



e-ISSN: 2319-8753 | p-ISSN: 2347-6710

# IJIRSET

International Journal of Innovative Research in  
**SCIENCE | ENGINEERING | TECHNOLOGY**

# INTERNATIONAL JOURNAL OF INNOVATIVE RESEARCH

IN SCIENCE | ENGINEERING | TECHNOLOGY

Volume 12, Issue 7, July 2023

**ISSN** INTERNATIONAL  
STANDARD  
SERIAL  
NUMBER  
INDIA

Impact Factor: 8.423

9940 572 462

6381 907 438

[ijirset@gmail.com](mailto:ijirset@gmail.com)

[www.ijirset.com](http://www.ijirset.com)

# An Improvement to PEGASIS Protocol in WSN

Prof. Aasha Verghese, Fasmina, Fathima Nidha Pk, Fathima Naima, Fathima Sinu AK

Department of Computer Science and Engineering, MEAEC, Vengoor, Malappuram, India

**ABSTRACT:** Wireless sensor network is one of the successful technologies that are currently receiving significant consideration in scientific and engineering discipline. Throughout the years, several routing methods have been introduced to improve energy economy and lengthen the lifetime of wireless sensor networks (WSNs). The most well-liked chain-based routing protocol, Power-Efficient Gathering in Sensor Information System (PEGASIS), uses a greedy strategy to build the data chain. A new expansion of the PEGASIS protocol is suggested here to enhance the current protocol. Nodes close to the sink often consume more energy to send information from their neighbors to the sink, which leads them to exhaust their energy supply faster. The issue is known as the "hot spot problem," and these nodes are referred to as hot spot nodes. In this research, a novel algorithm called IPEGASIS is proposed to address these issues. In order to reduce energy consumption during transmission, the optimal communication distance is first determined. There has been set a threshold value to protect the dying nodes. By comparing the residual energy of each cluster with the neighboring cluster heads, mobile sink technology is used to balance the energy consumption among nodes. The clusters with the lowest residual energy switch relay nodes and will send the nodes from them to the clusters with the highest residual energy. This will aid the nodes in the clusters in maintaining an energy balance, preventing node death, and extending their network lifetime.

**KEYWORDS:** Wireless Sensor Networks, PEGASIS, Hotspot Problem, IPEGASIS

## I. INTRODUCTION

The use of sensor networks is widespread because they can monitor a variety of environmental factors, including temperature, sound, light, and the presence of other objects that can help with disaster management. WSNs have become a significant tool for monitoring the physical environment in recent years. Energy efficiency and energy balancing have been a very hot and challenging research issue for WSNs for many years. Since large number of sensor nodes is deployed under very harsh environment, it is unrealistic to change the sensor batteries for them. For many years, WSNs have struggled with the difficult research problems of energy efficiency and energy balancing.

### A. PEGASIS

The area of Wireless Sensor Networks (WSNs) is one of the fast growing and emerging fields in the scientific and engineering world. A typical sensor network consists of sensors, controller and a communication system. If the communication system in a Sensor Network is implemented using a Wireless protocol, then the networks are known as Wireless Sensor Networks. It is an ad-hoc network that consists of small nodes with sensing, computing and communicating wireless abilities. These sensor nodes are densely deployed in the sensor field environments. Each node can collect data, and then the data is transmitted to the receiver transmitter Sink through "multiple hops" in a certain routing way. In Wireless Sensor Networks energy efficiency plays a crucial role as the sensors are generally battery powered.

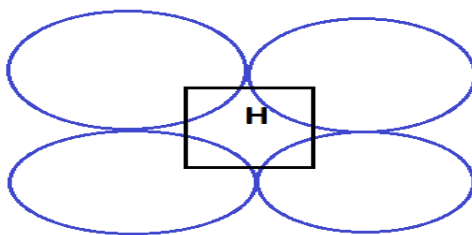
The LEACH[3] serves as the foundation for the PEGASIS algorithm. PEGASIS central idea is to connect together all of the sensor nodes such that each one may communicate with its nearest neighbor. The collected data is sent to the BS by a chosen node (the cluster head) once it has been fused and moved from node to node. The average energy used by each node every round is decreased when nodes alternate sending data to the BS. The travelling salesman issue, which is known to be insoluble, is comparable to the approach used to build a chain to reduce its overall length. But using the radio communication energy characteristics, a straightforward chain constructed using a greedy method.

