RESEARCH AND IMPLEMENTATION OF LEACH ALGORITHM FOR WIRELESS SENSOR NETWORKS

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Abstract:- The sensor nodes (also known as motes) in wireless sensor networks (WSNs) are typically dispersed throughout a sensor field, or region where the sensor nodes are installed. These mobile devices are tiny and have limited storage, computing power, and battery life. Each of these dispersed motes has the ability to gather information and route it back to the base stations, which may be stationary or mobile. The motes in these networks are coordinated to create high quality information. The Low Energy Adaptive Clustering Hierarchy (LEACH) protocol optimization is the major goal of this research project. Hierarchical routing should be investigated for two reasons. One, there is a lot of communication redundancy due to the dense sensor networks. Second, to expand the sensor network's scalability while maintaining communication security into consideration. In order to enhance the efficiency of the LEACH protocol, this research study implements the LEACH routing protocol using the NS2 simulator. Finally, the I-LEACH routing protocol ensures that the chosen cluster-heads will be evenly dispersed over the network. The findings were then examined in order to determine their viability for usage in wireless sensor networks based on factors such as energy consumption, average life span, and average throughput. In terms of the network's throughput, it performs better than LEACH as well. In a network with 100 nodes, I-LEACH increases energy consumption by around 45% and throughput by 42%, while in a network with 200 nodes, it increases energy consumption by about 48% and throughput by 65%.

Keywords:- LEACH, WSN, Throughput and Nodes

1. INTRODUCTION

Thousands of low power, multipurpose sensor nodes operate in unsupervised environments as part of wireless sensor networks, which have a limited capacity for processing and sensing. Small, often irreplaceable batteries with constrained power capacity are used in sensor nodes. Wireless sensor networks are being used more and more often, but they also have a limited battery lifespan due to energy limits. There are many ways to reduce the energy required by wireless sensor networks' communication. Adopting energy-efficient routing techniques is one of them. The three major kinds of routing algorithms used in sensor networks are flat, hierarchical (or cluster), and location-based routing [1]-[5]. Numerous hierarchical routing schemes have drawn inspiration from the concept presented in LEACH. LEACH's operation is divided into rounds, each of which starts with a set-up phase during which the clusters are arranged and ends with a steady-state phase during which data transfers to the base station take place. The steady-state phase is longer than the setup phase in order to reduce overhead. Setting up: Each node chooses whether or not to act as the cluster head (CH) for the current round during this phase. The basis for this choice is the selection of a random integer between 0 and 1. Number becomes the cluster head for the current round if it falls below a threshold T(n).

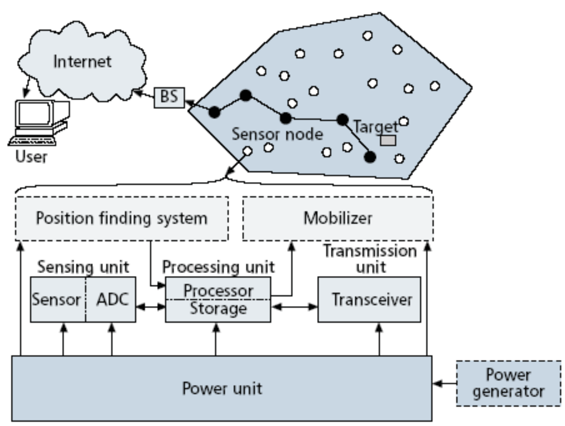

Figure.1. WSN Architecture

In PEGASIS, each node receives and transmits to its immediate neighbours, and each node alternately serves as the transmission leader to the BS. Through this method, the network's sensor nodes receive an equal share of the energy load. The it node is in a random location because sensor nodes are distributed at random throughout the sensor field [6]-[10]. The organisation of the nodes into a chain can be done in one of two ways: either by the sensor nodes themselves using a greedy algorithm beginning at some node. Alternatively, the BS can compute this chain and broadcast it to all the sensor nodes. For constructing the chain, it is assumed that all nodes have global knowledge of the network and employ the greedy algorithm. Before the first round of communication, the chain is built using a greedy strategy that works well. To construct the chain, it starts with the furthest node from the BS.

Sensitive to threshold and energy-efficient Internet protocol (TEEN). The network's nodes periodically turn on their transmitters and sensors, sense the surroundings, and transmit the pertinent data. As a result, they offer periodic snapshots of the pertinent parameters, or proactive networks. They work well for applications that call for routine data monitoring. A multi-hop clustering algorithm with a focus on effective clustering by careful selection of cluster heads based on the physical distance between nodes is called Hybrid Energy-Efficient Distributed Clustering (HEED). E- LEACH methodology enhances the CH selection process. It turns the remaining energy of a node into the primary factor that determines whether or not nodes transform into CH after the first round. Similar to the LEACH protocol, E-LEACH is divided into rounds. In the first round, each node has the same probability of becoming a CH, meaning that CHs are chosen at random. In the subsequent rounds, however, the residual energy of each node after one round of communication is different and is taken into consideration when choosing the CHs. That indicates that nodes with greater energy will develop into CHs as opposed to nodes with less energy [11]-[15].

