categorized into clusters

B. Shortest route for Mobile Sink:

Searching power efficient traversing route for the mobile sink is one of NP issues. Inaccurate route creates extensive data aggregation duration . Cluster centres are persistent as data aggregating points. When the mobile sink searches to a data aggregating point, it will transfer with sensor nodes in the traversed cluster and achieves information from them by utilizing Time Division Multiple Access (TDMA) approach in one hop. During data-aggregating route of the mobile sink, it traverses the centres of every cluster. For instance, let DAP = DAP 1 , DAP 2 , DAP 3 … DAP n shows a set of data aggregating points. After that , data aggregating route of the mobile sink can be build as following .

- $\text{BS} \rightarrow \text{DAP}_1 \rightarrow \text{DAP}_2 \rightarrow \cdots \rightarrow \text{DAP}_n \rightarrow \text{BS}$

To search an precise data aggregating route , we used graph theory Let's consider that provided G = (V, U) graph, V-set of vertices shows the data aggregating points, U-set of edges which are route linking two data aggregating points. In Fig. 2, vertices cluster 1, cluster2 , cluster3 ,cluster4, cluster5 and cluster6 are data aggregating points and edges such as shortest route (cluster1,3) and (cluster2,4) are routes linking two data aggregating points. The base station is consider as beginning point. It is necessary to search minimum weighted path that goes through every graph nodes.

in weighted graph, minimum spanning tree (MST) is utilized to find the shortest data aggregating path . In MST, odd vertices are designated and emanate minimum weight which connects them.

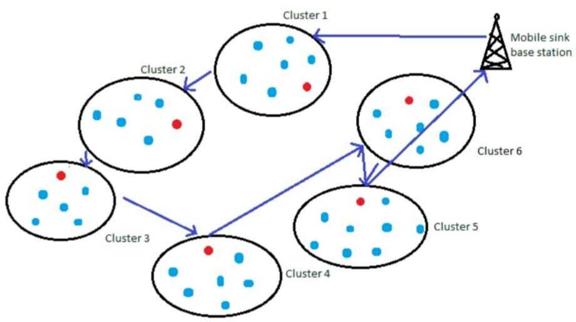

Fig. 5. MST route

Algorithm 1: Minimum Spanning Tree (MST) Algorithm for Optimal Data Gathering

Function `PrimMST`(*Graph, source*)
  Initialize an empty set MST to store the minimum spanning tree
  Initialize a priority queue pq to store vertices with their corresponding weights
  Initialize a list visited to track visited vertices
  Add source vertex to pq with weight 0
  while *pq is not empty* **do**
    Extract the vertex v with the minimum weight from pq
    if v *is not in visited* **then**
      Add v to MST and visited
      foreach *neighbor* u *of* v **do**
        if u *is not in visited and weight of edge* (v, u) *is less than key value of* u **then**
          Update the key value of u to weight of edge (v, u)
          Add u to pq with updated key value
        end
      end
    end
  end
  return *MST*

C. Plane sweep algorithm for optimal data gathering

To optimal aggregating in minimum time this algorithm gives more effective outcomes. The mobile sink organizes the sensor nodes, while moving through the multiple sensor nodes' transmission distance , depend upon their end-points' locations on P. The sensor node whose end-point appears first on P has greater priority than that sensor node whose end-point appears unpunctually. Let PR denote the priority of a sensor node. Generally , assume a horizontal data aggregating route P for the MS. In the plane sweep algorithm, a online sweep line at 90 degrees to P travels (sweeps) through the route P from S to E. While sweeping, the sweep line divides the sensor node' transmission disks. in this defined two kinds of events : start-point event and end-point event for each sensor nodes. Start-points and end-points of the sensor nodes are reserved in an event queue Q according to their aspect on P from left to right. At a particular location of the sweep line on P, balance a record of sensor nodes in a status line data structure L. The sensor nodes whose transmission disks bisect the sweep line on P are in L.If multiple sensor node' transmission disks bisect the sweep line on P and they have information , then a sub-sink in location with higher priority and having information and power to communicate achieves the predilection to transfer information to MS. Initially, all the start-points and end-points of the sensor nodes are summed to the event queue Q. We are requesting three approaches to accomplish dissimilar activity on the event queue Q. InsertInQ() approach is utilized for inserting an event, RemoveFromQ() approach deletes the leftmost event on P, and PeekFromQ() approach recover the leftmost event but does not delete it from the queue. Comparably , three approach InsertInL(), RemoveFromL(), and PeekFromL() are for the position line data structure L. Events are refined one by one from the event queue Q, as the sweep line travels through the path P. It starts by initializing an empty priority queue to reserve events related to sensor nodes' activations and deactivations. For each sensor node, it computes the time when the node becomes active and inactive, and inserts the corresponding events into the priority queue. Then, it sorts the events in the priority queue by their time stamps. In upcoming , it initializes an empty list to store the optimal data gathering trajectory for the mobile sink. It iterates through the sorted events in the priority queue. If the event is a node activation, it computes the time it takes for the mobile sink to reach the node and calculates the energy consumption for data gathering. If the energy consumption is within the sink's energy budget, it updates the sink's trajectory to gather data from the node and adds the gathering trajectory to the list. If the energy consumption exceeds the budget, it resumes to the upcoming event.