### B. Coverage Hole

Through nodes, the sensor may keep track of and gather physical data from its surroundings. Since the sensor can easily analyze and send data, the wireless sensor network made up of sensors is used extensively in a variety of industries.



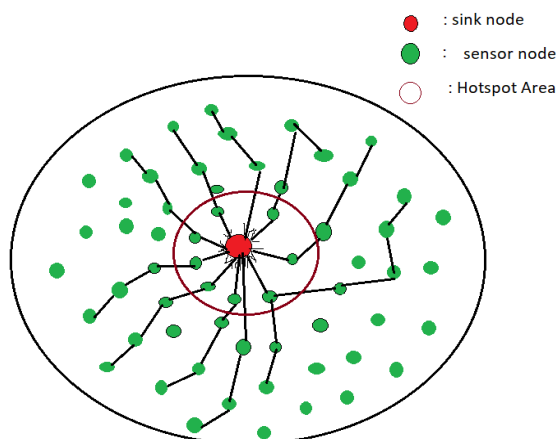
The integrity and dependability of the data gathered by the sensor, as well as the level of service the wireless sensor network offers, are directly influenced by how well the detected region is covered by sensor nodes. As a result, the coverage issue is a crucial area of study for wireless sensor networks. Due to its significant economic worth and social relevance, it is generally worried. The detected region is typically not covered by the sensor nodes, leaving some coverage holes[2]. These coverage holes must be found in order to obtain complete sensor node coverage. A crucial challenge, according to Debbarma et al., is minimizing gaps in wireless sensor networks. It must be found when there are obstructions. Although Voronoi polygons and Delaunay triangulation may be utilized to successfully navigate around obstacles, their detection effectiveness is modest. Coverage hole is shown in **figure 1**



**Figure 1:** Coverage Hole

C. Hotspot Problem

The HOT SPOT PROBLEM is a problem that occurs when nodes close to the sink typically need to consume more energy to convey data of their neighbors to the sink. Many routing methods are introduced with sink mobility technology to address the hot spots issue. This issue can arise due to a variety of reasons such as the malfunctioning of sensor nodes, environmental factors like extreme heat or radiation, or faulty communication protocols leading to excessive energy consumption by some nodes. To mitigate the hotspot problem in WSN, some techniques such as load balancing and energy-aware routing algorithms can be used. Load balancing helps to distribute the traffic evenly among the nodes, preventing some nodes from being overburdened with data processing tasks. Energy-aware routing algorithms aim to minimize the energy consumption of nodes by selecting the most energy-efficient paths for data transmission. Regular monitoring of the network and prompt identification of hotspot problems can also help in timely intervention to prevent node failure and ensure the smooth functioning of the WSN. The hotspot problem is shown in the **figure 2**



**Figure3:** Hotspot Problem

## II. REVIEW OF RELATED LITERATURE

[1] In this paper, we suggested an enhanced PEGASIS algorithm with support for mobile sinks to boost WSN performance. Nodes choose the forwarder based on the best possible communication distance, and a threshold number is set to prevent nodes from dying too soon. We modify the communication distance of nodes based on their proximity to the mobile sink in order to further enhance network performance. As a result, nodes near to the mobile sink will have low communication distances, which will reduce its energy consumption and considerably extend the period until the initial node dies. Numerous simulation results demonstrate that our suggested algorithms work better than conventional PEGASIS. The issue with the hot spots is still there, though, in some areas. The main focus of our future work will be on designing sink moving trajectories properly and jointly optimizing the routing algorithm and sink trajectory design.

[2] In this study, we suggested a DSN-based IAPSO-based area coverage and energy consumption optimization problem. First, in order to increase coverage ratio and decrease redundancy ratio, we put up a multi-objective area coverage optimization model. Then, we developed an algorithm for cluster formation based on weight function and an energy-efficient cluster head selection optimization model. By sensing rotational direction, we used IAPSO-MOACO to achieve high coverage ratio and low redundancy ratio. We used IAPSO-CHSO as well to balance energy usage through prudent cluster head selection.

