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An Efficient Mobile Descend Scheduling for Enterprise of Mobility-Grounded Systems for Wireless Sensor Networks

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Abstract: One of the main objectives of the WSNs is data collection, where there is a difficult situation between effective information gathering and energy efficacy. Because of the large demand for the relay nodes that are closer to the base station, data routing also has an impact on the hotspot issue. A way to overcome the aforementioned difficulties is by mobile descend -based data collecting. In the beginning, we provide an approach for data collecting utilizing a single portable descend. In order to cover the entire network and reduce end-to-end delay, a new collecting method called K-medoid with amalgam gathering head assortment procedure Hybrid HH-SS (hybrid Harris Hawk and Slap Swarm) optimization method are used. Using the use of the AACO (Adaptive Ant Colony Optimization) process, a path that is ideal for the mobile descend is discovered. The mobile descend uses the best route to gather data and connects to CHs via short-range communications. Descend mobility increases battery-operated device longevity while lowering energy consumption. This research suggests a data collection method for large-scale WSNs based on several mobile descends. In this case, the best set of mobile descends is enough to collect the data packets for network scheduling. By combining the three ideal operations, such as gathering, local, and universal mobile descend trajectory designs, the suggested approach maximizes the network lifetime. A modified gap statistic approach is applied to handpick the paramount set of clusters after first considering a hierarchical clustering mechanism.

Keywords*: *WSN; AACO; HHH-SS; CHs

1. Introduction

Wireless sensor networks, also known as WSNs, have been hailed as potentially useful instruments for the long-term, in-location surveillance of activities and environments [1]. For the delivery of observations to centralised places known as descend s, a large number of simple and compact sensor devices must communicate with one another through a number of hops using short-range wireless interfaces. This process takes place over a number of hops. Due of these qualities, WSNs are being considered for usage in a variety of critical application contexts, including security applications, habitat monitoring, traffic monitoring, and military surveillance, among others. These applications, as well as sensor nodes, are subject to certain limits, including limitations on processor, storage, communication, and power supplies [2]. When developing WSNs and associated protocols, there are a number of challenges that must be overcome; nevertheless, maintaining connectivity and increasing the network's lifetime are two of the most important considerations. In most cases, the necessity for connectivity can be satisfied by either the installation of a sufficient number of sensors or the use of specialised nodes that are equipped with the capacity for long-distance communication. The lifetime of the network is the second issue to consider, and it is closely tied to how long the power sources in the sensor nodes will last. It is possible to lengthen the lifetime of a network by implementing methods that save energy, such as battery replenishment schemes and protocols and algorithms that are efficient in their use of energy [3].

The connectivity and longevity issues in WSNs can also be addressed by using mobile devices in an orthogonal way. Mobile systems are already present in numerous deployment situations, such as troops in applications for battlefield surveillance, animals in applications for habitat monitoring, and buses in applications for traffic monitoring. Mobile devices, such as airborne and ground-

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based vehicles, can be incorporated into the architecture of the WSN in other circumstances [4]. The connectivity and energy efficacy (and consequently, network lifetime) issues with communication devices on mobile platforms can be solved as follows: • Connectivity: Information can be transferred between remote WSN components via mobile platforms. • Energy efficacy: By decreasing multi-hop transmission, the information conveyed by mobile devices can lower the energy consumption of sensor nodes [5].

A new clustering method known as K-medoid with Hybrid HH-SS optimization strategy is utilized to collect data in a single mobile descend while minimizing latency and covering the entire WSN environment [6]. AACO algorithm is used to determine an acceptable trajectory for the mobile descend. The mobile descend communicates with RPs with low communications while also accumulating data along a trajectory. By using this strategy, the energy dispute is reduced and the battery life of SNs is increased [7].

Accessing every single sensor node in the network always uses the least amount of energy. For larger networks, a single MS cannot deliver optimal results as shown in Figure I. To address the issues noted above in large-scale WSNs, multiple mobile descend s (MMS) are developed. A difficult problem is figuring out how many MSs are needed to cover the entire WSN, as well as how each MS will move across it [8]. Although having fewer MSs will lower costs, it will not meet the demand for a productive data collection procedure. The expense and difficulty of creating the controlling algorithms both rise when more MSs are taken into account. Yet, selecting the ideal MS count and managing them is a difficult issue [9].

