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Implementation of Honey Bee Routing Technique in Mobile Wireless Sensor Networks

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ABSTRACT
Mobile Wireless Sensor Networks (MWSN) utilize transmitters to allow data gathering and transfer from stations to access points. Depending on the requirements of the application, these stations can be fixed or mobile. The deployment of mobile nodes that promote mobility and energy efficiency, and LEACH routing changes have produced a positive outcome. Communication throughout extended distances among base stations (BS) and cluster members can use a huge amount of energy in large networks. In order to provide reliable and energy-efficient navigation, a new routing method named Enhanced Routing Method for Enhanced Connectivity of Mobile Wireless Networks is introduced. This study proposes a Low-Energy Adaptive Tier Clustering Hierarchy (LEATCH) method to find the best balance between latency and energy consumption to solve the MWSN coverage issues. Furthermore, a new Honey Bee algorithm is proposed with multi hop approach to select the optimal hyper cluster head and deploying the energy in a more efficient manner. In terms of network life, durability, coverage, stability and efficiency, the LEATCH protocol performs better than previous energy-saving protocols, which greatly benefits MWSN applications.

KEYWORDS
Sensor nodes, Clustering, Honey Bee Algorithm, Low Energy Adaptive Tier Clustering Hierarchy, Multi hop, Mobile Wireless Sensor Networks

1. INTRODUCTION

In today's connected world, technologies such as electrical systems and connected vehicles are globally connected through the Internet of Things (IoT). Wireless sensor networks combined with information and communication technologies enable precise data transmission and regulatory emission. This integration makes it possible to send precise measurements and control instructions across large-scale IoT infrastructure networks around the world.

The development of MWSN is substantially more versatile compared to stationary wireless sensor networks., was one of these significant wireless sensor innovations for the networking industry, because deployed mobile networks must adapt to communication network variations [1]. Weapons research, systems monitoring, precision agriculture, medicine, animal monitoring, and environmental monitoring are some MWSN applications. A mobile sensor network (MWSN) may be established employing mobile sensor nodes and sinks. Forwarding and blocking are the responsibilities of mobile sensor networks [2].

Batteries are the most common power source for nodes containing sensors. In most circumstances, including undersea shipping, natural disasters, embedded networks, etc., cells cannot be readily replaced, terminals cannot be quickly changed, and backup power cannot be given in any way. Key organizational problems are necessary. Optimize battery life and power while being efficient. A network connection allows the equipment to run correctly [3]. As a result, minimizing energy consumption is crucial for improving WSN efficiency while maintaining node capacity. Because energy consumption is lower, the network life is extended, allowing the networking to perform better. Network connectivity is critical for design and development, topology determination, and supplying energy to nodes [4].

Some of the authors have made an effort to improve solutions, strengthen communication channels, and theoretically and practically optimize energy use. However, there are numerous design problems with MWSN, such as hardware cost, architecture, layout, storage, cell capacity, computational power, shifting topologies, device mobility, adaption, location, and coverage [5]. The grid's primary purpose in MWSN is to enhance secure and sustain their states of energy, as the point of contact fluctuates with each occurrence. Data transmission is essential in this situation since it needs to be done correctly while also saving energy and retaining connectivity [6].

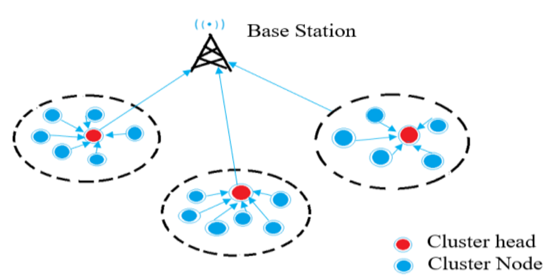

Fig. 1 Clustering in MWSN

This is what this study's network model aims to achieve. Consequently, the suggested routing protocol offers improved quality of service and increased dependability in end connections and transport networks. Motion, on the other hand, describes the sensor node's behavior through motion patterns.

The present investigation presents the subsequent important findings:

- In modern technology, Member nodes and base stations have the necessary capacity. Therefore, the study shows the positive energy efficiency routing Algorithm to Improve Wireless Cell Coverage for network connection, the new LEATCH - HBA technology and multi-hop approach have been introduced. With a productive life cycle, efficiency, durability, and scalability.
- The Honey-Bee Routing Algorithm for Mobile Wireless Sensor Networks (MWSNs) uses the honey-bee optimization approach to improve cluster formation and routing. It consists of initial clustering of sensor nodes, setting a steady-state transmission schedule for data collecting, and adaptive re-clustering to respond to changing network conditions. The algorithm's key components are efficient energy usage, maximum data throughput, less communication disputes, and dynamic adaptation to the environment to improve network performance and longevity.