D. Linear Programming Formulation

The linear programming formulation consists of an objective function and constraints.

1) Objective Function: The objective function represents what we want to optimize, such as minimizing or maximizing a certain quantity. In our case, let's consider minimizing the total energy consumption (E) of the mobile sink while gathering data from active sensor nodes. The objective function can be represented as:

$$\text{Minimize } \sum_i E_i \cdot \Delta t_i$$

Here, E_i represents the energy consumption at each step i of the mobile sink, and Δt_i represents the time duration at each step.

2) Constraints: Constraints are conditions that the decision variables must satisfy. These constraints could involve limita-

Algorithm 2: Plane Sweep Algorithm for Optimal Data Gathering

Data: Sensor nodes' data, Sink mobility trajectory
Result: Optimal data gathering trajectory for the mobile sink
Initialize an empty priority queue Q;
foreach *sensor node* **do**
  Compute the time when the node becomes active and inactive;
  Insert the node's activation and deactivation events into Q;
end
Sort events in Q by their time stamps;
Initialize an empty list L to store data gathering trajectory;
foreach *event in sorted events* **do**
  if *event is a node activation* **then**
    Compute the time it takes for the mobile sink to reach the node;
    Compute the energy consumption for data gathering;
    if *energy consumption is within the sink's energy budget* **then**
      Update the sink's trajectory to gather data from the node;
      Add the gathering trajectory to L;
    else
      Continue to the next event;
    end
  else
    Update the sink's trajectory to move away from the node;
  end
end

tions on the sink's mobility, energy constraints, communication range constraints, etc. we could have constraints such as:

- The sink's position (x_i, y_i) must be within the bounds of the deployment area.
- The sink must visit each active sensor node j within its communication range R before the node deactivates.
- The total energy consumption of the sink must be less than or equal to the energy budget.

E. Improve the data aggregating time by Plane sweep algorithm

This algorithm plays a essential role to enhance the data aggregating time.In this section, initially we describe linear programming problem (LPP) formulation of the proposed problem (data gathering in minimum time). further , describe a plane sweep based online algorithm. The mobile sink MS moves through the route P and gathers maximum information from the sub-sinks. The information availability and remaining energy budget of the sensor nodes are provided. The MS collects information from one sensor nodes at a time. The data gathering schedule of the MS is minimized . the time the MS collects from every sensor nodes at the dissimilar portion of the route P is optimized based on the sensor node's data delivery time.

V. Implementation

After sensor nodes are organized, the mobile sink has accomplished clustering stage and protect the cluster centres as well as DAP = (DAP 1 , DAP 2 . . . DAP k) data aggregating points and C = (C 1, C 2 . . . C k) list of clusters on its storage. The mobile sink begins data aggregating route and travels along the determined route. When it achieves information DAP i aggregating point, it ends and transmits 'Hii' message to sensor nodes . This 'Hii' message consists ID numbers of sensor nodes. When the sensor nodes attain this message, they examine the message. Whenever they get their ID number in the transmission message, they transfer a declaration message to the mobile sink and wait for reply . This declaration message consists ID of sensor nodes. If sensor nodes do not get their ID, they neglect the message. The mobile sink collects many declaration messages from all nodes of a cluster. On the basis of these declaration messages, the mobile sink makes a TDMA schedule for the nodes in the clustering environment . In TDMA schedule, duration slot is established for each node. When it accepts the declaration messages, the mobile sink transfer back a TDMA schedule to sensor nodes. In TDMA slot duration, sensor nodes transfer their information to the mobile sink. If cluster consists of n number of sensor nodes, TDMA schedule will have n slots, single for every node. As soon as the mobile sink terminates data aggregating in single cluster, it can protect them on its storage . The mobile sink travels towards to the upcoming data aggregating point on its route . After aggregating information from all clusters, the mobile sink reaches to the base station, transmits information and resumes data aggregating route for the upcoming level.