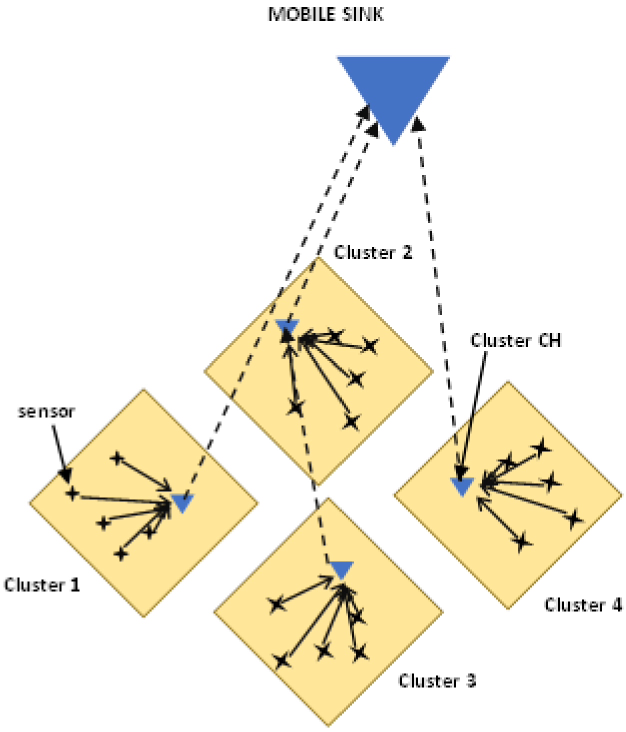

Fig I: Architecture of cluster formation and CH selection.

Because it takes time to visit each SN in the network, RPs selection is a crucial duty in MS-based data packet collection. Also, one of the most important factors to improve WSN effectiveness is figuring out the best visiting order. Also, the drawbacks of current algorithms for MS-based data collection are examined and evaluated. Even yet, managing energy in WSNs is difficult, therefore it's important to keep the network running for as long as feasible [10-11].

Although other research uses multi-hop data aggregation or non-uniform sensor deployment to minimize energy usage, the "hot spot" issue still persists. Many techniques with mobile descend s collecting data via arbitrary or organized movement are created to reduce the overall network energy in order to solve the aforementioned issue and lengthen the lifespan of WSNs. When the mobile descend stops at one of the nearby sojourn spots, the sensor nodes within the communication range can send their monitoring data to the mobile descend in a single-hop or multi-hop fashion [12]. As a result, by optimizing the data collection path, the mobile descend can traverse all nodes in its area and the whole energy ingestion can be decreased. It should be noted, too, that the mobile descend's longer route would cause a greater delay in the transfer of data because it necessitates visiting many more meeting places. Particularly, data aggregation with multi-hop transmission will cause a greater time delay than intermediate data aggregation with the single-hop transmission [13].

What follows is the outline for the rest of the paper. The related work is briefly described in part 2, and the methodology and the theoretical foundations of the methods used are described in section 3. The simulation results and analysis are presented in section 4. For the chapter’s final section, “key findings” we summarize the most important results.

2. Related Work Done

In addition to this, the MS determined the movement time, the data overflow, and the optimal path [14]. When compared to previous established algorithms, the method that has been offered enables the avoidance of longer communication distances. The ACMDGTM approach resulted in an increase in the packet delivery rate while simultaneously resulting in a decrease in energy consumption. Throughout the operation of transmission, the ideal communication distance was determined at the beginning in order to decrease the amount of energy that was used [15]. This was brought into equilibrium across all of the nodes, and a threshold value was determined in order to preserve the energy-hungry important nodes. After then, the communication range of the node was adjusted so that it took into account its distance from the descend node. As a consequence of this, the proposed procedure is superior to the methods that have already been utilized [16].

