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PAPER

# Cluster-Factors of Mobile Sensor Network Technology for Security Enhanced PEGASIS

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## ABSTRACT

Mobile wireless sensor networks (MWSNs) have been a hot topic of research, and numerous routing methods have been developed to increase energy efficiency and extend longevity. Nodes close to the sink often use more energy to transmit data from their neighbors to the sink, which causes them to run out of energy faster. These places are also referred to as rendezvous points, and choosing the best one is a hard task. The likelihood of choosing an ideal node as the rendezvous point will be extremely low because hierarchical algorithms only use their local information to select these places. The warm spot problem is addressed from four angles in this work using the Enhanced Power-Efficient Gathering in Sensor Information Systems (EPEGASIS) technique. In order to limit the amount of energy used during transmission, the ideal communication distance is first calculated. To balance the energy consumption among the nodes, mobile sink technology is employed once a threshold value is set to safeguard the dying nodes. The node can then modify its communication range based on how far away the sink node is from it. Thorough testing has been done to demonstrate that our suggested EPEGASIS works better in terms of longevity, drive usage, and web latency.

## KEYWORDS

mobile wireless sensor networks (MWSNs), Enhanced Power-Efficient Gathering in Sensor Information Systems (EPEGASIS), network latency, energy usage, nodes, low energy adaptive clustering hierarchy (LEACH)

## 1 INTRODUCTION

The mobile wireless sensor networks (MWSNs) has been used in a variety of applications, including monitoring physical phenomena such as temperatures, adhesion, tremors, solar energy, medical services, defense, smart homes, agriculture, and the military, among others. A network setup that jointly collects, processes, and communicates environmental or physical data circumstances is

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referred to as a spatially dispersed gadget in MWSN. Energy usage is one of the most important issues with mobile nodes of sensors [1]. Numerous studies are being conducted to improve the energy-efficient sensor nodes (SNs), network technology, and topology mentioned above. A SN uses energy while gathering and transmitting data. The task that uses the most energy is disseminating information across all media. Clustering is one of the key methods for lengthening heterogeneous mobile sensor networks. Mobile sensor protuberances are gathered into clusters and cluster heads (CHs), and transmission takes place between SNs, CHs, and base stations (BS).

The SNs typically include a transistor transceiver, an analog-to-digital converter, an antenna, a power source, and one or more sensors (such as temperature, light, moisture, water, stress, brightness, closeness, etc.). Again, due to their small dimensions, the protuberances have restricted onboard preservation, battery life, division, and broadcasting capabilities. The construction of the mobile device node is nonetheless remarkably similar to that of the standard sensor node. However, several extra components, such as positioning devices, mobilizers, and power generators, are taken into consideration for mobile sensor nodes.

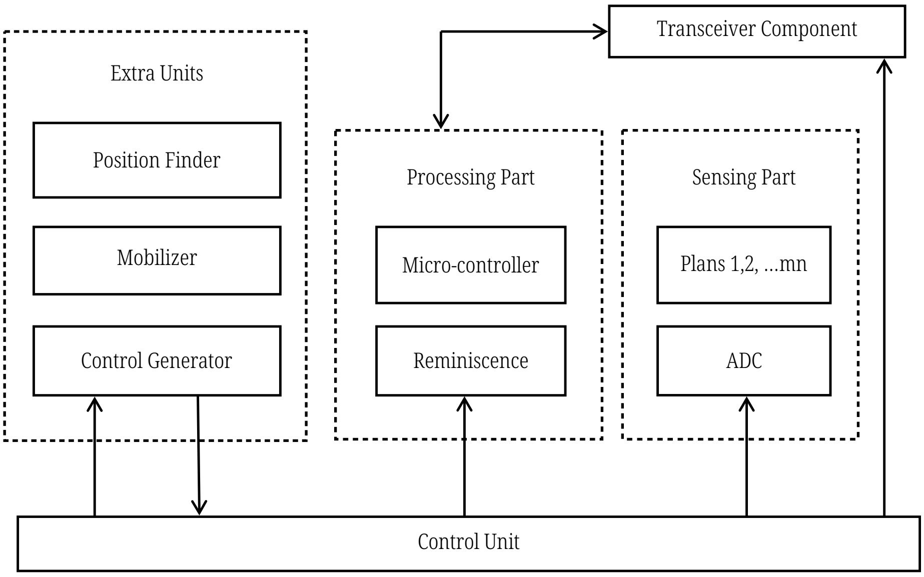


**Fig. 1.** The architecture of mobile sensor node

Figure 1 depicts the mobile sensor node's structure. The mobilizer provides mobility, while the location detection system determines the position of a sensor node [2]. The control generating unit is in charge of producing power to satisfy the additional energy requirements of the sensor node using any special means, such as the solar cell. Due to MWSNs' minimal electrical consumption, tremendous flexibility, and quick network speed, research on MWSNs has mostly focused on data collection, geolocation computations, energy-efficient mobile path optimization, interaction, reliability, and endurance.