2. LITERATURE REVIEW

Researchers examine a range of aspects while studying wireless sensor networks in varied situations. The prevalent method for creating reconfigurable sensor networks has been to concentrate on ad-hoc networks and broadband service.

Dhanalakshmi et al. [7] proposed a safe and efficient networking system using fuzzy logic and node real principles. Furthermore, the presented system includes an additional channel in case of a connection breakdown. The proposed approach predicts the best course of action for establishing clear transmission between every connection across many pathways, hence enhancing core quality-of-service parameters like latency, hop count, and volume of activity, even at a greater processing cost.

Tao Yang et al. [8] An Energy Optimization Secure Networking Protocol was developed especially for Wireless Sensor Networks and offers protection against undiscovered nodes. The protocol probably makes use of variables like trust distribution, power remaining, and distance travelled in order to maximize energy efficiency and maintain secure communication. However, that the connection between the sensor nodes has not been shown, which raises the possibility that there is a gap or limitation in their research concerning the validation or real-world application of the protocol's efficiency in connection sensor nodes. This section may require clarification or research to evaluate the effectiveness of the proposed solution.

Kamalanathan et al. [9] proposed a method using a fuzzy logic that creates a clustering model for internet traffic management. It appears that grouping traffic into three categories will enable safe and effective packet channeling. They seek to find comparable patterns and behaviors inside clusters using clustering algorithms and a distance metric, allowing for efficient control of internet traffic trends. This method of arranging and directing traffic according to its needs and characteristics probably improves network security and efficiency.

Maryam Naghibi et al. [10] suggested a geographic routing method based on power usage to partition the network into smaller geographical units. There are two categories for units: single-hop and multi-hop. Moving information from nodes with sensors and several wireless sources is necessary for the latter. Nevertheless, the suggested study does not concentrate on the mobile sensor sinks' end network connections.

Gayatri Sakyaa et al. [11] proposed an Energy-efficient Adaptive Multichannel (ADMC) Media Access Control protocol, which allows data to be sent based on the traffic circumstances at a particular moment. Two approaches were developed: the first gives priority to choosing the strongest member nodes, while the second one is based on how frequently a cluster changes about the transport conditions at the time. This enhances the system's overall speed and precision.

Selvakumar et al. [12] proposed a package routing based on the arithmetic filtering approach's significant capability that enhanced the discovered voltage. As access points for enhanced correlation, each hub activity identifies the recent developments and all forthcoming advances. It chooses the data mailboat transporting route that is most effective.

Several research have been proposed to address energy consumption and network connectivity issues. Nonetheless, Yet, there will be limitations, such as a lack of emphasis on the difficulty of computation, device network architecture, or multi-hop methods. By creating a unique routing method, which is explained in the parts that follow, the aforementioned problems were fixed.

3. METHODOLOGY

3.1 Improved coverage for mobile wireless sensor networks: An optimized energy-efficient multi-hop routing algorithm

The rising popularity of Mobile Wireless Sensor Networks (MWSNs) can be attributed to their wide range of applications in many sectors. They are employed for a number of functions in the military, including surveillance and monitoring, automation for process optimization, and traffic control in transportation, monitoring and control in industrial infrastructure, remote patient monitoring in health, and smart home applications in the consumer sector.

Low-Energy Adaptive Layered Clustering Hierarchy (LEATCH) is the new approach presented in this study, which addresses various intrusion issues in mobile wireless sensor networks (MWSNs) while managing latency and energy consumption. To find possible cluster heads and hyper cluster heads, a Honey Bee Algorithm is also used, which is modelled after the seeking habits of honey bees. This method uses hives to search new possible ways, thereby maintaining a random searching component. The framework for the potential techniques is presented.

3.2 Operation of LEATCH

A lot of research has been done on creating sensor nodes that can move and use energy into account the greatest outcomes.