The performance of the network was significantly improved by a neural network (NN), which is responsible for DF. Because of this, the useful life of sensor networks can be extended while simultaneously reducing their energy consumption. In the beginning, the virtual grids are what are utilised to partition the entire network into different subdomains [17]. The strategy that was recommended has been utilised for the purpose of discovering forest fires. In addition, a mobile agent was utilised to collect the data, and an agent node was utilised to mark the location of the mobile agent. The mobile agent data collecting method known as EHL (empower Hamilton loop) was developed by a select few researchers working in isolation (MA). In addition to this, a non-uniform clustering method was utilised in order to address the problem of energy gaps [18]. Combining the PEGASIS algorithm and HL was done in order to cut down on unnecessary resource overhead. In order to do this, a combination of single-hop and multi-hop tactics was required. A distinct method known as "local optimization" was used in the process of designing the perfect empower Hamilton loop. The performance results showed that the suggested routing-based solution was capable of balancing resource usage, reducing propagation latency, and extending the lifetime of the network [19].

To balance energy consumption across the network, a group of employees devised the SEAR (safe energy-aware routing) routing technique. SEAR sends data through trust nodes and was built on the evaluation of trust nodes. The proposed method has been compared on a number of factors with current protocols that detect malicious nodes, such as energy-aware data (EAD) focused, and energy-aware secure routing (EASER) [20-21]. The results of the simulation showed that the SEAR methodology outperforms the current approaches.

PSOBS, which stands for particle swarm optimization-based selection, was applied in wireless sensor networks (WSNs) by a few more researchers in order to facilitate energy-efficient mobile descent routing. The PSOBS method was utilised in order to determine which places would make the most suitable RPs (rendezvous points). The weight of each SN was also taken into consideration. An analysis was done on the performance measures. PSOBS was found to be more effective than weighted RPBS (rendezvous planning-based selection), according to the findings of the simulation [22].

To extend the life of WSN, some researchers implemented a cooperative data-gathering technique to the equilibrium of the energy among SNs. The MMS handles the network's effective data collection role in this work. This strategy does not, however, concentrate on selecting the ideal number of mobile descend s [23]. The other team suggested a WSN data collection strategy that is both highly accessible and location-predictive. In this method, the SNs use time synchronization to track the location of the mobile descend. In this scenario, each round of following the mobile descend requires more energy from the SNs [24]. Another group of academics has suggested an MMS-based data collection strategy for industrial WSNs. Academic researchers examined many performance criteria, but their work was ineffective in reducing the number of mobile descend s needed in the network with an effective data collection mechanism. Several researchers have suggested an effective strategy for choosing cluster heads during data collection in WSNs based on probability estimation.

3. The Objective of the Work

1) To develop Mobile Descend Scheduling for the Design of Mobility-based Algorithms for Wireless Sensor Networks.

4. The Projected Work:

This subsection suggests an MS technique for a WSN that is both energy-efficient and robust. It includes things like making a cluster, picking a CH, and moving the MS. In order to prolong the life of WSNs, energy-efficient scheduling is the most effective way. Cluster-based routing decreases power consumption. With this idea, MS technique in WSN can extend the lifespan of the network as a whole. When gathering data, the MS moves around inside the network and talks to the CHs. The BS is treated as MS throughout this work. Using the K medoid technique, the entire network model is divided up into a large number of distinct groups as shown in Figure II.

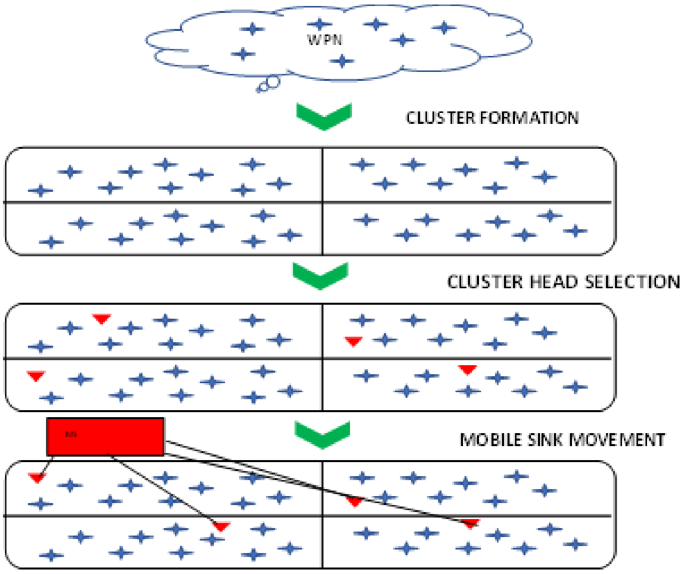

Fig II: Schematic diagram of energy-efficient WSN.

