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P- LEACH: A Low Energy, High Performance Routing Protocol for WSNs

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Abstract:

Cluster-based hierarchical routing systems have the potential to significantly enhance WSNs' power efficiency. The low-energy adaptive clustering hierarchy (LEACH) is one example of a protocol architecture developed specifically for WSNs. Without accounting for the CH distribution in the rotation basis, utilising the LEACH protocol might lead to increased network energy usage. To improve the WSN's energy efficiency, we suggest a novel modified routing technique. The proposed P-LEACH considers the optimal number of CHs and removes nodes that are physically closer to the base station (BS) with the goal of reducing sensor power consumption

Keywords: P-LEACH,Base Station,WSN

Introduction

The majority of the sensor nodes (SNs) employed in WSNs are heavy and have short operating lives. WSNs are randomly dispersed over an area for the purposes of monitoring and event detection to gather data on a variety of environmental parameters and send that data to a central base station (BS) [1]. The potential of these sensors in several areas, such as preventing forest fires, enhancing security and defence, monitoring human health, and more, has researchers fascinated [2,3]. It may be difficult to maintain and replace the batteries in WSNs due to the circumstances in which they are often used. Another problem for WSNs is the difficulty of operating a human network [4,5,6]. Low power consumption should be a priority when developing protocols or hardware for SNs. Numerous routing strategies [8,9] have been devised as a result, all with the common objective of reducing the power consumption of the sensor network.

The most attention has been given to distribution techniques that prioritise the development of clusters and the use of several communication channels. Cluster-based routing strategies outperform other methods when it comes to using SNs [10]. Large datasets must be culled by CHs by eliminating duplicate or related data. The BS receives the combined data after it has been delivered through the CH [11,12,13]. In order to share resources and reduce the amount of energy required for long-distance transmission, cluster-based routing algorithms organise SNs into several clusters. Clustering could assist in lowering overall energy use and distributing workload more fairly across the system, given the stark difference in energy depletion between CHs and other nodes. Clustering is a potential method for prolonging the life of networks while drastically reducing expenses as a consequence. The majority of clustering algorithms include optimal CH selection to prolong the life of the network and avoid SNs from dying out too soon. [14,15]

We are aware that SN computing requires less energy than SN communication. However, near-BS nodes in multi-hop communication systems have a high transmission overhead, which causes energy

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shortages throughout the whole sensor network. Even though the LEACH regimen's effectiveness has been well studied, there is always room for improvement. A disproportionately high number of nodes at the network's edges may be selected as CH at any one moment since the round robin that chooses who serves as CH is random. The amount of energy at each node and the distribution of CHs are not taken into consideration when a cycle is complete. These issues have a direct impact on the growing cost of electricity.

Numerous strategies have been created that improve upon the initial generation of hierarchical clustering algorithms in order to deal with this problem. In contrast to LEACH, the revolutionary distributed protocol known as Scalable Energy-Efficient Clustering Hierarchy (SEECH) does not allocate CHs or divide duties among individual nodes. This method generates a CH fitness function and a relay fitness function, both of which are solely reliant on energy consumption. The SEECH protocol, on the other hand, allows any node to be selected as a CH or relay, with nodes nearest to the BS receiving precedence. Researchers at created Learning Automata-based Multilevel Heterogeneous Routing (LA-MHR). The LA-MHR employs an S-model based learning automaton to identify potential CHs, while the BS is in charge of allocating cognitive radio spectrum. To enable communication over many SNs, the LA-MHR technique employs a multi-hop communication strategy as opposed to a single-hop communication strategy. When the CHs and SNs are geographically separated, a significant amount of power is required for transmission since only one communication route is enough. The LEACH-Mobile (LEACH-M) protocol has been recommended to increase the dependability of data transfers between mobile nodes. LEACH-M and the LEACH method are used, respectively, for cluster creation and selection. Due to its high administrative expenditures, LEACH-M wastes more energy than LEACH. Distributed fibre sensors (DFS) function as network nodes in a hybrid sensor network with a rectangle topology and communicate with one another using the optical LEACH (O-LEACH) protocol. Compared to LEACH, this method increases the efficacy and longevity of WSNs. However, O-LEACH still consumes a considerable quantity of energy. The usage of stable energy efficient networks (SEENs) is advised for WSNs. Using a distance parameter and the nodes' remaining energies, the Cluster Head is identified. In wireless sensor networks, only the most sophisticated sensor nodes are able to perform complex tasks like processing and interfacing with other nodes. These measures' main objective is to roughly split the CH's initial energy burden in half between the CH and its support system. We would predict a lower network lifetime because of this spread.