[3] In this paper, LEACH and PEGASIS hierarchical routing protocols are used to choose a closer head and construct the chain connecting all CH. the improved performance of our CLP-Protocol. When compared to the original LEACH and PEGASIS, the CLP-Protocol consistently lowered energy consumption and lengthened the life of the WSN, which shows the effectiveness of the method while accounting for the energy element in both leader selection and chain building. The study, for instance, may be applied in a variety of ways in future work, such as by suggesting a method that uses less energy and lengthens the lifespan of a gadget.

[4] In this paper, we proposed a new method that is based on the idea of the PEGASIS protocol and gave a revolutionary energy-efficient clustering protocol in WSN. The efficiency of our suggested technique in comparison to the well-known clustering protocol LEACH is demonstrated by simulation results. Future work is what we cite these statements: Compare our strategy to other strategies and protocols, such as other the simulation's parameters and evaluate our strategy in mobile networks.

[5] In this paper, we discuss the value of WSN technology in a number of areas where it meets the demands of people living in the Accelerated World. As was previously discussed in this study, WSN routing protocols play a critical role in the overall enhancement of networks. In this, a hierarchical routing scheme receives all the emphasis. Specifically, those who are mentioned in the protocols for cluster-based routing. The description is based on the protocols that detail the development of the PEGASIS protocol over time are described there models and mechanisms Then, a thorough comparison table that represents various protocols is created.

[6] In this paper, a distributed localized technique was suggested for locating covered redundant nodes in wireless sensor networks. The covered redundant nodes in wireless sensor networks were to be found using a localized distributed technique, which was proposed in this work. After a random node distribution, recognizing the redundant covered nodes can significantly increase the covered area, especially in hostile conditions or in situations where routine node deployment is difficult or impossible. A node that is completely covered by its neighbouring sensor nodes is referred to as a covered redundant node. By relocating the detected covered redundant nodes to the network's uncovered area, finding the covered redundant nodes may expand the coverage area Additionally, placing the redundant nodes that are covered into sleep mode could help them conserve energy and prolong the life of the network. The fully-covered additional nodes are found by the proposed technique by examining the connectivity between nodes in each node's 2-hop local subgraph. The simulation results demonstrate that the suggested technique can locate the majority of redundant nodes in the dense network.

[7] This study presents two modified LEACH protocols: the energy-LEACH protocol and the multihop-LEACH protocol. The phase of cluster head selection in the Energy-LEACH procedure takes leftover energy into account. The Multihop-LEACH protocol uses many hops for communication between the sink and the cluster. According to the results of the simulation, the energy-LEACH and multihop-LEACH protocols perform better than the LEACH protocol.

[8] A method for deploying sensors that takes into account the region where a network is disconnected and several partitions are made has been proposed. The entire exposed region is segmented into polygons. To identify the pattern of node placement in this region, utilize the medial axis. By doing so, it lessens the stress placed on the moving machine



that places the node in the field. This approach is expandable. The method first estimates the distance between the two tracks by taking into account the sensor node's sensing and communication range. By doing this, the sensing area overlap is optimized. In order to rejoin the network with maximum coverage and minimal overlapping region is segmented into polygons. To identify the pattern, the approach installs nodes appropriately.

### III. PROPOSED WORK

#### A. Improved PEGASIS Routing Protocol

Chain generation is a key component of the Power Efficient Gathering in Sensor Information System (PEGASIS), a routing system. The key flaw with PEGASIS is that chain construction does not take the distance between the primary node and the other nodes into account, even if multi-hop transmission of packets reduces energy consumption. Longer chains may therefore grow in big WSNs, increasing latency. By reducing the transmission distance between nodes, PEGASIS aims to extend network lifespan. Chain-based routing, however, has a significant communication cost and latency. Some new protocols combine the advantages of chain and cluster routing to minimize or combine their respective drawbacks.