The CH is chosen using an optimization technique that combines elements of both the Harris hawk and the salp swarm. Finding the most efficient mobility path for the MS also improves efficacy. In this case, it appears that the AACO algorithm, which is based on descend moving strategy, is the best option for determining the best possible path of traversal. This method shortens the period of time needed to pick a CH. In addition, the AACO method makes advantage of MS by taking CHs' distances into account. The very short distance that MS and CH have to travel in order to communicate greatly reduces the amount of energy that is lost in the process as presented in Figure III.

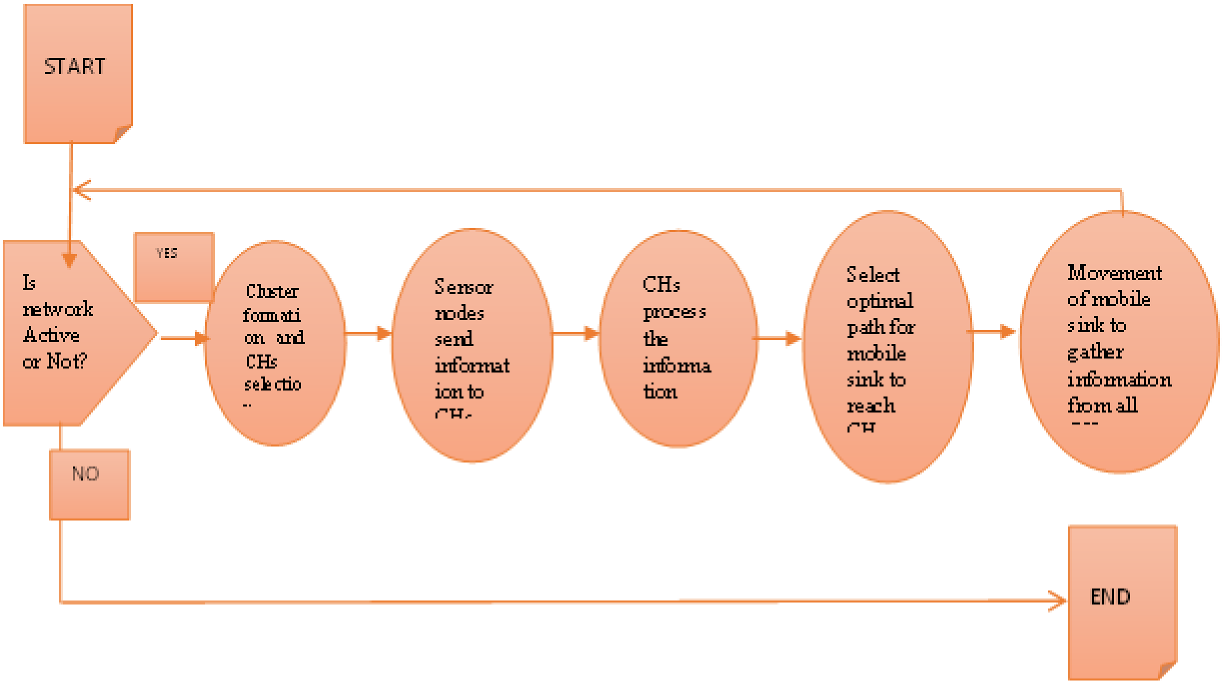

Fig III: Flow chart for the proposed mobile sink-based data collection strategy

4.1. Energy Model: There are two main uses for energy: data transmission and reception. First, we look at signal production and improvement. The signal is amplified using two separate sources of power, one of which is selected based on the transmission's distance. The channel model is divided into FSM (free space model) and MPF (multi-path fading model) depending on the distance between the forwarder and the receiver. D^2 power loss (FSM) is used for short distance communication, while d^4 power loss (FSM) is used for long distance communication (MPFM). To calculate the energy drain of data transmission, the first radio energy model is used.

4.2. Cluster Formation: Maximum power consumption occurs when every SN in the network transmits data directly to the MS. In this work, clustering is employed as a means of remedying the aforementioned problem. To divide a data set into k distinct clusters, the k-medoid clustering algorithm is used. Only a small fraction of SNs are capable of establishing direct contact with the MS, but by banding together they can do so.