The most recent routes for MWSNs are covered in this research, along with a thorough classification of the procedures for MWSNs based on several criteria [3]. There are comprehensive contrasts between MSNs and MS nodes. In addition, an analysis of home computer programmers is provided along with the MWSN evaluation measures. Future trends and difficulties are then examined.

The following is the survey's overall structure: In Section 2, relevant work is provided. An explanation of MWSN routing protocols is provided in Section 3. We discuss the platform's implementation in Section 4 along with the simulations that were performed to gauge how effective our proposed approach is. This paper concludes in Section 5.

## 2 RELATED WORKS

According to Bhushan, B., et al. [4], the capacity of a routing method to accomplish the desired outcome or aim while using the limited power resources at its disposal is known as survival. The distribution of the storage load is a crucial survival concern. Additionally, SNs must be sufficiently scalable to constantly adjust their architecture and node density. Due to the predominantly diverse nature of SNs in wireless sensor networks (WSNs), device diversity is a crucial survivability issue. The main problem is bandwidth consumption, which can change throughout a network's lifespan. The fact that the nodes are battery-powered adds to the problem of energy usage in wireless sensor networks.

Ganesh, S., et al. [5] have observed that the target region's source nodes send packets to the BS in two steps: intra-cluster route and inter-cluster forwarding. Using an avaricious inter-cluster relaying mechanism, the data packages from the CHs of the intended areas are transmitted to the BS. When the threshold is reached but there are not enough intra-cluster nodes, a straightforward flooding technique is employed for intra-cluster routing to flood the cluster with packets. In the absence of this, the recurrent geographic transmitting, the data packet is distributed throughout the target cluster. To accomplish this, the CH divides the target clusters into several regions, produces a number of fresh copies of the question packet, and then sends each of these copies to a node that is positioned in the center of each sub region.

Dhivya, S., et al. [6] stated that low energy adaptive clustering hierarchy (LEACH) is the clustering technique that WSNs use the most. It employs the random rotation approach for the LEACH protocol's cluster heads to minimize the energy used by SNs. In WSNs, several variations of the LEACH protocol have been put forth. The circumstance phase and the steady-state phase are the phases of operation for the LEACH technique. The choice of the cluster head, cluster creation, and time-division multiple access (TDMA) schedule assignment are all done during the setup phase. Centralized, distributed, and hybrid models are used to build the clusters.

Hussaini, M., et al. [7] argue that for medical purposes and medical body area networks, the first-order radio model is more appropriate. One of these programs was created as part of the Vital Sign project, which involves manually deploying specialized sensors (UC Berkeley motes running TinyOS software) for patient identification. Around ten to twenty nodes are installed, making the network size modest, and as a result, the deployment area is also small. Since they are made for small-scale applications, the SNs are used to monitor a single event for a brief period.

Kaur, K., et al. [8] have observed that the link between people in this protocol is created as a chain architecture. Data will be transferred from one node to another in a chain, and it will all be combined in the end. In the case of this protocol, these two are the primary factors on which routing itself depends. This protocol functions similarly to a chain, where one link might serve as the head link when exchanging information. As LEACH struggles, it also encounters various issues. The main drawbacks of this are that it is not adaptable, which prevents it from being utilized in connected sensors because of the enormous number of nodes and the lack of knowledge about them.

Barbier, M., Araújo, R., et al. [9] have expressed that the seaweed aquaculture industry needs more funding to increase the production of seaweed in the continent. Research and development efforts as well as enterprises operating in Europe that are expanding sustainable seaweed farming should be aided. However, as there is not yet a special legislation or regulation controlling this developing industry (which is covered by the broader aquaculture regulatory framework and may not effectively handle the particulars of the marine sector), the possible risk of a detrimental ecological effect should not be disregarded. Therefore, industry and decision-makers must accept scientific advancements and information regarding seaweeds (including their genetic makeup and the mechanism of ecosystem genetic flow).