#### B. Rectification of Hotspot problem

To address the hotspot problem in wireless sensor networks. It works by optimizing the energy consumption of the nodes while maintaining data transmission reliability. To apply Enhanced PEGASIS to rectify the hotspot problem, the following steps can be followed:

1. Identify the nodes that are consuming more energy than others due to high communication load. These nodes are the hotspots.
2. Determine the transmission range of each node and select the nearest neighbor for communication to reduce energy consumption.
3. Deploy a data fusion node that will act as the data aggregator and communicator between the sensor nodes and the base station.
4. Implement Enhanced PEGASIS on the data fusion node, which will perform data aggregation and transmit the aggregated data to the base station.
5. Configure the Enhanced PEGASIS algorithm to collect data from the hotspot nodes at a lower frequency, so that their energy consumption is reduced.
6. Monitor the network to ensure that the hotspot problem has been rectified and that the network is functioning properly.

By implementing Enhanced PEGASIS, the hotspot problem can be addressed effectively, and the network lifetime can be prolonged. The algorithm optimizes the energy consumption of the nodes by selecting the nearest neighbor for communication, reducing the communication load on the nodes, and prolonging their battery life. Additionally, data aggregation and transmission are performed by the data fusion node, which further reduces the energy consumption of the nodes. The below Figure 3 shows the whole proposed methodology.

### IV. PROPOSED ALGORITHM

*Summary of IPEGASIS* : This section will discuss details of our suggested algorithm. The chain-based routing strategies group includes our proposed strategy, called Improved PEGASIS (IPEGASIS). When selecting a relay node from among its neighbors in IPEGASIS, each node uses the optimal communication distance. We developed a protective mechanism based on the average residual energy of its nearby neighbors in order to prevent excessive energy consumption for particular nodes with special locations. For the purpose of balancing the energy use across several regions, data is collected by a mobile sink.

*Description of IPEGASIS* : Review of the ideal communication distance. According to the energy consumption model, as communication distance increases, energy consumption also increases quickly. Multihop transmission is used to

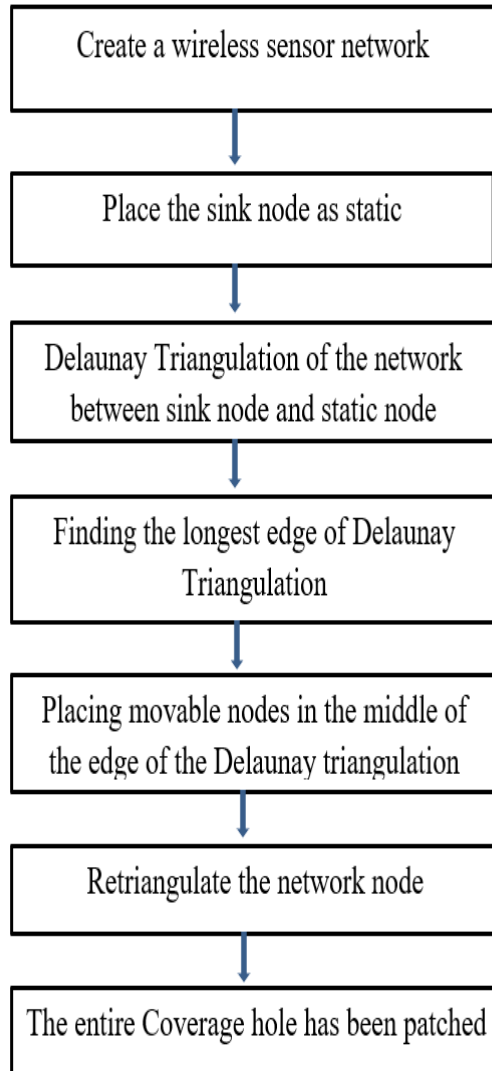


reduce energy consumption and prevent long-distance communication. Too many hops, however, could make forwarding more difficult and increase end-to-end latency. Figure shows the connection between total energy use and hop counts. Figure makes it very evident that, as the number of hops increases, the overall energy consumption first decreases to reach its lowest point before expanding. Each line's lowest point, indicated by the triangle in each line, represents the energy used when  $m/k = d_0$ .

*Initial Stage of the Network* : After the deployment of nodes, the network starts up. The main aim of the first stage is information exchange in order to set up data transfer. The mobile sink broadcasts a NETWORK package at the starting point to remind all the nodes to set up the network. Each node has a route table to keep track of its neighbours. Following that, every node broadcasts a package with its maximum transmission range.