4.3. Hybrid HH-SS optimization-based CH selection: The following step, after the cluster has formed, is to locate its apex. A CH can be chosen using a combined HH and SS approach. A fitness function that takes into account both the SN's energy and its distance from the cluster centre is proposed to make the hybrid HH-SS optimization algorithm more power-efficient. The CH is selected using a weight function based on both the remaining energy and the physical distance between the source hub and the CH.

Hybrid HH-SS optimization algorithm:

To begin, we'll need to generate a random hawk population and set the initial salp population (Xi, I = 1, 2,..., n) in motion. To determine the health of each hawk and salp, you must:

```
The output is Xr's coordinates (best solution)
In the meanwhile (t max iterations), do
Each time a hawk (Xi) do,
Change the E0 and P0 starting values (E)
Condition: if (|E| >1)
move the current answer to the forefront
end if
when I<(N/2)
Change the status of the current leader, Salp
else
Follower Salp's position has to be updated.
end if
conclusion for
Adjust the salps using the ranges of the varying factors.
Determine each hawk's updated fitness level.
If you find a better approach, please update Xr.
t = t + 1
Cease during
Send Xr back
```

4.4. Data collection and transmission: By exchanging information with itself in a single hop, MS travels to the monitored area and begins gathering data. The CHs determines MS data, such as the Im1 and Im2 entry and exit points. When the MS is within range of the CHs, the CHs will begin to collect information from the member SNs. As the MS moves out of range of the CH signal at Im2, data collection and transmission will cease. After collecting information from SNs, CHs send it on to the MS during a predetermined communication window.

4.5. Descend moving strategy: In this research, we propose a novel mobility technique for sensor networks to reduce the impact of the hot spot issue and extend the operational lifetime of the networks. The primary challenge in WSNs is the phenomenon known as the "hot spot problem," in which a disproportionate number of nodes (SNs) close to the MS exhaust their energy relative to the rest of the network. In this case, the use of an AACO (adaptive ant colony optimization) technique seems like a viable option for locating the optimal course of travel. As a result, the computation required to select the CH will be reduced. For this reason, the AACO methodology for WSNs makes use of mobile descend s by accounting for CH distances. The AACO algorithm determines the best route for MS to take.

5. Result and Discussion:

It is considered to be energy efficient if the proposed WSN has a longer network lifetime, a greater packet delivery ratio (PDR), a lower packet loss rate (PLR), more throughput, and a reduced end-to-end (E2E) delay. We evaluate the efficiency of the network using a variety of performance metrics, such as its longevity, packet delivery rate, energy consumption, average throughput, packet loss rate, and end-to-end delay.

5.1. Energy Reduction: The term "energy reduction" is used to describe the total amount of power that is utilised by a network throughout the process of sending and receiving information. This value is extremely important for the routing process; but, once clusters begin to form, it also becomes an energy drain. Network Lifetime: This subsection assesses the network's expected lifespan in relation to the total network area. Network lifetime is the period that elapses before the first node dies from lack of power. The implemented scheme's energy efficacy can be gauged by its ability to assess the network's lifetime.

5.2. PDR (Packet delivery ratio): PDR is the ratio of packets received to packets sent. The primary success of wireless networks is the transmission of packets. As far as PDR is concerned, this delivery ratio is a success.

$$PDR = \frac{Recieved\ Packet\ Count}{Delivered\ Packet\ Count} \tag{1}$$

5.3. Packet loss occurs when sent data does not arrive at its intended destination. The network's efficacy and durability are both improved by a decrease in the packet loss rate.

$$PLR = Forwaded\ packet - Recieved\ packet \quad (2)$$

5.4. End-to-end delay: Reducing Reduced power consumption and increased reliability are two benefits of end-to-end (E2E) delay. Hence, less time spent waiting improves both efficacy and dependability. E2E delay measures how long it takes for a packet to go from one node to another. Time spent on tasks such as data processing, transmission, and reception are all factored into the end-to-end delay.

$$End\ to\ end\ Delay = Time\ for\ (Data\ transmission + Data\ processing + Data\ delivery\ ) \quad (3)$$

5.5. Throughput: The throughput is the rate at which data packets are successfully relayed from the sending node to the receiving node.

$$Throughput = \frac{Forwaded\ data}{Transmission\ time} \quad (4)$$

Table I: Comparison of existing and proposed algorithms concerning different performance metrics by varying the number of sensor nodes between 100 to 500.