Lindsey, Stephanie, et al. [10] observe that information from all nodes must be gathered throughout each round of this data collection application and sent to the BS, where the end user can view the data. Direct data transmission from each node to the BS is an easy way to complete this operation. The overall energy cost per round will be largely due to the BS's remote location, which makes it expensive to transmit data to the BS from any node. The quantity of data exchanged between node sensors and the BS in sensor networks can be decreased thanks to data fusion. A single packet is created through data fusion, which merges one or more data streams from several sensor measurements. This data-gathering issue can be elegantly solved by using the LEACH procedure, in which a few clusters grow in a self-organized way.

## 3 METHODS AND MATERIALS

### 3.1 An analysis of wireless sensor networks

A more sophisticated kind of WSN, MWSNs introduce mobility as a new element that affects both SNs and dishonorable stations. MWSNs need to take into account network topology, routing algorithms, corporal safety, and data security because mobility presents new difficulties for networks, such as dependability and security concerns.

### 3.2 Cluster-chain mobile agent routing system

The network design under the suggested framework integrates the chain-based unstructured network, Power Efficient Gathering in Sensor Information System (PEGASIS), and the cluster-based arbitrary chain LEACH. Data aggregation is carried out via an MA to enhance the network's energy efficiency, longevity, and latency. The primary distinction between the proposed system and ECCP is the use of MA. The system is created taking into account the WSN-related network design, node portability, and data aggregating tactics now in use. It's structural focus is on creating an effective network design.

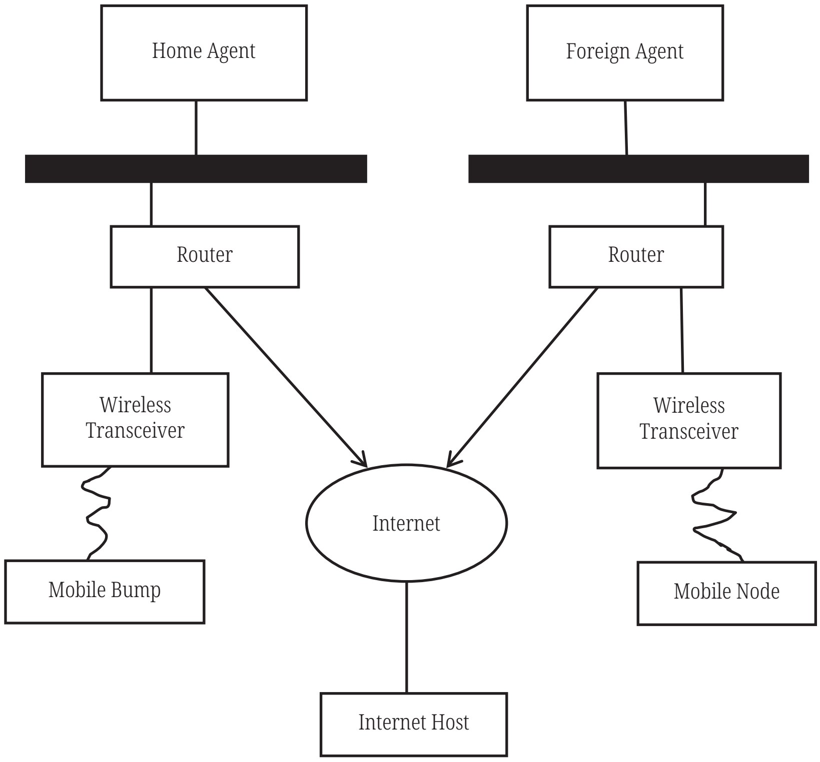


**Fig. 2.** Protocol routing architecture for an MWSN

As an outcome, a CCMAR methodology is suggested in this study for carrying out an effective data collection process. It integrates the benefits of LEACH and PEGASIS to achieve low energy usage and a quick transmission delay. The sensor network is divided into a few clusters by CCMAR, which then uses LEACH to assign an individual cluster head to each cluster. To accomplish the compilation of data, a chain is then created between the nodes located inside each cluster using PEGASIS [11], working its way outward from the cluster head. As a result, it can be identified as a cluster or chain head in the remainder of the paper's talks. The collected information will be kept in clusters or chains after processing. To further increase network lifespan efficiency, an MA is installed to acquire the data rather than having the cluster or chain head broadcast it to the base station. This will lessen the leakage of energy in the group or chain throughout the transmission of information, which could once again result in network failure. Improving functionality concerning lifetime and node energy: the goal of this effort is to improve latency measures, which are important in many time-critical operations. As a result, the suggested network design resolves the problem that the cluster head had with the conventional LEACH algorithm, which quickly depletes node energy when acquiring, aggregating, and relaying details to the base station. Constructing a hybrid network out of the same cluster and chain rather than a single continuous chain also decreases the transmission time.