A. Performance Evaluation and Experimentation Outcomes:

To calculate accomplishment , power consumption of sensor nodes in the suggested approach and other correlating approaches are experimented . Then comprehensive simulations with dissimilar amount of clusters are organized and the outcomes of the suggested approaches with other existing mobile data aggregating mechanisms are correlated.

1) Experimentation Environment:: Various amounts of simulations are established and calculated to substantiate their accomplishment . during simulation the amount of sensor nodes is differing for 100, 125, 150 and 175 . the transmission range of the sensor is set to 75m . the sensing range of the sensor is 100m .The proposed method is assumed with different number of clusters.. The power efficiency of a sensor network is assumed for every condition . Simulation parameters are given as Table 1. 500 nodes are deployed in the connection region, 400 m × 400 m. The region is categorized into for sub areas of length 100m each. This is finished to finalized that the incidental transmission topology categorized into some connected components. During the simulation , the MS travels along horizontal route through the centre of the area. Inceptive energy of sensor nodes is 1 Joule. For the experiments , connection simulator 2 (NS-2) has been utilized . In the experimentation environment, 802.11ad MAC protocol, a wireless channel prototypes are utilized.

TABLE II
SIMULATION PARAMETERS

Simulation Parameters	
Simulation Tool	MATLAB
Number of sensor nodes	500
Number of surface sink nodes	2
Network Size	$400\,\text{m} \times 400\,\text{m}$
Transmission Range	75 meters
Sensing range	100 meters
Initial energy of sensor nodes	$1 - 5\,\text{J}$

VI. PERFORMANCE EVALUATION:

In WSNs, the long interval communication approach is not precise since sensor nodes have restricted power source. In other study, substantial quantity of power is exhaust by cluster heads. According to the energy model, CH (Cluster Head) exhausts Energy CH quantity of energy in single step . This power can be computed by given formulas.

$$E = \sum_{i=1}^{n} \left(\alpha \cdot d_i \cdot p_i + \beta \cdot d_i^2 \right)$$

where n is the number of member nodes in one cluster.d (amount of data transfer between cluster head to mobile sink) is power used by a CH to transfer information of member nodes in a cluster to the base station and p (amount of data transfer from sensor nodes to cluster head) is power utilised by a CH to collect information of member nodes. One of the distinct points of the suggested approach is intra-cluster transmission . When cluster head is nearer to cluster border, the worst case of the clustering approaches must be assumed. Nodes which are placed the adverse side of the cluster consume extra power to transfer with their cluster head. In suggested approach this type of memory of clustering is enhanced by traversing the mobile sink to the cluster centre. power consumption of nodes is minimized by neglecting utilize of CHs. Preferably , the mobile sink is worked as a CH for each cluster in connection . All sensor nodes consume their power to sense and to transfer with the mobile sink. The quantity power utilised by sensor nodes in single round is computed by below formula.

$$R = \left\lceil \frac{N}{C} \right\rceil$$

where: R represents the number of rounds. N is the total number of sensor nodes. C is the capacity of the mobile sink (i.e., the maximum amount of data it can collect in one round).