The proposed protocol's threshold is determined by adding together all network energies, averaging all network energies, starting network energies, and ending network energies. The node nearest to the BS has to be excluded from the cluster in accordance with the IEE-LEACH standard. As a result, it seems that the method may lower energy consumption without sacrificing load balancing. The IEE-LEACH protocol under consideration also compares the energy requirements of single-hop and multi-hop connections. We'll make contact using the least power-intensive method we have available. As a result, the recommended approach lowers overall communication costs while significantly extending the network's useful life.

Scientists are becoming more interested in wireless sensor networks (WSNs) because of its adaptability. WSNs were initially intended for military usage, but they are now widely used in civilian settings that call for constant monitoring and administration of a wide range of activities. In a WSN, self-contained nodes referred to as "sensors" gather data and wirelessly transmit it to a centralised hub or the next node in a chain of receivers. In WSNs, the number of inexpensive sensors might reach the hundreds or thousands. Electronic devices have become smaller and less expensive as technology has developed. The multitude of sensors at our disposal allows us to monitor a variety of environmental parameters, including temperature, pressure, humidity, motion, and light. Sensor nodes are too small and inexpensive to use a conventional rechargeable battery. To fulfil these demands, the sensor must be able to retain less data, transfer less power, and execute fewer computations. To keep their communication protocols up to speed with the most current information, sensors must routinely speak with one another. The necessity for routing adjustments could be reduced by selecting the optimum routing protocol. In this paper, we aim to design a low-power routing method for WSNs. As a result, we think our approach will be more effective than current ones in terms of throughput, the number of dead nodes, and overall energy consumption.

Literature Review

K P Sampoornam et.al.,(2021) The Wireless Sensor Network (WSN) is vulnerable to a wide variety of assaults because of its special characteristics, such as its limited battery capacity, adaptable architecture, and limited bandwidth. WSN security research has gained traction in recent years. The security of WSNs is complicated by the fact that they are decentralised and operate independently. The WSN is in grave peril from the wormhole assault. Wormhole attacks, also known as denial-of-service attacks, may be launched by malicious nodes in a network by building a tunnel through which signals can be replayed to the attacker's benefit, therefore disrupting the normal flow of communication and potentially changing the network's routing. This article demonstrates how changing the overall number of Cluster Heads (CHs) may significantly impact energy consumption and the lifespan of individual network nodes. We put LEACH through its paces by simulating wormhole assaults.

T.Y.S.S Pranathi et.al.,(2020) WSNs have several uses in the fields of defence, environmental monitoring, public health, and disaster assistance because of how easily a large number of small sensor nodes may be placed in unattended regions. It is vital that sensor nodes use efficient routing protocols since their power is finite and cannot be refilled. The majority of what has been written on WSNs may be broken down into two broad classes: centralised and decentralised routing. The Low-Energy Adaptive Clustering Hierarchy (LEACH) technique is a centralised strategy in which individual nodes have one-on-one interactions with the leaders of clusters. Cluster leaders collect information from all sensor nodes and transmit it to the hub. In WSNs, it is common for nodes to break down. All data in a cluster will be wiped out if the leader fails. As a result, centralised protocols are more susceptible to disruptions in network topology as a result of node failures. By having nodes exchange data with other nodes (not just their neighbours), and then calculating a weighted average at regular intervals, distributed techniques like average consensus algorithms may be utilised to solve this issue. This procedure will be continued until all of the nodes' parameters have settled into an average value. Even though it uses far more power than the LEACH protocol, it can better withstand disruptions in the network infrastructure.