LEACH protocol (TL) Two-level Leach, a novel variation of LEACH, was suggested. This protocol employs one of the CHs that is located between the CH and the BS as a relay station, collecting data from other cluster members as it did in the original LEACH. Multihop LEACH protocol: In this protocol, additional CHs are used as relay stations to send data between the CH and the BS through the most efficient route. First, CHs start using multi-hop communication. Then, these CHs send data to the matching CH that is closest to BS in accordance with the chosen optimum route. The CH then transmits information to the BS. The sole difference between M-LEACH and LEACH is that it changes the communication mechanism between CHs and BS from single hop to multi-hop . Data might be sent between cluster heads in a multi-hop backbone formed by the cluster heads until it reaches the BS. By creating "super-clusters" out of the cluster head nodes and having a "super-cluster head" that processes the data from every cluster head node in the super cluster, LEACH may alternatively develop into a hierarchical protocol. With these modifications, LEACH will now function with more types of wireless sensor networks [16]-[18].

2. LEACH ALGORITHM IN WSN

The suggested I-LEACH makes sure that the chosen cluster-heads are dispersed equally over the network. As a result, it is unlikely that all cluster-heads will be located in a single area of the network. The outcome of the simulations shows that the suggested clustering strategy is more scalable and energy-efficient than LEACH, and as a consequence, beneficial in extending the network life. In terms of the network's throughput, it performs better than LEACH as well. In a network size of 100 nodes, I-LEACH reduces energy usage by around 43% and increases throughput by 40%. As part of the application, sensor nodes will recurrently turn on their transmitters and sensors, perceive the surroundings, and communicate pertinent data at regular, periodic intervals. As a result, they provide a picture of the important properties periodically. In the latter kind, sensor nodes respond instantly to abrupt and significant changes in the value of an attribute that is perceived as a result of an event. Detecting environmental conditions like temperature, movement, sound, light, or the presence of specific items is improved by the implementation of the LEACH protocol in intrusion detection, weather monitoring, security and tactical surveillance, distributed computing, and intrusion detection. Another solution built on fuzzy logic and combining the midpoint method and K-means algorithm has been suggested. The Euclidean distance may also serve as the foundation for a CH evaluation in addition to residual energy. Depending on the distance between them, the CHs in these situations transmit packets to the BS. The sparsity-aware energy efficient clustering (SEEC) and the enhanced cluster formation technique coupled with fuzzy logic (EERRCUF) are two other approaches that have previously been put forward. While the EERRCUF technique uses a super cluster head (SCH) as the intermediate hop to the BS, the SEEC method chooses the strongest node in each cluster.

The whole WSN functioning is impacted by the energy loss brought on by transferring data from a CH to the BS. The node chosen as a CH will run out of energy since it takes a lot of energy to transfer data from a CH to the BS. A node will age more quickly than other nodes if it is regularly chosen as a CH. The WSN's lifespan will shorten as a consequence. The primary research contribution of this study is to change the data transmission mechanism from a CH to the BS, which will enhance the performance of E-LEACH and other approaches. To reduce the amount of energy used by a cluster, hierarchical routing is used. Fusion and data aggregation are additional functions of hierarchical routing. A WSN's overall energy consumption may be reduced by reducing the amount of energy consumed for data transmission. Two routing strategies are often used in hierarchical routing. While the second operation distributes and aggregates data to the BS, the first technique is utilised to choose a CH and subsequently a member node. Saving energy is crucial in deciding the lifespan of the sensor network since a sender node's energy capacity is very small. Numerous strategies have been suggested to lengthen a network's lifespan. The first is the LEACH approach, in which sensor nodes send information to a CH rather than the BS directly. Among hierarchical routing protocols, the LEACH approach rose to prominence, and other LEACH-related enhancements have been suggested. A LEACH enhancement, the LEACHC procedure makes use of location and residual energy characteristics. The LEACHH algorithm was developed to address the issue of low degrees of load balancing. Another variation used to address the distance issue between CHs and BSs is the TL-LEACH protocol. LEACH is also used for CH data collection and fusion, although a CH will utilise another CH that is located closer to the BS. Another protocol that only allows nodes to communicate with their nearest neighbours is the power-efficient gathering in sensor information systems (PEGASIS). To make sure that all nodes have routes to the base station, sensing node systems build transmission chains using a greedy algorithm. The very energy-efficient LEACH variation V-LEACH is another one is shown in Figure 2.