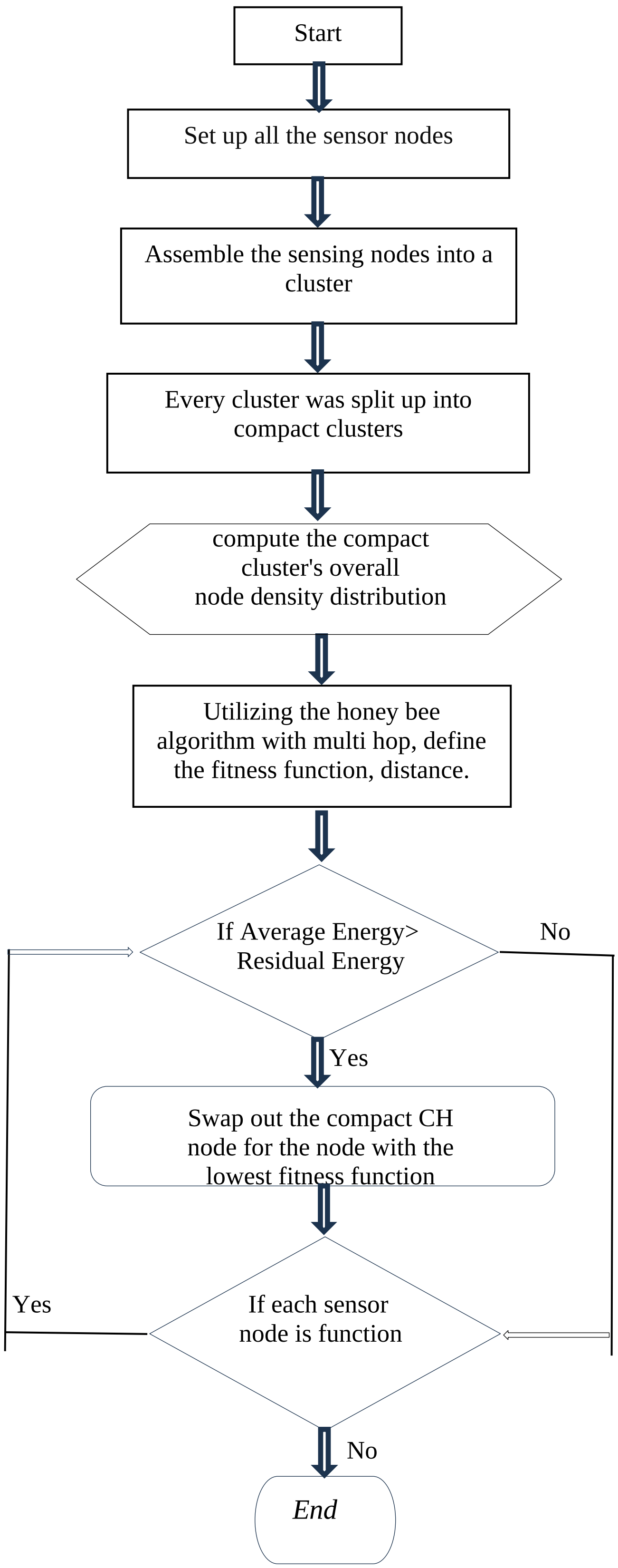

Fig. 2 Flow Chart of Proposed Method

have been produced using LEACH-based routing algorithms. However, in a large network, long-range communication between cluster head and the base station wants a significant net On the other hand, small-scale networks are best suited for the power-ability navigation method, which depends on LEACH energy. As a result, the suggested approach, known as LEATCH, functions by carrying out a succession of processes, each separated into two phases: deployment and a steady state. During the deployment phase, groups are formed, and member nodes are allocated Time Division Multiple Access, which is configured by grouped heads.

We emphasize web design that allows for gradual adjustment in order to create smaller subdivisions using multi-level hierarchical clustering. Our method selects compact and hyper clusters based on acceptable behaviours and classes. Clustering algorithms must identify entrance spots for secure information routing.

The accumulation of compact-cluster groups headed by a hyper-group head constitutes a hyper group in a hierarchy structure. Because it is adjacent to the BS, it helps to carry the data collected by the compact clusters to the connection point. In contrast, each logical sub-region of the network's structure is represented by a compact-cluster that is in some way linked to a hyper-cluster head.