The CCMAR's assumptions are as follows.

- All sensor nodes are capable of establishing a connection to the sink node; homogeneous sensor nodes; identical initial power settings for all sensor nodes;
- The amount of power used by a single bulge for sending and getting a message remains constant.

The cluster-chain MA routing architecture for a WSN is shown in Figure 2. The network is separated into a small number of groups, and each cluster's nodes join together to form a chain. In order to accomplish in-network data aggregation, each cluster elects one node as its hub or chain leader. A MA is sent from the node that is sinking to each cluster or chain head in order to acquire the aggregated statistics.

**State-of-the-art MWSN routing protocols.** This section discusses well-known modern MWSN routing methods and associated improved combination of MWSNs routing procedures as depicted in Figure 3 [12]. The functionality and safety mechanisms of the routing algorithms appropriate for MWSN are the main topics of this section.

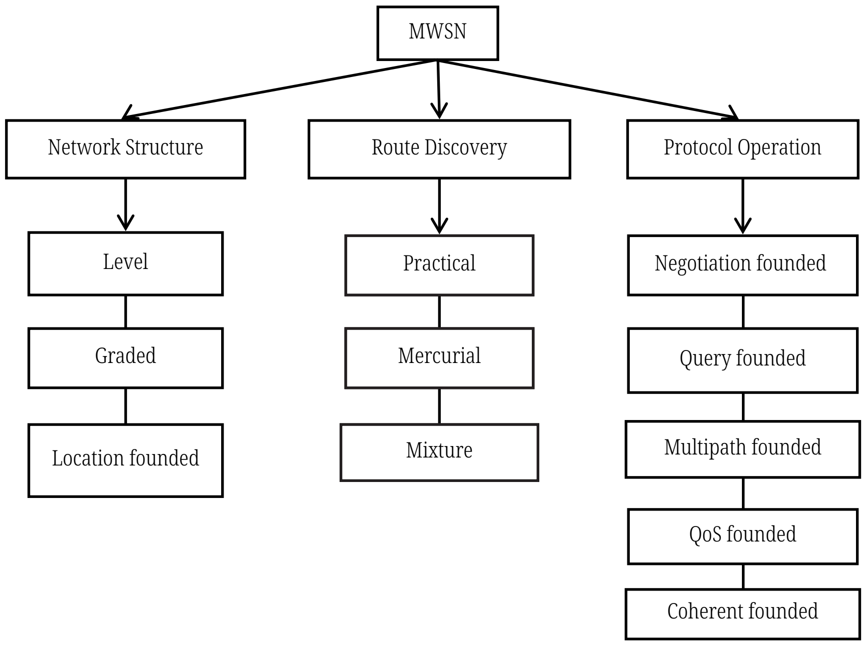


**Fig. 3.** Combination of MWSNs routing procedures

## 3.3 LEACH family

One of the most well-liked, systematically organized protocols for routing WSNs is LEACH. The protocol does not require knowledge of the entire network because it is made for dispersed networks. LEACH is a TDMA, which enables spreading over the identical channel with numerous time slots per transmitter. LEACH enables low consumption of energy by enabling nodes to activate their transceivers only during predetermined periods, requiring little or no energy for transmission to reach the heads of the cluster. Data transmission in LEACH is separated into rounds of predetermined lengths of time.

The setup phase and the steady-state phase are the two phases that make up each round. Cluster heads will be chosen during the setup phase with equal chance depending on the nodes' signal quality and remaining energy. Once a node has served as the hub of the cluster, it cannot serve in that capacity again until all the nodes have been selected. During the setup phase, the cluster heads and the base station also form multi-hop links. The cluster leaders communicate with the cluster members during the steady-state phase using a procedure known as intra-cluster transmission to collect data from the cluster members. Afterward, the combined data will be integrated and transferred to the base station for processing through a procedure known as inter-cluster delivery.