*Generation of network topology* : Because each node in PEGASIS chooses its nearest neighbor to act as a relay node for data forwarding, there is a heavy burden on the network and a significant delay in the delivery of data. We primarily aim to reduce data forwarding times and achieve an optimal energy consumption using our proposed approach. After selection of relay node the energy of two nearest neighbour relay nodes are compared. After comparing the residual energy switch relay nodes and will send the nodes from to them the cluster with the maximum residual energy.

```
function compare_relay_energy(relay1, relay2):  
  
    if relay1.energy > relay2.energy:  
        return "Relay 2 has lower energy consumption"  
  
    elif relay2.energy > relay1.energy:  
        return "Relay 1 has lower energy consumption"  
  
    else:  
  
    return "Both relays have equal energy consumption"
```



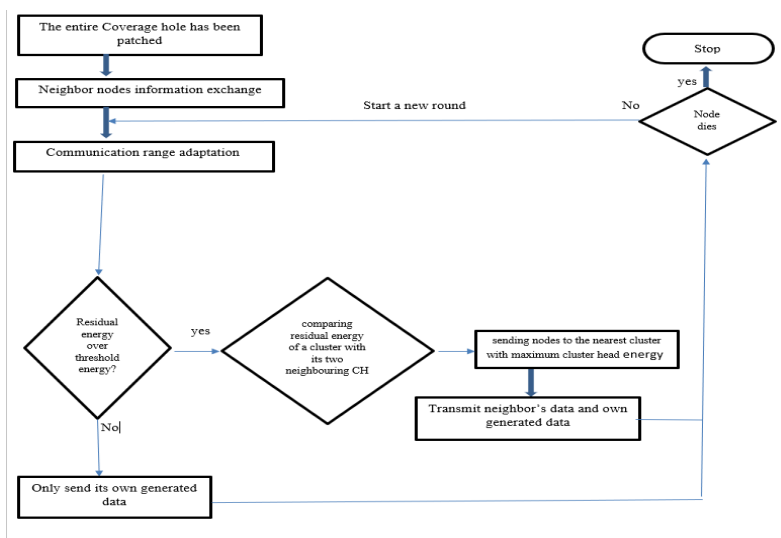


Figure3:Proposed Methodology

### V. IMPLEMENTATION

#### A .Generation of sensor network after the coverage hole maximization using Delaunay Triangulation:

A flexible sensor deployment strategy that may be used for a variety of applications is necessary to achieve a wireless sensor network that performs satisfactorily. Delaunay triangulation is used to triangulate the positions of wireless sensor nodes. Current positions of mobile nodes are highlighted after random sensor node deployment. The longest edges are first found in order to deploy movable nodes in the middle of the edges in order to locate the coverage holes. Successful retriangulation using deployed mobile nodes.

#### B. Generation of wireless sensor network with the mobile sink node:

A mobile sink node is added to the network that can link the sensor network to an existing communications system or the Internet. It moves with a definite direction and speed.. The mobile sink node moves through the center with a fixed radius. Therefore, only during the initial phase, the mobile sink needs to broadcast its position. The mobile sink relocates to a new location after t time.

#### C. Formation of cluster after finding the relay node:

One of the primary methods for prolonging the lifespan of wireless sensor networks (WSNs) is clustering. The cluster heads (CHs) for each cluster are chosen after the sensor nodes have been organized into groups called clusters. In order to make wireless sensor networks more energy efficient, CHs gather data from certain cluster nodes and provide the aggregated data to the base station. Clustering is a well-known optimization problem that has been extensively calculated to increase the lifespan of wireless sensor networks.

#### D. Compare residual energy of a cluster with the neighboring cluster heads:

Each cluster's residual energy is determined, and it is compared with the neighboring cluster head.

#### E. Sending nodes to the nearest cluster with maximum cluster head:

After comparing the residual energy of each clusters with the neighboring cluster heads, the clusters with the the lowest residual energy switch relay nodes and will send the nodes from them to the clusters with the maximum residual energy. This will help the nodes in the clusters to balance the energy and thereby avoiding the dying of nodes and to increase the network lifetime of them.