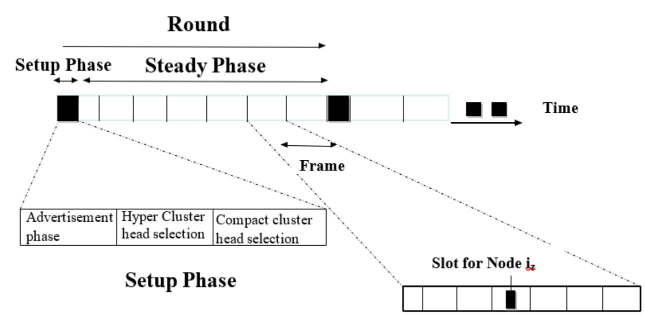

Fig. 3 Operation of LEATCH

The CCHs use the data from their peers to build logical compact clusters. Thus, the collection of sensor nodes is often referred to as a compact cluster. Information from their linked IoT devices is analyzed by the CCH, which then uses multi-hop communication to communicate the results to the HCH. To deliver the last set of data packets to the access points, the HCH then combines the data delivered to CACHs. The following describes the nodes in the network: A node may function as an ON, HCH, CCH, or Cluster Member (CM) in the suggested method.

- Hyper-Cluster Head (HCH): These type of nodes have direct communication with the Base Station. In a hierarchical clustering technique, the Hyper Cluster Head, or HCH, is in charge of a collection of clusters.
- The main head of a compact cluster inside a hyper group, a sub network, is known as a Compact-Cluster Head (CCH). These nodes have the ability to communicate directly or indirectly with an HCH.
- Member Node (MN): These nodes gather information and forward it to the Cluster Head (CH) as part of a cluster.
- Orphan Node (ON): Orphan nodes cannot join to other groups or clusters since they are isolated from the rest

of the network. The network setup step involves the usage of the following packet types:

- START-PACKET: This packet is transmitted by the base station to initiate the off-grid strategy.
- ADVERTISEMENT-PACKET: During the advertising phase, all nodes transmit these packets. They facilitate the building of the network architecture by enabling every node to make the details about its neighbours.
- ANNOUNCEMENT-PACKET-CCH: The Cluster Head (CCH) transmits these packets during the second stage. They are picked up by nearby free nodes, which facilitates the clustering process.
- ANNOUNCEMENT-PACKET-SCH: A terminal uses the data packets to connect with the peers of its new location when it becomes a Hyper Cluster Head (HCH).
- JOIN-PACKET: Every terminal sends a JOIN-Packet to the MCH to which it belongs after identifying the CCH or SCH it is a part of.

3.3 Transmission Strategies in LEATCH-L

SET-UP PHASE:

Advertisement phase: To start a network, the Base Station displays a START packet. The group of terminals used to gather the data might function as the Base Station's entrance. They are called as Heads of Hyper Clusters. After receiving this packet, the nodes start flooding ADVERTISEMENT PACKETs, with each node getting one and adding it to its neighbor's database.

Choosing the Hyper Cluster Head: The ability to become an HCH is granted to each networks that Base Station has sent the START-PACKET. During the HCH Selection Phase (Upper Layer), each network generates a collection of numbers (σ_{z1}).

$$\sigma_{z1} = \beta_z \times \left[\frac{E_{oz} - E_{iz}\ (t_z)}{E_{oz}} \times \left(1 - \frac{1}{d_z}\right)\right] \tag{1}$$

The node i_z, has its starting energy represented by E_{oz}, its remaining power is shown by $E_{iz}(t_z)$, and the spacing between the BS and the node i_z, has been set by the algorithm. The timer (σ_{z1}) may run out of energy faster for terminals with higher energy levels and proximity to the BS. As an outcome, low-energy endpoints near higher amounts of energy are less likely to transform into HCH. By acting as a connecting point, these nodes would prevent unconnected groups from forming and failing to provides data packets to the Base Station.

The approach for selecting the nearest node to the BS as the HCH emphasises the node's separation from the BS to achieve consistent CH dispersion. Unlike LEACH easily prediction approach for CH selection, this methodology sends a broadcast packet to one-hop peers, and nodes become HCHs after a delay time. Non-HCH nodes select the HCH with the lowest transmit power depending on message power and range. Nodes transmit a JOIN PACKET to the selected HCH, and existing HCH-connected nodes look for nearby free nodes by inspecting their neighbours. Nodes identifying Free Nodes (FNs) among peers serve as unfamiliar Cluster Heads, connecting FNs to the HCH.