VII. RESULT ANALYSIS

A. DBSCAN Clustering

: DBSCAN (Density-Based Spatial Clustering of Applications with Noise) is a popular clustering algorithm in data mining and machine learning. It's particularly useful for clustering spatial data points based on their density distribution. DBSCAN groups together closely packed points and identifies outliers as data points that lie in low-density regions. distributed sensor nodes in the clusters shown in figure 6 it calculated by given formula:

A point p is a core point

$$\text{if } |\{q \in D : \text{distance}(p, q) \leq \epsilon\}| \geq \text{MinPts}$$

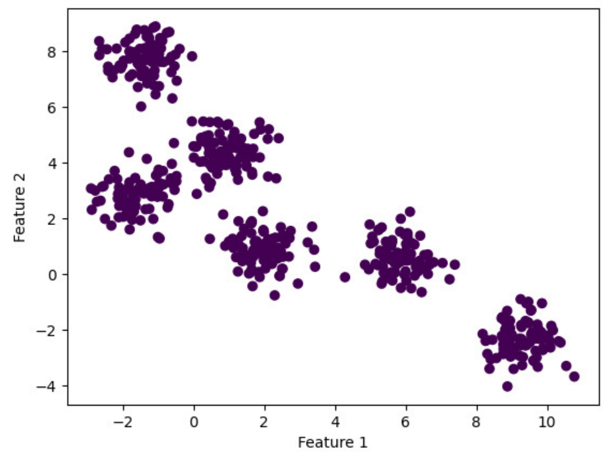

Fig. 6. Comparison with clustering algorithm

1) MST based clustering:: MST (Minimum Spanning Tree) based clustering is a clustering mechanism that utilizes the idea of Minimum Spanning Trees to deploy data points into clusters. In this approach, every cluster is represented by a subtree of the Minimum Spanning Tree. MST ensures that each data point is connected to every other data point within the cluster, promoting efficient communication and information exchange. cluster deployment shown in below figure 7

2) DBSCAN clustering with Plane sweep algorithm:: In DBSCAN with a plane sweep algorithm, the plane sweep technique is employed to precisely process spatial data points.The sensor nodes are distribute into sectors or strips using the plane sweep algorithm.Within each sector, DBSCAN is applied to identify clusters based on density.The plane sweep algorithm supports in organizing the spatial data and reduces the computational complexity of DBSCAN by limiting the amount of data points processed at every step.As the sweep progresses, clusters are formed and outliers are identified, leading to precise clustering of spatial data. distribution of sensor nodes of the sensing area is represents in below figure8

3) MST based clustering with Plane sweep algorithm:: In MST clustering with a plane sweep algorithm, the plane sweep technique is employed to efficient process spatial data