VI. RESULT

- As we can see that the average energy consumption per round in EPEGASIS1 reduces about one-third that of PEGASIS due to the using of optimal communication distance.

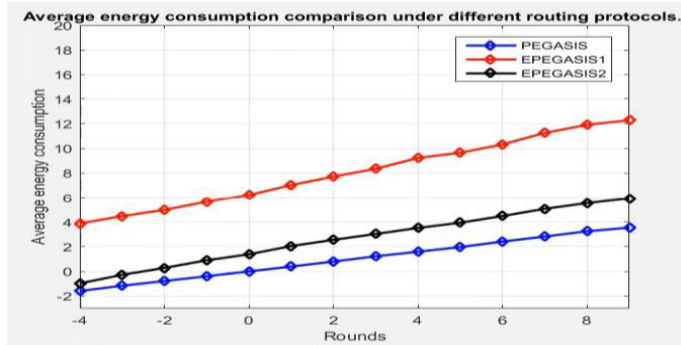


Figure4: Average energy consumption comparison

- Here the network latency has a great improvement in both EPEGASIS1 and EPEGASIS2.
- In EPEGASIS2, due to the adoption of communication distance adjustment, some nodes extend their communication distance and some nodes short their communication distance.

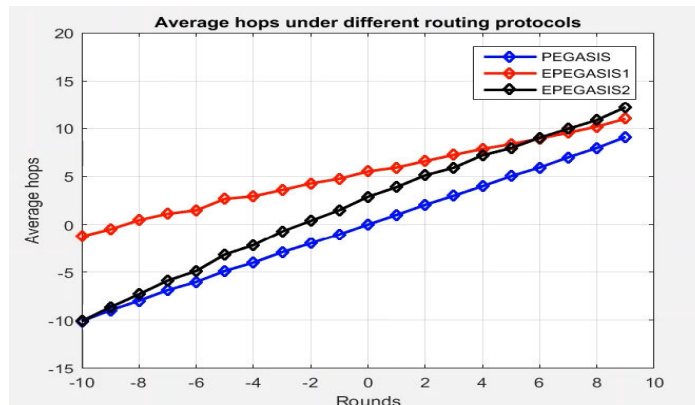


Figure5: Average hops under different routing protocol

- It demonstrates that when the mobile sink travels around the sensor field with R radius, the network has a better performance in terms of network lifetime

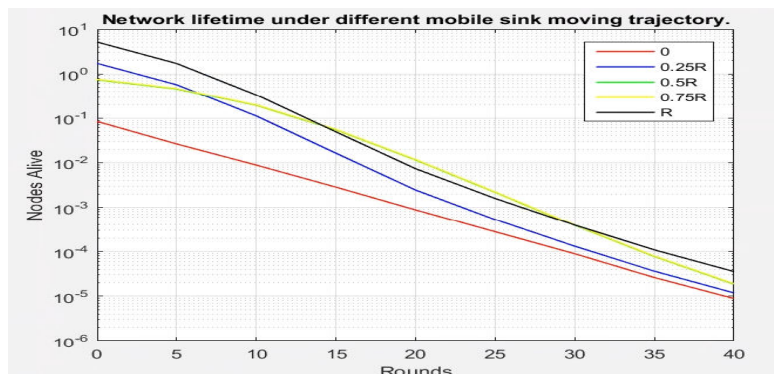


Figure6: Network lifetime under different mobile sink

- The figure 7, illustrates the comparison of IPEGASIS with the existing PEGASIS variants.
- Here it shows the network latency between different routing protocols, and the result is shown as Figure7 We can clearly see that the network latency has a great
- Improvement in IPEGASIS when compared to EPEGASIS2 and other previous protocols.
- In EPEGASIS2, due to the adoption of communication distance adjustment, some nodes extend their communication distance and some nodes short their communication distance.
- But there still exist the problem of network lifetime. This problem is solved by introducing a better variant known as IPEGASIS.