Parameters	Nodes Count	Approach	
		SEAR	Hybrid HH-SS
Throughput (kbps)	100	137	154
	300	132	143
	500	122	133
PDR	100	0.97	0.98
	300	0.95	0.97
	500	0.94	0.96
Packet Loss Ratio	100	3.2	2.7
	300	13	9.1
	500	18	11.2
Energy Depletion (J)	100	32	20.3
	300	34	24.6
	500	42	28.6
End-to-End Delay (sec)	100	0.24	0.18
	300	0.7	0.35
	500	0.9	0.51
Network Lifetime (rounds)	100	5500	5650
	300	5050	5290
	500	4770	485.

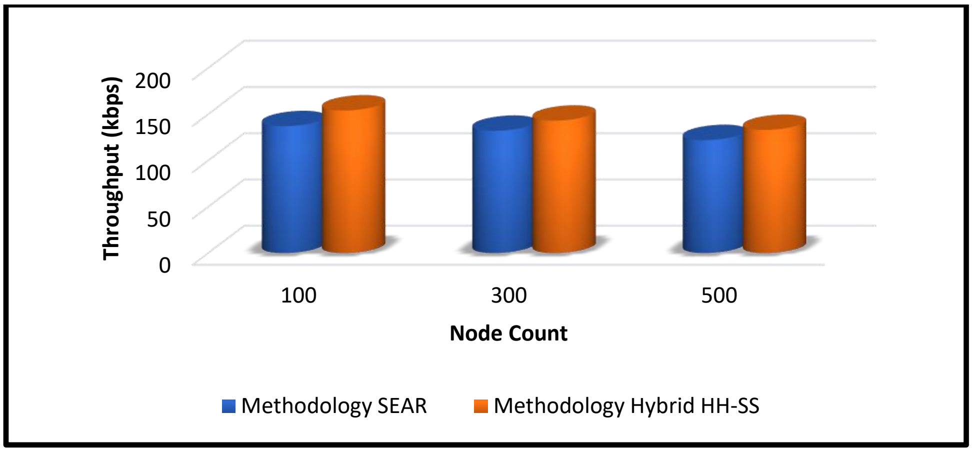

Fig IV: Throughput comparison of proposed method with existing SEAR.

As can be seen in the image, the output of the Hybrid HH-SS is significantly higher than that of its predecessors. Hybrid HH-SS is also superior to SEAR. Compared to other techniques, the proposed methodology achieved good throughput in node 100. As a result, the proposed method's throughput is highlighted as being noticeably superior than that of existing alternatives.

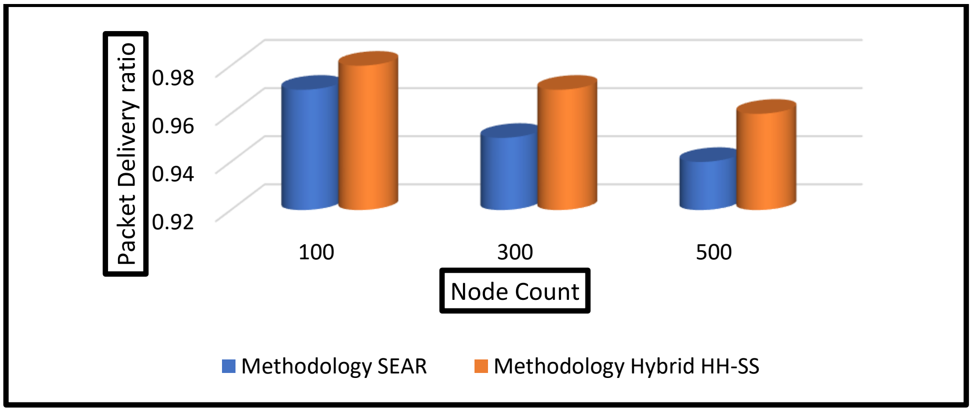

Fig V: PDR comparison of proposed method with existing SEAR.