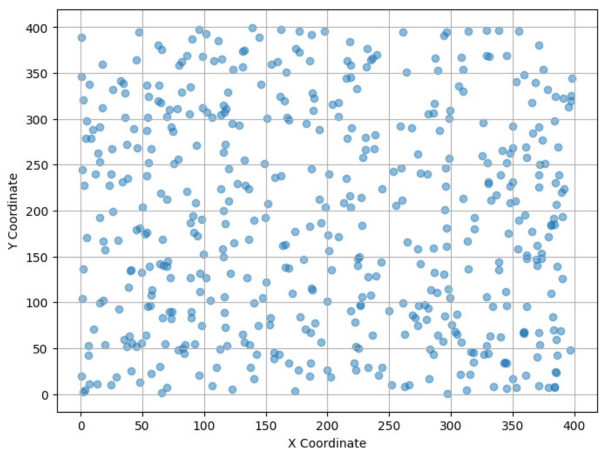

Fig. 7. MST based clustering for sensor deployment in the environment

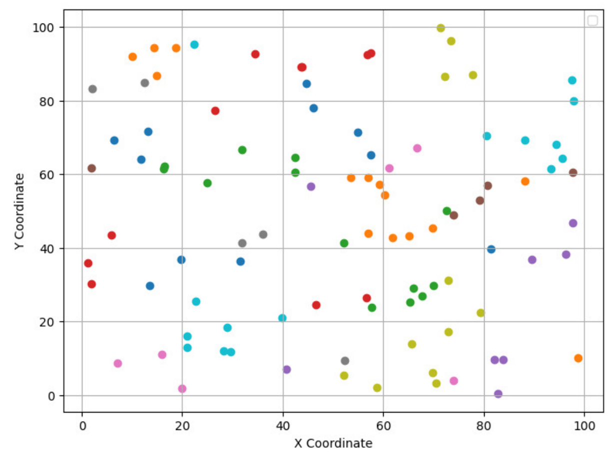

Fig. 9. MST based clustering with plane sweep algorithm

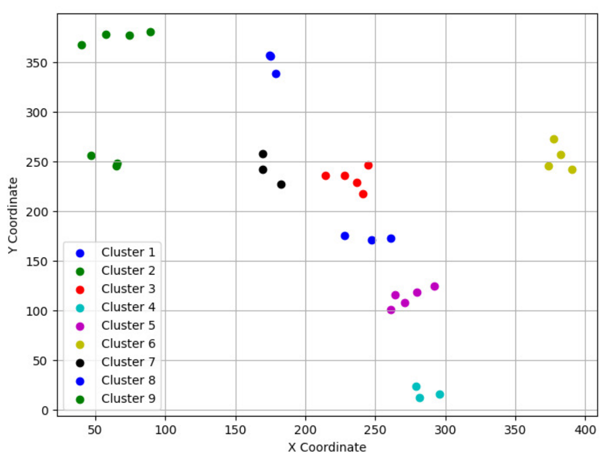

Fig. 8. DBSCAN clustering with plane sweep algorithm

points. The space is divided into sectors or strips using the plane sweep algorithm.Within each sector, it is applied to construct a Minimum Spanning Tree from the data points.The Minimum Spanning Tree is then utilize to partition the data points into clusters based on the structure of the tree.this combinations helps in organizing the spatial data and reduces the computational complexity of constructing the Minimum Spanning Tree by limiting the number of data points processed at each step. this gives a precise energy expenditure and increase the lifetime of connection. it is generally used to find a robust performance . in this, sensor nodes categorized efficiently. the distribution is shown below figure 9

B. WSNs with MST based clustering and Mobile sink:

MST (Minimum Spanning Tree) based clustering with a mobile sink is an method utilized in Wireless Sensor Networks (WSNs) to deploy sensor nodes into clusters and facilitate data aggregating with the help of a mobile sink. it beneficially to achieve optimal data aggregating points and shortest transmission route to reduce the energy consumption and increase the life time of connection .the organization of the sensor nodes and mobile sink is shown below figure 16.

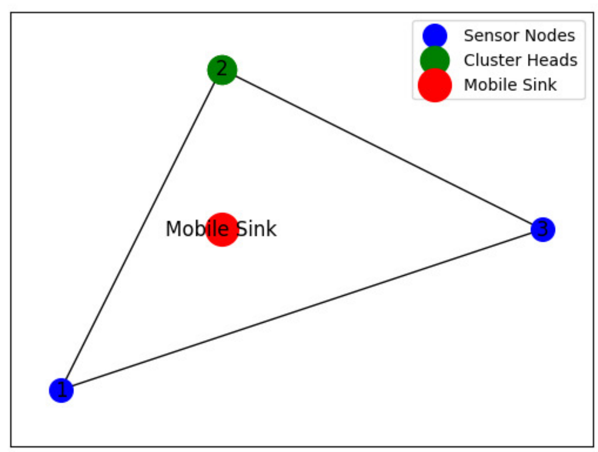

Fig. 10. MST based clustering and Mobile sink is used as a solution to find optimal data gathering

C. Optimal Data Aggregating using MST with Plane sweep algorithm

VIII. Comparison with other work

In this section proposed work is correlate with related study for Mobile sink and clustering methods:

A. Compare Cluster formation of DBSCAN with K- means and Fuzzy(GMM)

DBSCAN is capable of identifying clusters of arbitrary shapes and sizes, whereas K-means and GMM assume clusters to be spherical or elliptical. in case , where clusters have irregular shapes or vary in density, DBSCAN is provide more precise cluster formation.It is robust to noise and outliers as it identifies them as data points that do not belong to any cluster.and handle clusters with varying densities effectively.

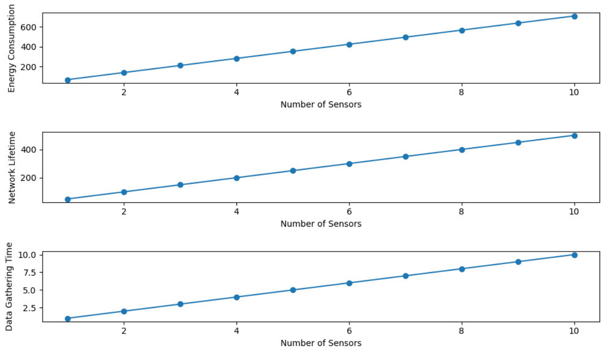

Fig. 11. Optimal Data aggregating using MST with Plane Sweep algorithm for efficient energy consumption, improve network lifetime and improve data aggregating time.