M.Jogendra Kumar et.al(2021) The term "Wireless Sensor Network" (WSN) refers to a system in which sensors are wirelessly connected to one another and share information. As reliable hub sites arise in the dispersed network, WSN is tasked with sustaining the network's dynamic topology. In a WSN, nodes are simply sets of devices that work together to execute activities like collecting data, analysing it, and sending it on to the next node. Batteries built within the hubs are utilised for accuracy. WSNs' astronomical need for battery power may be attributable to the intensive computations they perform. WSN will develop a mainly standard exploration domain over the next several years, and its logical significance will increase in tandem to offer a more accurate assessment. Due to the organisational make-up of the group, recommendations are separated into two distinct

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types: conventional coordination and alternative coordination. The anticipated job application employs Grey Wolf Optimisation (GWO) due to constraints imposed by division and energy. The selection of the bundle head additionally takes into account GWO and IPv6 at three different granularities. Finally, the constraints of throughput, dead hub, live hubs, and energy are compared between the existing approach, Low Energy Adaptive Clustering Hierarchy (LEACH), and the suggested work.

Abdul Razaque et.al.,(2016) WSNs update the routing information, forward data, and enable dependable multi-hop communication, making them indispensable in today's networks. Maximising the network's efficiency and longevity is a top priority. Researchers have created a variety of protocols to address the issue of network energy consumption, such as Power-Efficient Gathering in Sensor Information Systems (PEGASIS) and Low Energy Adaptive Clustering Hierarchy (LEACH). Existing routing protocols, however, are limited in different ways by their power consumption. LEACH is unique since it is dynamic and cluster-based, yet it has drawbacks that are overcome by PEGASIS. In this study, we enhance the cluster-based chain protocol PEGASIS to create PEGASIS-LEACH (P-LEACH), which outperforms LEACH. This protocol transmits data over a WSN using a power-efficient routing method. We perform simulations in MATLAB and the Network Simulator (NS2) to check P-LEACH's efficiency and make sure it doesn't waste energy.

Homogeneous vs. Heterogeneous WSN

The initial energy levels of the network's nodes define whether the network will be homogeneous or heterogeneous. Some nodes (called "advanced nodes" in a heterogeneous network) have much more juice than the rest of the network, while in a homogeneous network all of the nodes have the same amount of juice to begin with. Most studies of WSN take this uniformity for granted. However, sensors may exhibit a wide variety of capabilities, including but not limited to a variety of beginning energies and decay rates. A subset of nodes, often those with much greater energy, is responsible for data filtering, fusion, and transport. This is why real-world deployments may benefit from DSNs.