The WSN LEACH protocol effectively increases the longevity of static nodes, but it struggles on large mobile networks, prompting the creation of LEACH variations such as TLEACH, LEACH-mobile, and LEACH-mobile-enhanced. LEACH has some shortcomings, including a selection process that only takes into account available energy for choosing cluster heads and arbitrarily and inconsistently distributed cluster heads throughout the network. The most environmentally friendly choice isn't necessarily one-hop communication between the cluster heads and the base stations. Another restriction of LEACH is the ineffective randomization of the cluster head structures. The WSN LEACH protocol effectively increases the longevity of static nodes, but it struggles on large mobile networks, prompting the creation of LEACH variations such as TLEACH, LEACH-mobile, and LEACH-mobile-enhanced. LEACH has some shortcomings, including a selection process that only takes into consideration available energy for choosing cluster heads and arbitrarily and unevenly distributed cluster heads throughout the network. The most environmentally friendly choice isn't necessarily one-hop communication between the cluster heads and the base station. Another restriction of LEACH is the ineffective randomization of the cluster head structures. Figure 4 illustrates WSN clustering routing protocols classification.

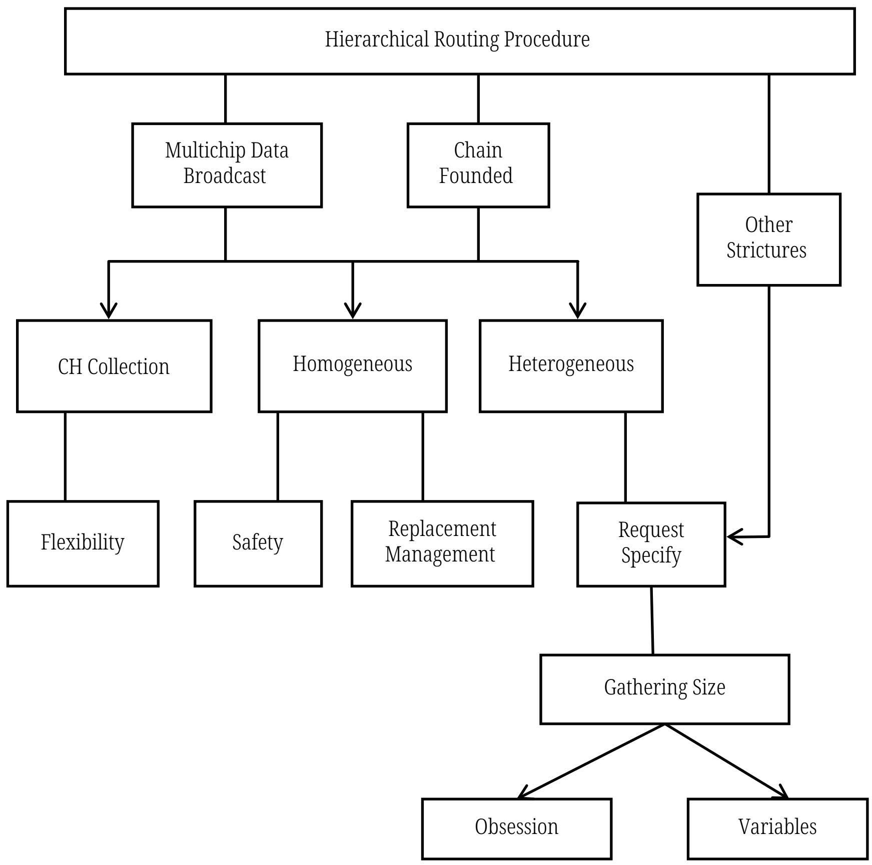


**Fig. 4.** WSN clustering routing protocols classification

LEACH-ME takes mobility factors into account when choosing the cluster head. Depending on the node's speed and the duration it needs to travel between two points, a mobility factor is computed for every individual frame. Although LEACH-ME is more trustworthy for MWSNs, it uses a lot of electricity to calculate each node's portability factor for every frame. By utilizing tree-based navigation, power control, and multi-hop migration, the procedure improves power consumption and packet delivery rates. The protocol's improvements allow it to deal with massive MWSNs and dispersed mobile nodes [13] [14]. The topological development and topological maintenance stages make up TLEACH's two phases. The grouping framework, multi-hop mechanism, and information grouping tree are all built during the topology development phase.