DBSCAN can handle large datasets efficiently, as it only requires pairwise distance calculations between data points within a specified neighborhood. K-means and GMM may struggle with large datasets due to the need to compute distances between all data points and centroid . the deployment of the sensor nodes are shown in given figure 12

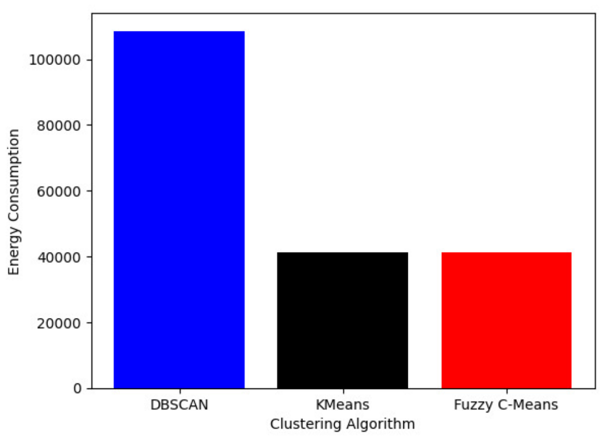

Fig. 12. Comparison graph among K means, DBSCAN and Fuzzy(GMM) clustering for efficient data aggregating

B. Comparison of Clustering Algorithm:

DBSCAN is outperform K-means and fuzzy clustering methods such as Gaussian Mixture Models (GMM) in terms of silhouette score in certain scenarios due to its ability to handle complex cluster shapes, outliers, and varying cluster densities. k-means algorithm provides 0.57 silhouette score, DBSCAN gives 0.59 silhouette score and fuzzy (GMM) gives 0.41 silhouette score. it represent that DBSCAN is better than both of them.It is shown in below figure 13

C. Comparison of Clustering Algorithm for optimal Data aggregating:

our proposed work shows that it is better than existing works . it reduce more energy precisely and increase the connection

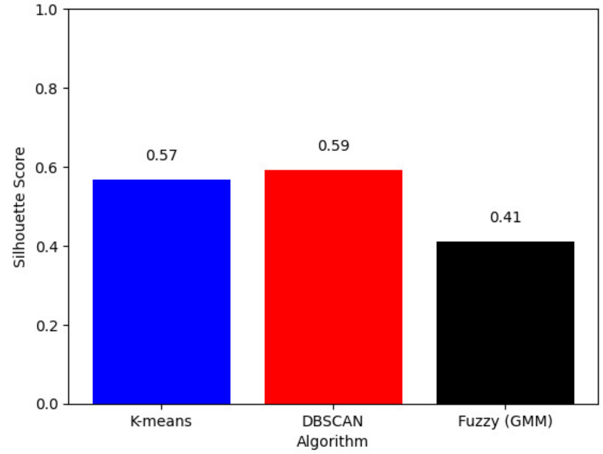

Fig. 13. Compare algorithms (K means , DBSCAN , Fuzzy(GMM) on the silhouette scores

lifetime. by this approach we find a optimal visiting points and shortest data transmission path. In this, MST based clustering focuses on organizing data points into clusters based on the structure of the Minimum Spanning Tree constructed from the data points. It utilizes the connections between data points to form clusters and Plane sweep algorithm is a computational technique used in computational geometry to process spatial data efficiently. It involves sweeping a line or plane across the space to detect and process events efficiently.it provides robust energy consumption without noise.which prolongs the lifetime of connection. Below figure 14 represents the efficiency of network.

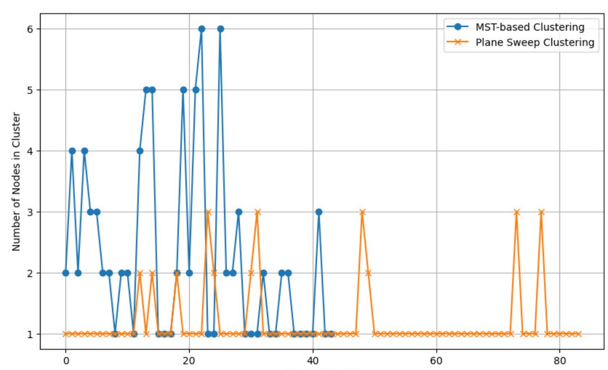

Fig. 14. Comparison with clustering algorithm

D. Compare with existing method

This method provides the better outcome with existing method. it shows the better outcome in figure 15