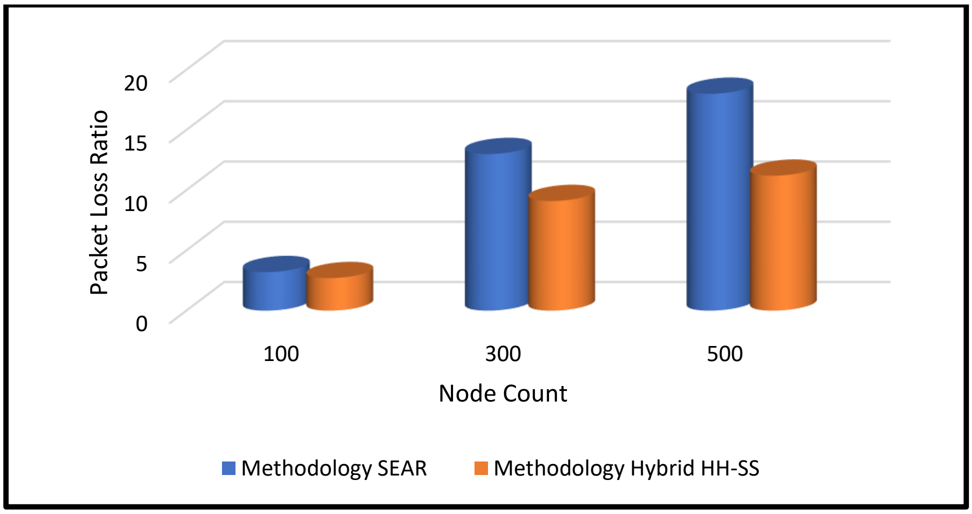

Fig VI: PLR comparison of proposed method with existing SEAR.

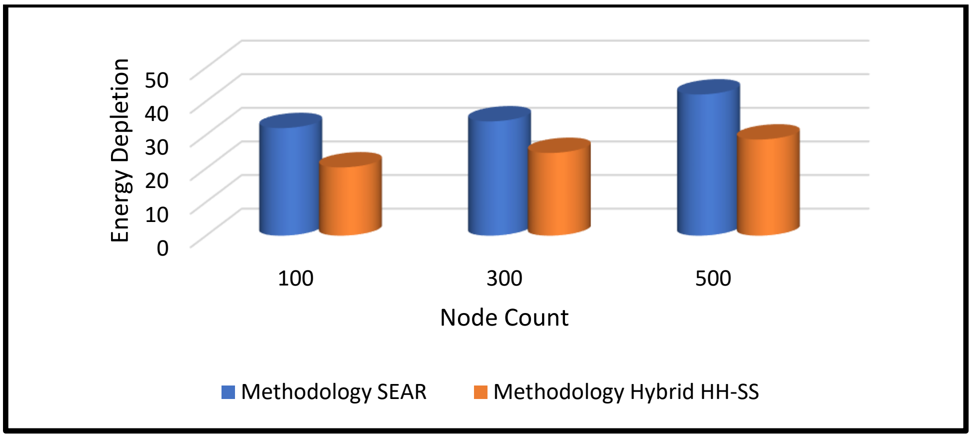

Fig VII: Energy Depletion comparison of proposed method with existing SEAR.

Energy depletion routing and malicious SN detection are also features of the Hybrid HH-SS approach. Results from the simulations show that the PDR grows with the number of SNs, in contrast to the case with present methods, where a rise in the SN count reduces the rate of discovery. When compared to SEAR, hybrid HH-SS provides superior performance and significantly less packet loss. Hence, it's possible to boost the network's efficacy.