### 3.4 PEGASIS-E

PEGASIS-E is an improved round-based, chain-based routing technique. Chain formation, leader selection, and data transmission are its three phases.

- **Chain building phase**
  - Set up the network's settings. To begin with nodes the beginning energy, the location of the base station (BS) etc., are identified. The construction of the chain then begins.
  - To gather fundamental network data, such as the ID of active nodes, each node's distance from BS, and the distance between nodes, BS transmits a hello message to the entire network.
  - Node 1 is specified as the end node, which is the node that joins the chain from the last and is farthest from the base station.
  - All nearby radio-reachable nodes that have not yet joined the system, is added to the chain.
  - In order to determine the minimal distance node, the distances of all the bulges connected to the chain is then compared.

- **Leader selection phase**

The process for choosing leaders in PEGASIS-E is the same as in PEGASIS. A leader node is a node that broadcasts data from the chain. On the chain, the supreme ruler will be in an arbitrary position, j. In round i of the rotational transmission protocol, nodes will communicate with the BS using node count J mod S (where S is the total number of nodes). As a result, the leader in each series of exchanges will be at a random location on the chain for node deaths at varied locations. The idea of random node deaths on the chain ensures the network's resistance to failures.

- **Data transmission phase**

Following the selection of the leader node and effective chain creation, data transmission begins. When a node has only one link, the leader nodule launches a token-passing strategy to begin data transmission from that node. During the time periods allotted to them by the TDMA technique, each node in the chain transmits its own data gathered to its neighbor node. The incoming data is then combined with the neighboring nodes' own data and forwarded in the direction of the leader. Up until BS receives information from the leader, a round will continue. Additionally, when a node in the chain fails during simulations of an experiment, it is assumed that the chain is rebuilt.

# 4 IMPLEMENTATION AND EXPERIMENTAL RESULTS

## 4.1 Situational simulation

We use the Matlab simulator to carry out the test in order to assess the effectiveness of our suggested EPEGASIS technique [15] [16]. With regard to standard PEGASIS, we will contrast our suggested algorithm. In addition, Table 1 includes a list of the simulation parameters.

**Table 1.** Simulation parameters

| Parameter Name | Parameter Value |
|---|---|
| The network radius (S) | 200mm |
| Radius(r) of a mobile washbasin | [1, 65, 140, 220, 200]m |
| Mobile sink velocity (w) | Qi/4 |
| Nodes present: (N) | 400 |
| Length of a packet (l) | 400 bits |
| Energy at first (0) | 0.04j |

EPEGASIS1 has a significantly longer network lifetime than PEGASIS. Nodes near the sink start to fail at around 60 rounds because of the high weight of transmitting neighbors' data packets. However, due to node security, communication distance adaptation, and sink movement, the first dies in EPEGASIS2 are at roughly 90 rounds.

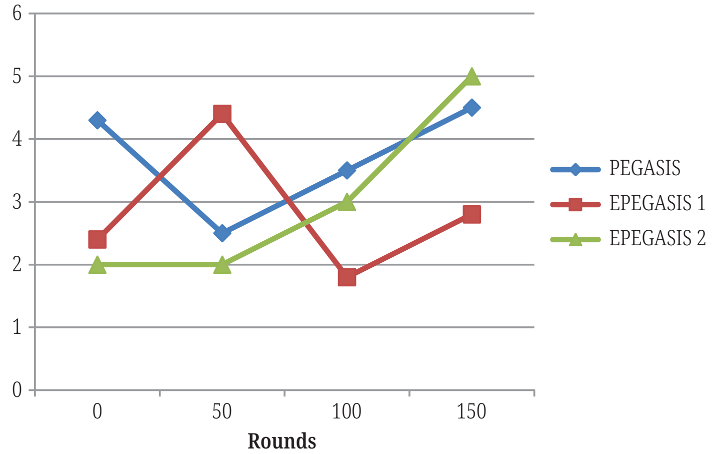


**Fig. 5.** Comparison of network lifetimes under various routing protocols

According to Figure 5, EPEGASIS1 has a significantly longer network lifetime than PEGASIS. Nodes near the sink start to fail at around 80 rounds because of the high weight of transmitting neighbors' data packages. However, due to node protection, communication distance adjustment, and sink mobility, the first dies in EPEGASIS2 are at roughly 80 rounds.