IX. Conclusion

This paper proposes optimal traversing points and a data aggregating path for mobile sinks in WSNs and the suggested approach increases and manages the power consumption of

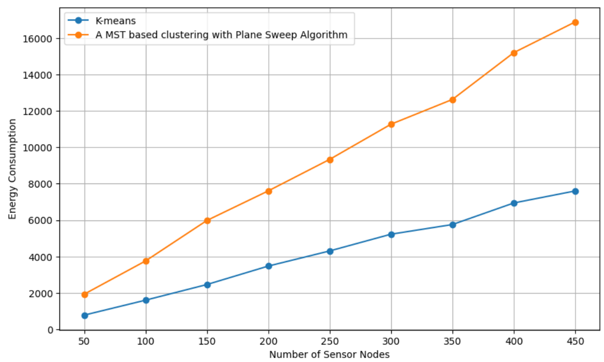

Fig. 15. Comparison of Energy consumption existing approach with proposed approach

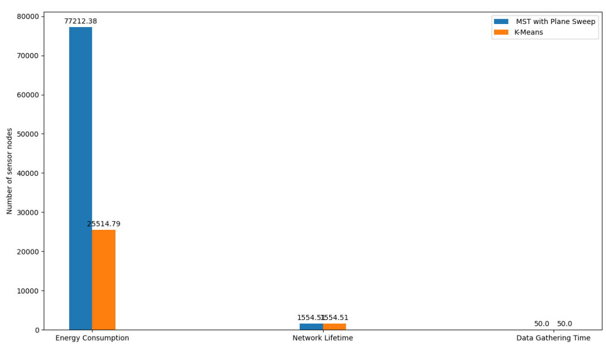

Fig. 16. Comparison between existing method and proposed approach

sensor nodes in WSNs. For the mobile sink, an optimal traversing route is achieved based on cluster centres (cluster heads)to enhance data aggregating route . The suggested data aggregating approach enhance the connection lifetime of sensor nodes and enhance the working duration of sensor connections by aggregating information precisely at the centre of clusters. The accomplishment of the precised energy approach is experimented with dissimilar amount of clusters. Simulation outcomes represent that suggested approach is much precise for the power consumption and prolong the connection lifetime.

REFERENCES

[1] N. S. Kurian, R. Preetha, J. Vaijayanthimala, *et al.*, "Mobile sink data gathering and path determination in wsn based on p-aaco approach," pp. 223–229, 2021.

[2] Z. Wu and G. Wan, "An enhanced aco-based mobile sink path determination for data gathering in wireless sensor networks," *EURASIP Journal on Wireless Communications and Networking*, vol. 2022, no. 1, p. 100, 2022.

[3] I. Ha, M. Djuraev, and B. Ahn, "An optimal data gathering method for mobile sinks in wsns," *Wireless Personal Communications*, vol. 97, pp. 1401–1417, 2017.

[4] J. Zhang, J. Tang, T. Wang, and F. Chen, "Energy-efficient data-gathering rendezvous algorithms with mobile sinks for wireless sensor networks," *International Journal of Sensor Networks*, vol. 23, no. 4, pp. 248–257, 2017.

[5] A. Alsaafin, A. M. Khedr, and Z. Al Aghbari, "Distributed trajectory design for data gathering using mobile sink in wireless sensor networks," *AEU-International Journal of Electronics and Communications*, vol. 96, pp. 1–12, 2018.

[6] H. Zhang and Z. Li, "Energy-aware data gathering mechanism for mobile sink in wireless sensor networks using particle swarm optimization," *IEEE Access*, vol. 8, pp. 177 219–177 227, 2020.

[7] R. Ashween, B. Ramakrishnan, and M. Milton Joe, "Energy efficient data gathering technique based on optimal mobile sink node selection for improved network life time in wireless sensor network (wsn)," *Wireless Personal Communications*, vol. 113, no. 4, pp. 2107–2126, 2020.