This introduces a unique technique known as Low Energy Adaptive Tier Clustering Hierarchy. To find possible cluster heads and hyper cluster heads, a Honey Bee Algorithm is also used, which is modelled after the seeking habits of honey bees. This method uses scout bees to find new possible solutions, thereby maintaining a random searching component.

Compact-Cluster header selection: A terminal can become a CCH if it is set up in front of the safe zone. During the advertising phase, each network node keeps track of non-member node (FN) neighbours. HCH and CCH terminals present themselves to their colleagues during the conversation. When the terminal receives a JOIN PACKET from the FN partner for the specified CCH, it updates its neighbor record. If MN is finds that it is in front of the protected area at the ends and its neighbour's database contains |FNiz|>0 can also identify itself as a new CCH. Timer σz2 needs to be started to advertise as a single CCH and the FN can join the network system without a new group. When a neighbor's link is lost the node reports with its own CCH.

$$\partial_{z2} = \beta_z \times \left[\frac{E_{oz} - E_{iz}\ (t_z)}{E_{oz}} \times \frac{1}{|FN_{iz}|}\right] \tag{2}$$

The total number of FN in the node i_z Peers database is represented by $|F_{iz}|$

The setup stage Establishing a Schedule: This method performs Code Division Multiple Access separations to prepare packets for transmission and avoid going through the first and second stages. Once the cluster is established, designated CCHs and HCHs are responsible for allocating time slots. Each CCH and HCH submitted the plan to the members of the cluster.

STEADY PHASE:

Transmission and gathering of data: LEATCH-L represents both single-hop and multi-hop intra-cluster communication strategies as a continuous phase. Each compact cluster has single-hop intra-cluster networking. All individual CM information from the compact cluster is delivered to the appropriate CCH. Anyhow, multi-hop intra-cluster movement in the supercluster is routed through intermediate CCHs before arriving at an appropriate HCH. Multi-hop communication within a cluster exceeds single-hop intra-cluster routing when it comes to improving network reliability. Each HCH gathers its own data on the hyper cluster and speaks with the CH directly. Additionally, the procedures for choosing root nodes and members of hyper clusters have been refined.

3.4 Multi Hop Honey Bee Protocol

The sensor nodes described by their coordinates (Six, Siy) share the same data space. While hierarchical clustering involves multiple hops, the cluster head (CH) is chosen based on priority and update criteria. A specific relation is used to find the shortest possible distance between the CH and the receiver. After determining the distance, the sets are divided into three layers: t1, t2, and t3. Calculate the distance between t1 and t2, and the t2, CH sends signals to the t1 CH that is closest to it. Data from third-tier CHs is sent to first-tier CHs via second-tier CHs.

$$\text{d} = \sqrt{(((Bx - C(i)x)^2 - ((By - C(i)y)^\wedge\ 2)))} \tag{3}$$

The aggregated data is subsequently sent to the sink, with a maximum of three hops to the base station. In order to find new medicines, this system combines components of random search with scout bees. To boost stability, the framework now includes revised node ideas and CH selection criteria. The parameters of the multi-hop with Honey Bee Algorithm (HBA) include the number of scout and the head bees. Scout bees are randomly deployed around the search area to analyze the surrounding environment.

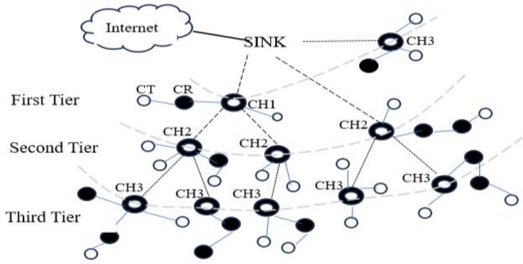

Fig. 4 Three Tier Multiplier Sensor Network

Detection and selection simulate natural processes. The optimized multi-hop HBA approach outperforms alternative energy-effective approaches in terms of power consumption, latency as well as insurance coverage, lifespan of the network, and reliability.

HONEY BEE ALGORITHM WITH MULTI HOP:

Step1: Initialize the population using a random solution.

Step2: Evaluate the fitness of the population.

Step 3: While (Introduce new population) (Close

Criteria if not met).

Step 4: Select only the finest hives.

Step 5: List possible locations for an area analysis.

Step 6: Move the hives to appropriate sites and evaluate their efficiency.

Step 7: Select the most suitable bee from each location.