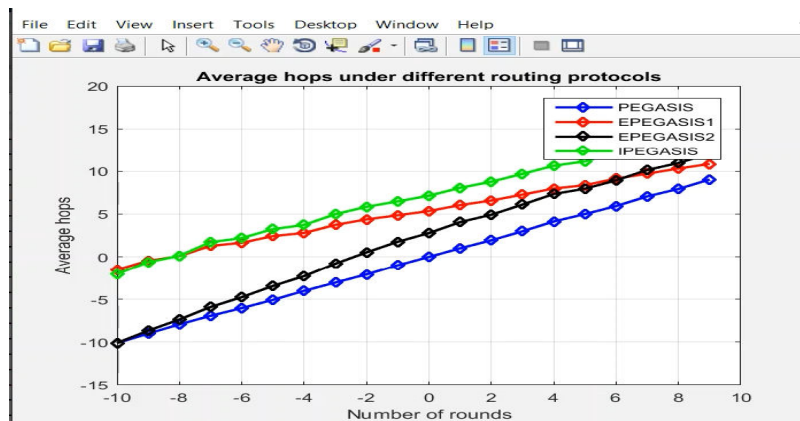


Figure7: Comparison of IPEGASIS with the existing PEGASIS variants

## VII. CONCLUSION

In order to enhance WSN performance, we suggested an improved PEGASIS algorithm in this study with support for mobile sinks. To choose the forwarder, nodes employ the shortest possible distance for communication, and a threshold value is specified to prevent nodes from dying too soon. We alter each node's communication distance based on how far away it is from the mobile sink in order to further enhance network performance. In order to reduce energy consumption and lengthen the period until the first node dies, nodes near to the mobile sink will have low communication distances. Along with choosing clusters with maximum energy cluster heads and moving the closest nodes from least energy cluster heads to maximum energy cluster heads for longer network lifetime, we also used mobile sink technology to balance the energy consumption among nodes. The issue with the hot spots is still there, though, in some areas. The main focus of our future work will be on designing sink moving trajectories properly and jointly optimizing the routing algorithm and sink trajectory design

## REFERENCES

- [1] Wang, Jin, et al. "An enhanced PEGASIS algorithm with mobile sink support for wireless sensor networks." *Wireless Communications and Mobile Computing* 2018 (2018).
- [2] Peng, et al. "An area coverage and energy consumption optimization approach based on improved adaptive particle swarm optimization and Networking for directional sensor networks." *Sensors* 19.5 (2019): 1192.
- [3] Kumar, et al. "AN INCORPORATION OF LEACH-PEGASIS PROTOCOLS FOR WIRELESS SENSOR NETWORKS:(CLP-PROTOCOL).
- [4] KADDI, et al. "A Novel Approach for Energy-Efficient of WSN Using PEGASIS Protocol".
- [5] Hussein, et al. "Improvements of PEGASIS routing protocol in WSN." *Int Adv J Eng Res* 2.11 (2019): 1-14.
- [6] Aljubori, et al. "Improving the Deployment of WSNs by Localized Detection of Covered Redundant Nodes in Industry 4.0 Applications." *Sensors* 22.3 (2022): 942
- [7]F. Xiangning, et al. "Improvement on LEACH Protocol of Wireless Sensor Network," *2007 International Conference on Sensor Technologies and Applications (SENSORCOMM 2007)*, Valencia, Spain, 2007, pp. 260-264, doi: 10.1109/SENSORCOMM.2007.4394931.



- [8] R. Kumar, et al. "Deployment of Sensor Nodes for Connectivity Restoration and Coverage Maximization in WSNs,"2021 Sixth International Conference on Wireless Communications,SignalProcessing(WiSPNET),2021,pp.209-213,doi:[10.1109/WiSPNET51692.2021.9419391](https://doi.org/10.1109/WiSPNET51692.2021.9419391).
- [9]A. M. Khedr, et al. "Successors of PEGASIS protocol: A comprehensive survey", Comput. Sci. Rev., vol. 39, Feb. 2021.



Impact Factor: 8.423



# INTERNATIONAL JOURNAL OF INNOVATIVE RESEARCH

IN SCIENCE | ENGINEERING | TECHNOLOGY

 9940 572 462  6381 907 438  [ijirset@gmail.com](mailto:ijirset@gmail.com)



[www.ijirset.com](http://www.ijirset.com)

Scan to save the contact details