[8] S. P. Tirani, A. Avokh, and S. Azar, "Wdat-oms: A two-level scheme for efficient data gathering in mobile-sink wireless sensor networks using compressive sensing theory," *IET communications*, vol. 14, no. 11, pp. 1826–1837, 2020.

[9] V. Rajagopal, B. Velusamy, M. Krishnan, and S. Rathinasamy, "Energy efficient data gathering using mobile sink in iot for reliable irrigation," *Sustainable Computing: Informatics and Systems*, vol. 40, p. 100 916, 2023.

[10] B. G. Gutam, P. K. Donta, C. S. R. Annavarapu, and Y.-C. Hu, "Optimal rendezvous points selection and mobile sink trajectory construction for data collection in wsns," *Journal of Ambient Intelligence and Humanized Computing*, vol. 14, no. 6, pp. 7147–7158, 2023.

[11] S. Mohan and S. Panda, "Multifactor optimized mobile sink data collection framework for hybrid wireless sensor network-long term evolution-assisted internet of things network," *International Journal of Communication Systems*, e5744, 2024.

[12] R. Saravanan and V. Sathya, "Wireless sensor network data gathering using a multi-fold gravitational search algorithm with a mobile agent," *International Journal of System of Systems Engineering*, vol. 14, no. 1, pp. 23–41, 2024.

[13] S. Satish Patil and T. Senthil Kumaran, "Fuzzy based rendezvous points selection for mobile data gathering in wireless sensor network," *Computational Intelligence*, 2024.

[14] L. Zhang, Y. Xiao, W. Wang, L. Ma, M. Zhang, and Y. He, "Designing energy-conserving scheme by mobile sink for mobile wireless sensor network," vol. 13090, pp. 1014–1020, 2024.

[15] D. Dash, "Plane sweep algorithms for data collection for energy harvesting wireless sensor networks using mobile sink," *Journal of Ambient Intelligence and Hu-*

manized Computing, vol. 14, no. 5, pp. 6307–6320, 2023.

[16] A. D. Gupta and R. Kumar Rout, "Smeor: Sink mobility-based energy-optimized routing in energy harvesting-enabled wireless sensor network," *International Journal of Communication Systems*, e5679, 2023.

[17] S. S. Vellela and R. Balamanigandan, "Optimized clustering routing framework to maintain the optimal energy status in the wsn mobile cloud environment," *Multimedia Tools and Applications*, vol. 83, no. 3, pp. 7919–7938, 2024.

[18] H. Salarian, K.-W. Chin, and F. Naghdy, "An energy-efficient mobile-sink path selection strategy for wireless sensor networks," *IEEE Transactions on vehicular technology*, vol. 63, no. 5, pp. 2407–2419, 2013.

[19] S. Najjar-Ghabel, L. Farzinvash, and S. N. Razavi, "Mobile sink-based data gathering in wireless sensor networks with obstacles using artificial intelligence algorithms," *Ad Hoc Networks*, vol. 106, p. 102 243, 2020.

[20] A. Mehto, S. Tapaswi, and K. Pattanaik, "Optimal rendezvous points selection to reliably acquire data from wireless sensor networks using mobile sink," *Computing*, vol. 103, pp. 707–733, 2021.

[21] N. N. Al-Salahat and Y. G. Eljaafreh, "Maximizing the lifetime of wireless sensor networks with mobile sink," *Journal of Communications*, vol. 18, no. 10, 2023.

[22] M. Krishnan and Y. Lim, "Reinforcement learning-based dynamic routing using mobile sink for data collection in wsns and iot applications," *Journal of Network and Computer Applications*, vol. 194, p. 103 223, 2021.

[23] H. Al-Mahdi, S. Saad, *et al.*, "An energy-efficient mobile sink-based intelligent data routing scheme for wireless sensor networks,"

[24] K. M. Chowdary and V. Kuppili, "Enhanced clustering and intelligent mobile sink path construction for an efficient data gathering in wireless sensor networks," *Arabian Journal for Science and Engineering*, vol. 46, no. 9, pp. 8329–8344, 2021.

[25] J.-Y. Chang, J.-T. Jeng, Y.-H. Sheu, Z.-J. Jian, and W.-Y. Chang, "An efficient data collection path planning scheme for wireless sensor networks with mobile sinks," *EURASIP Journal on Wireless Communications and Networking*, vol. 2020, no. 1, p. 257, 2020.