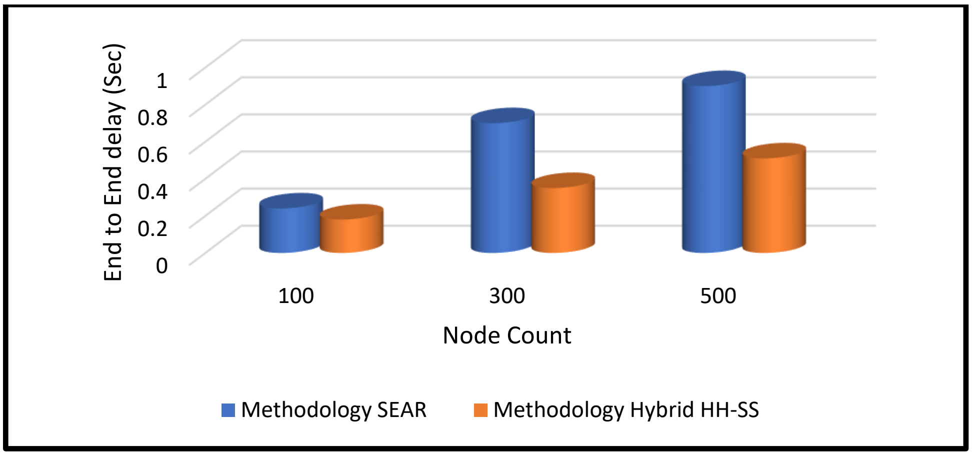

Fig VIII: End to End delay comparison of proposed method with existing SEAR.

Longevity is increased and energy is conserved thanks to the PL's low rate. E2E latency is crucial in time-sensitive programmes. When information is sent and received within a predetermined time frame, E2E latency is met. Keeping delays to a minimum improves the network's dependability and efficacy. The figure clearly shows that the HH-SS hybrid method is superior.

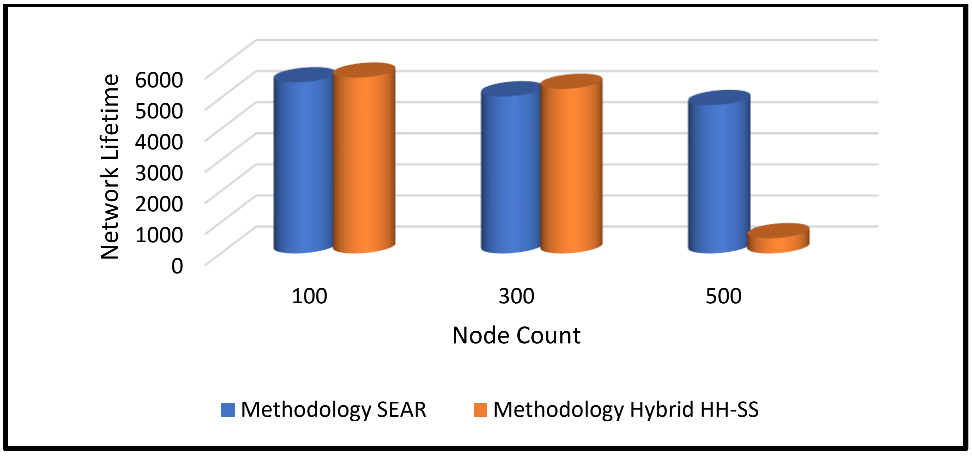

Fig IX: Network Lifetime comparison of proposed method with existing SEAR.

Results from simulations show that the proposed approach as presented in Figure (IV-IX) reduces energy consumption and increases the lifespan of the network. As a result, hybrid HHSS outperforms SEAR. When compared to the SEAR routing protocols, the new technique requires less energy to operate. Longevity of WSNs is typically reduced as the number of SNs increases.

6. Conclusion:

This article presents Hybrid HH-SS algorithms that utilise a mobile descend for the purpose of data gathering in wireless sensor networks (WSNs). Data packets from a variety of low-density systems are gathered by a single, mobile descender using the Hybrid HH-SS. A network is first clustered utilising the K-medoid method, and after that, the best cluster head for each group is selected from within the network utilising a Harris H-SS optimization algorithm hybrid. Cluster nodes can be conceptualised as a mobile descendant that moves around to different sites in order to collect information. In addition to this, an adaptive ant colony optimization strategy is utilised in order to plan a path that connects the leaders of the clusters. After the clusters have been established, a mobile unit will be dispatched to each one in order to collect data while travelling the quickest route possible. The planning for this local mobile descends route use a geometry method with a modest level of complexity. There is a new idea known as a global mobile descend, and the job of this mobile descend is to gather the data packets that have been sent in by all of the regional mobile descends and then bring them to the main station. Both methods are intended to reduce the amount of energy that is wasted in the process of gathering data from sensor nodes before the amount of information becomes overwhelming. Based on the results of our simulations, we discovered that the proposed method not only gathers data from the sensor nodes in an effective and efficient manner but also increases the lifetime of the network.

Conflict of Interests:

The authors declare that there is no conflict of interests regarding the publication of this paper.

Ethical approval: This article does not contain any studies with human participants or animals performed by any of the authors.

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