Step 8: Multi-hop Algorithm

Determine the distance between the elected CHs and

the BS, then arrange the results in ascending order in

array (A);

The clusters are organized into three levels;

tier (t1)= A[1],A[2],A[3];

tier (t2)= A[4],A[5],A[6];

tier(t3)= A[7],A[8],A[9],A[10];

Determine the distance between each element in t2

and each element in t1, then arrange the elements

according to that distance;

In the same way for t2 and t3.

distance=sqrt((tx(1) - tx(2))^2+(ty(1)-ty(2))^2)

The above-calculated minimum distances are used

to transfer the data in HOPS;

Step 9: CH aggregates data from CMs and transfers it

to the base station using a multi-hop mechanism.

Step 10: Determine the fitness of the surviving bees

by allocating them to a random search.

Step 11: Come to an end while.

4. SIMULATION ANALYSIS & RESULTS

The following section presents the different simulation results achieved using the suggested approach. The simulation results were produced using MATLAB software. The simulation results are calculated based on the number of rounds.

SIMULATION SYSTEM PARAMETERS:

In the suggested approach, 100 sensor nodes are deployed in random order, with various beginning energies, and each node may send x bits of data every round.

Table. 1 Simulation Parameters

Parameter	Value
WSN area/m^2	100*100
No. of nodes	100
Base Station location	(50m,50m)
Initial energy per joule	0.1
E_{elec}/(nJ. Bit^{-1})	50
ε_{fs}/(pJ.(bit.m^2)$^{-1}$)	10
ε_{mp}/(pJ. (bit.m^4)$^{-1}$)	0.0013
r_0/m	5
Sleeping % of Cs(%)	10
E_{agg}/(nJ.(bit.message)$^{-1}$)	5
Desired % of cluster heads	5
Data packet size/B	512

Cluster Division

Cluster division in MWSNs groups mobile sensors into dynamic clusters for effective data processing. Mobility, energy, and distance to the base station are multiple factors to consider while specifying CH.

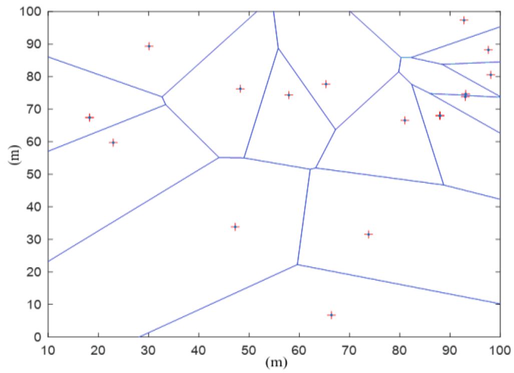

Fig. 5 Cluster Division

Total Number of Dead Nodes

Fig. 6 study highlights the failure rates of sensor nodes at different levels and suggests using the Low Energy Adaptive Tier Clustering Hierarchy technique to increase the network's lifespan after 1000 rounds.

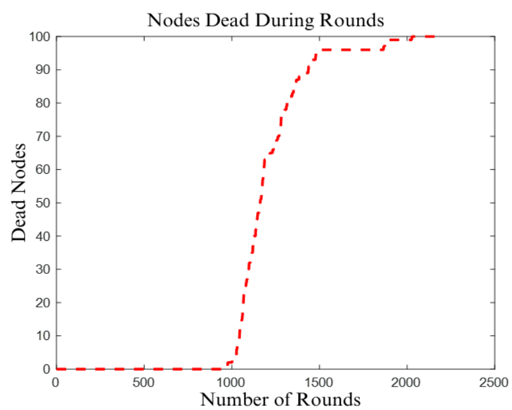

Fig. 6 Dead Nodes in Various Rounds

Total Number of Live Nodes

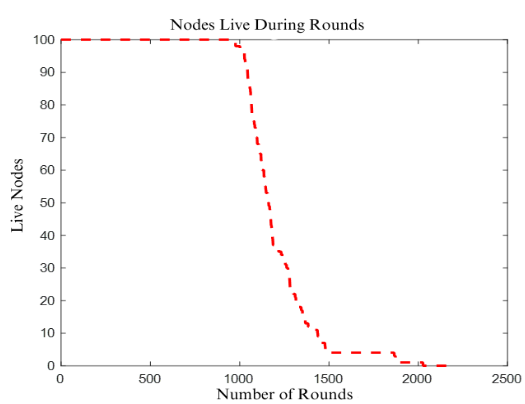

Fig. 7 Live Nodes in various rounds

Fig. 7 shows the active nodes at various stages of the sensor network's lifespan. The network's study highlights in Fig. 6 with a lifespan of approximately 1500 cycles from network initiation to the last node's death, displaying the effectiveness of the technique.