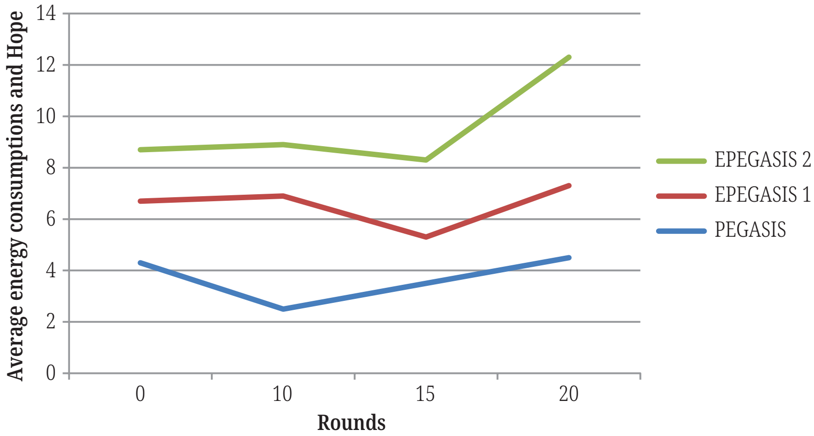


**Fig. 6.** Comparison of the average energy use and average hops for various routing protocols

Figure 6 illustrates the comparison of the typical energy consumption per round of various routing strategies. It is evident that EPEGASIS1 uses around a third less energy on average every round than PEGASIS does, thanks to the optimal communication connection. Additionally, we investigate the network latency between various routing systems. Both EPEGASIS1 and EPEGASIS2 exhibit a significant improvement across network latency, as is evident. Due to the use of messaging distance modification in EPEGASIS2, some nodes in the system increase and some nodes decrease in interaction distance. Therefore, in terms of network latency, EPEGASIS1 and EPEGASIS2 almost perform equally.

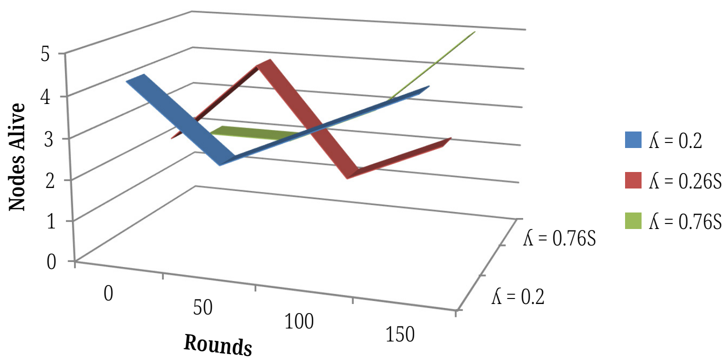


**Fig. 7.** Network lifetime with many modifying parameters and mobile sinks travelling in various directions

The adjusting parameter defines the specific adjustments. According to its proximity to the mobile sink, each sensor node adjusts the communication distance as we previously described. Figure 7 demonstrates how the network operates more effectively in terms of network lifespan, when = 0.2. The lifespan of the network is significantly impacted by the mobile sink's moving trajectory [17]. To improve network performance, we modify the radius of the movable sink in our suggested PEGASIS2 as it revolves around the middle of the circle. Figure 7 of the simulation results illustrates how the network performs better in terms of connection lifetime when the portable sink moves within a 0.26S radius of the sensing device.

## 5 CONCLUSION

This research conducted an analysis of MWSN, routing strategies, and hierarchical design and offers a succinct explanation of WSNs that can harvest electricity. Protocols should be created with the intention of keeping sensors active for an extended period of time in order to satisfy application needs and address scalability difficulties.

In order to enhance the accuracy of conventional PEGASIS, we proposed an enhanced PEGASIS algorithm with support for mobile sources. The issue with the hot spots is still there, though, in some areas. Our upcoming work will primarily focus on designing sink moving trajectories correctly and jointly optimizing the routing method and sink trajectory development. Energy-drained sensors are unable to perform their function until the energy source is recharged. A potential approach for numerous wireless sensor applications is the use of ambient energy to power sensor networks. Clustering is a technique that uses a lot of energy because MWSNs are mobile. There is discussion of the difficult aspects of clustered routing approaches. Efficient clustered routing in terms of energy depends on factors like remaining energy, compactness, duration, etc. CH selection affects the energy-efficient clustered routing algorithm. Future, more advanced MWSN exploration will increase network longevity, connection, and energy efficiency.

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