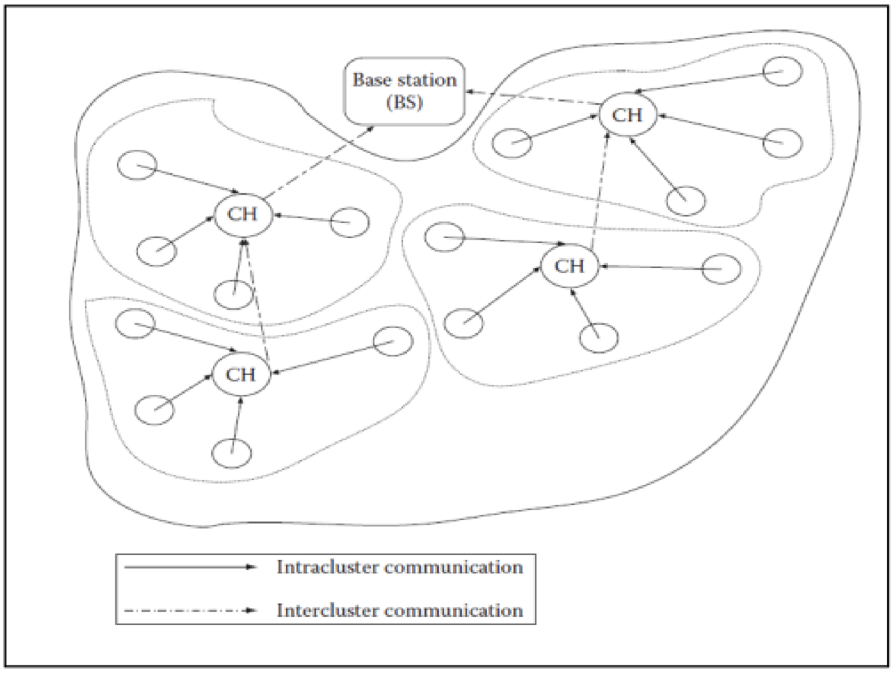

Figure 1 Data communication in a clustered network

The homogeneity or heterogeneity of a sensor network is determined by the initial energy of its nodes.A sensor network may be homogeneous or heterogeneous depending on the initial energy levels of the nodes. In contrast to a homogeneous network, where each node begins with the same amount of juice, a heterogeneous network has certain nodes (termed "advanced nodes") that are much more powerful than the rest of the network. Most research on WSN takes for granted its homogeneity. However, sensors may have a broad range of capabilities, from different initial energies to different decay rates. When it comes to filtering, fusing, and transmitting data, fewer nodes, often those with substantially more energy, take on these tasks. This is why heterogeneous or dispersed sensor networks are preferable in practical deployments. In contrast to a homogeneous network, where each node begins with the same amount of juice, a heterogeneous network has certain nodes (termed "advanced nodes") that are much more powerful than the rest of the network. Most research on WSN takes for granted its homogeneity. However, sensors may have a broad range of capabilities, from different initial energies to different decay rates. When it comes to filtering, fusing, and transmitting data, fewer nodes, often those with substantially more energy, take on these tasks. Diverse sensor networks are useful in real-world deployments because of this.

The BS processes the data gathered by the nodes that collect sensors and makes it available to the end user. Its presumed constant distance from sensor nodes is a common starting point for many analyses. Gateways, the CH nodes transmit information from the sensors node to the BS. The cluster head (CH) is responsible for coordinating the work of the other nodes in the cluster, such as collecting data for transmission to the base station (BS). If a BS is a source of data for CHs, then a CH is a sink for data that comes from the cluster's nodes. Hierarchical WSNs may be made with any number of sensor nodes, sinks, and BSs by simply replicating the existing structure.