Packets send to Base Station

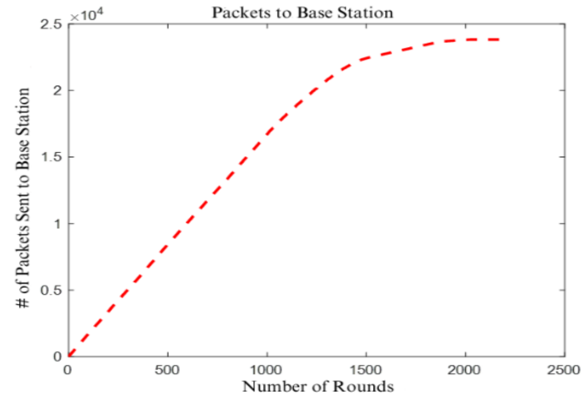

Fig. 8 Packets sent to Base station

Fig. 8 shows the total packets transmitted to each base station level. The suggested strategy allows for transmitting 1500 to 2500 rounds of packets to Base Station. Utilizing HBA-LEATCH with multi-hop technology leads to more packets being delivered to the base station.

Packets send to Cluster head (CH)

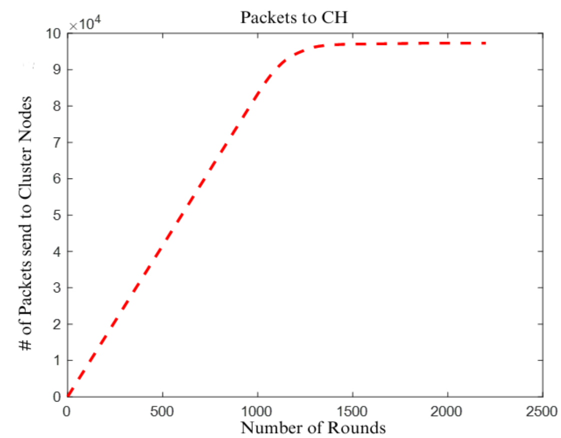

Fig. 9 Packet send to Cluster Head

Fig. 9 display the data sent to the cluster head and the improved packets sent in 1000 rounds, highlighting the effectiveness of the suggested method in enhancing throughput to the main station. The improved data packets transmitted to the cluster head indicate a significant enhancement in the quantity of data sent, showcasing the benefits of the proposed approach.

Throughput

Fig. 10 indicates the total number of packets broadcast by our proposed strategy according to the total number of rounds. The proposed method increases network lifetime and system node energy by utilizing energy-efficient CH selection. The proposed algorithm's increased capacity improves the efficiency of the deployed network, resulting in more packets being forwarded to the base station.

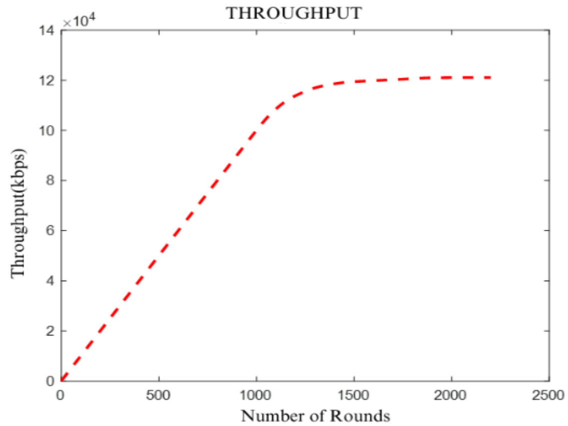

Fig. 10 Throughput

Residual Energy

Fig. 11 shows that each sensor node stats with about 50J of energy. Cluster heads are selected depending on parameters such as left energy, total number of nodes, location far from the base station. This selection process helps conserve energy in the sensor network, allowing devices to operate for long periods by efficiently utilizing the available energy.