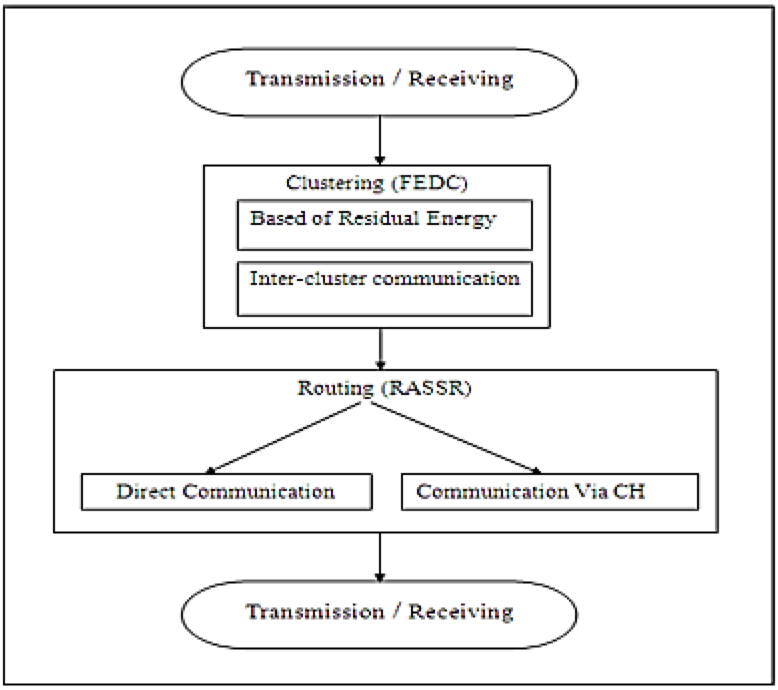

Figure 2 Architectural design of LEACH-PR

MODEL PARAMETERS	TYPE A (Hilly terrain with moderate to heavy tree density)	TYPE B (Hilly terrain with light tree density or flat terrain with moderate to heavy tree density)	TYPE C (Light tree density)
a	4.6	4	3.6
b	0.0075	0.0065	0.005
c	12.6	17.1	20

Table 1 MRRP model constants

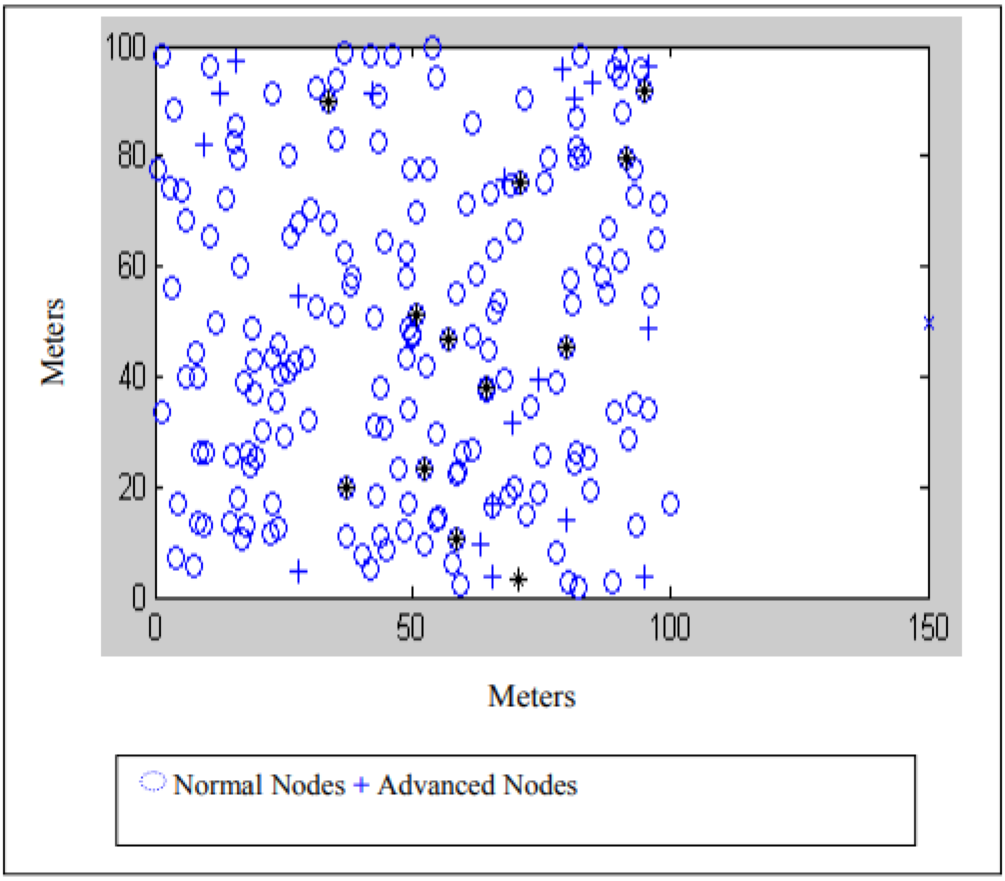

Figure 3 Random deployments of nodes when all the nodes are Alive

We employed the same combination of high-tech and conventional nodes with varied energy levels as in our p-LEACH-procedure so that our comparisons with I-LEACH, EHE-LEACH, and EEMLEACH would be fair and accurate. The simulation's conclusions were reached by manipulating three groups of inputs. The results of LEACH-PR are consistently superior to those of I-LEACH, EHE-LEACH, and EEM-LEACH. For a variety of choices of the proportion of nodes in advance and the energy factor, we have shown that the suggested protocol (LEACH-PR) is successful.

When compared to ILEACH, EHE-LEACH, and EEM-LEACH, our technique provides superior performance and a more evenly distributed energy footprint. To ensure that the CH has an acceptable energy supply in comparison to the other nodes, LEACH-PR monitors the system's average energy and the amount of energy that remains after each cycle. The rate at which CHs are chosen may be seen in Figure 4.

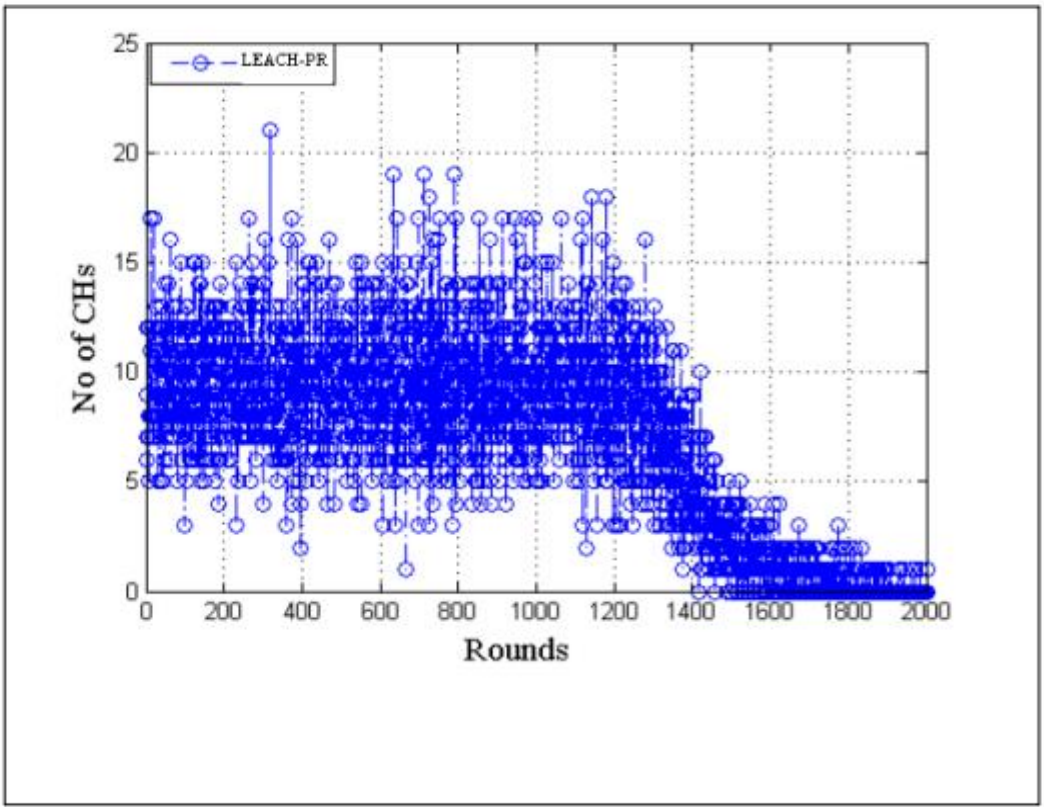

Figure 4 Number of CHs vs. Rounds in P-LEACH

Conclusion

Long-distance data transport with high free space route loss was accomplished using the MRRP model; efficient clustering was achieved using FEDC's focus on inter-cluster communication cost; and RASSR's focus on making effective use of residual energy allowed for the network's lifespan to be extended. Simulations of P-LEACH's clustering, routing, and data transmission show improved network throughput and sustained stability over extended periods of time.

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