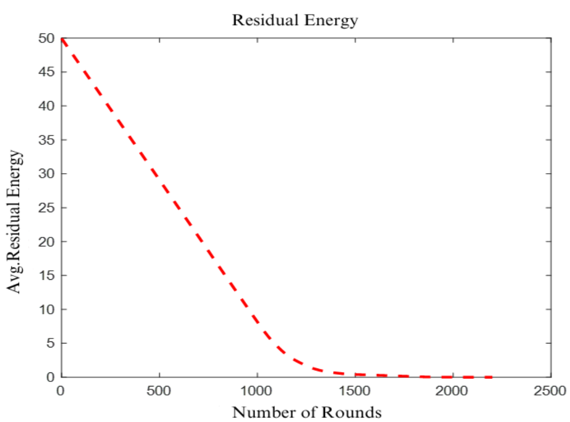

Fig. 11 Residual Energy

Table. 2 Comparison of Energy Dissipation and Lifetime

Round	Parameters	LEACH	ESO-LEACH	Proposed
500	Energy	0.061	0.048	0.043
	Life time	100	81	100
1000	Energy	0	0.025	0.042
	Life Time	6	45	100
1500	Energy	0	0.007	0.038
	Life Time	0	18	62
2000	Energy	0	0	0.027
	Life Time	0	4	15
2500	Energy	0	0	0.01
	Life Time	0	0	4

Comparison of Energy dissipation

Fig. 12 compares the energy dissipation in various rounds of the suggested approach with LEACH [22] and ESO-LEACH [22]. The suggested way shows higher energy dissipation when using the HBA-LEATCH with a multi-hop strategy.

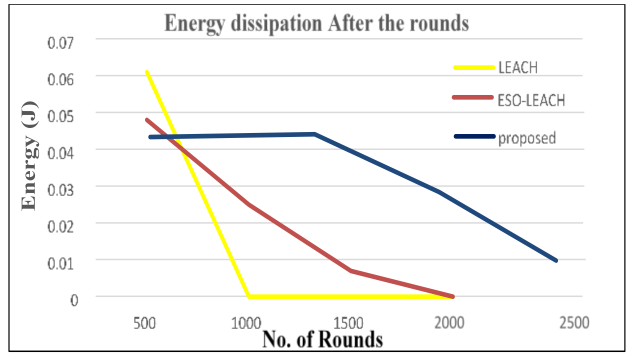

Fig. 12 Comparison on energy dissipation

Comparison of Node Lifetime

Fig. 13 compares the node lifespan of the proposed algorithm to that of the LEACH [22] and ESO-LEACH [22] Hierarchies in terms of the number of rounds, as the suggested strategy increases the number of active nodes and the amount of remaining energy.

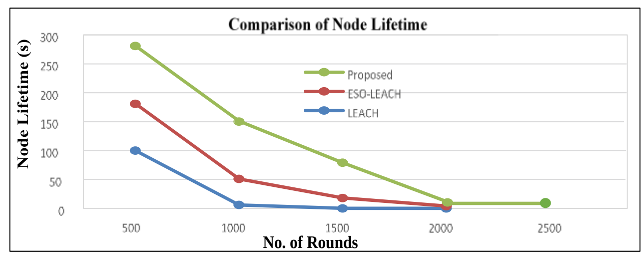

Fig. 13 Comparison on life time

5. CONCLUSION

The Honey Bee Routing Technique in Mobile Wireless Sensor Networks (MWSN) represents an innovative technique to addressing the difficulties of energy efficiency and data transfer in sensor networks. The routing method uses honey bees' foraging behaviour to optimise data gathering and transmission, hence improving network performance. Cluster Heads (CHs) and Base Stations (BS) are essential components of the algorithm for data aggregation and multi-hop transmission. The quantity of scout bees, elite bees, and designated areas are all important parameters that influence the algorithm's performance. The Honey Bee Routing Technique has several advantages, including increased energy economy, lower latency, and greater network scalability. By using multi-hop communication, the technique reduces power consumption and increases network longevity. However, network overflow and data packet loss may occur in some conditions. The algorithm's flexibility to dynamic situations and capacity to optimise energy usage make it appropriate for a variety of network circumstances. When compared to typical routing protocols, the Honey Bee Routing Technique performs better in terms of power economy and data throughput. Its capacity to dynamically adapt to changing network circumstances and optimise resource use distinguishes it from traditional techniques. The algorithm's emphasis on nature-inspired optimisation approaches provides a strong answer for improving network performance in a variety of deployment settings. Overall, the Honey Bee Routing Technique is a promising technique for increasing the efficiency and efficacy of data routing in MWSNs.

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