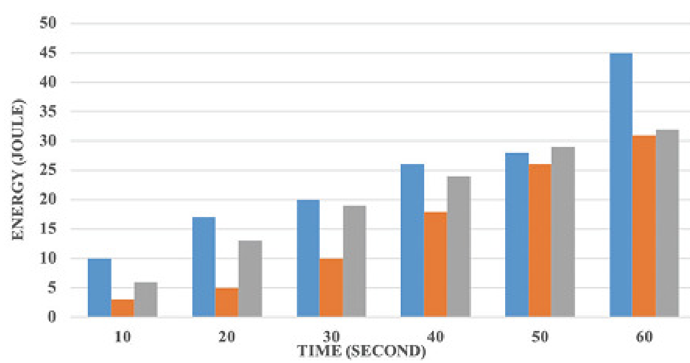

Figure.2. Energy in WSN

A strong node is present in each of the network's blocks using a different mechanism, known as SEEC [9]. At each degree of heterogeneity, energy efficiency is attained dependent on the location of a number of strong nodes. Utilizing the EERRCUF scheme is a further strategy. The particle swarm optimization (PSO) approach is used to group nodes. An SCH is recognised as the primary CH in the system. The CHs are linked to the BS through the SCH. The E-LEACH technique, which elects a CH using a node's residual energy as a parameter, is another cutting-edge idea. The chosen CH is the node with the maximum energy. The chosen CH sends out invitations to join the cluster to the other nodes. Time division multiple access (TDMA) scheduling is used for node data transfer.

E-LEACH is a multi-step process that starts with setup. All nodes calculate a random number in this stage (between 0 to 1). Later, a threshold value is compared to this number. The node then determines the threshold value to employ by comparing the proportion of its remaining energy to its beginning energy. Since the beginning energy and the leftover energy are equal in the first round, the value is 1 is shown in Figure 3.

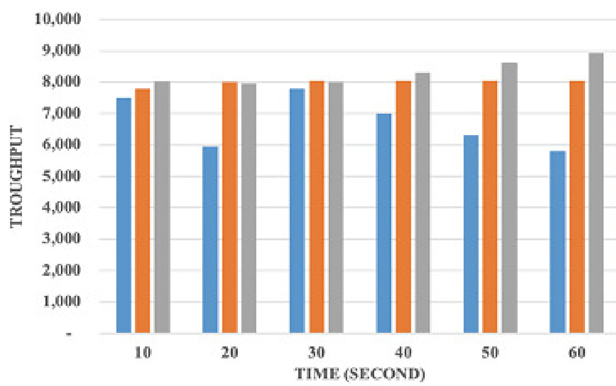

Figure.3. Throughput in WSN

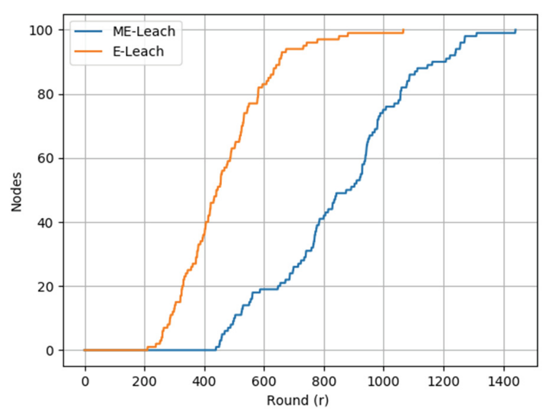

Figure.4. LEACH Algorithm

We have examined and enhanced the SEEC, EERRCUF, and E-LEACH algorithms in this study. The manner that the CHs transmit data to the BS has flaws in ELEACH. Finding strategies to reduce the distance of data transmission would be advantageous since distance is a significant element in estimates of energy consumption is shown in Figure 4. The suggested approach modifies how the CHs transmit data to the BS. As its next hop, a CH will choose the next closest CH with the shortest distance to the BS. Less energy is needed to transport data across shorter distances. The LEACH protocol and a modified version of the k-means algorithm are used to improve wireless sensor networks. Through the suggested effort, a lifespan of the network efficiency of 48.85% has been achieved. The choice of the cluster head is also adjusted with respect to the energy of the nodes. The suggested approach increases the rate of packets to BS and packets to cluster head. In this study, the optimal trade-off between energy and successful data transmission is maintained. The inclusion of additional data pertaining to the nodes' energy has resulted in an increase in the nodes' overhead. The amount of data bits used has grown. Work on the -e sink nodes grew when the cluster head was chosen. The fact that the same cluster head was chosen to lead the network for its entire lifespan demonstrates that the total energy consumption is kept within reasonable bounds. The sink node received over 77% of the sensed data. The additional inclusion of the energy threshold value increases the processing duration of the k-means algorithm. It requires more effort to optimise it. The request message and the additional energy status contribute to the -e node's overhead. The completion of the cluster head election takes longer thanks to the -e K-means algorithm.

In WSNs, there are two methods for routing. One is multi-hop flat routing, in which packets are routed, and the other is clustering, in which a collection of nodes forms a cluster with one node serving as the CH. All cluster nodes connect with CH, who then relays the information to the base station (BS). According to the research, cluster-based routing methods guarantee greater energy efficiency than flat routing protocols. The system is divided into little groups called Clusters, which is the most important aspect of bunching techniques. Every cluster has a CH that is in charge of advocating for and managing the member nodes in addition to sending sensed data from the member node to the BS. The task of constructing a clustering mechanism is fraught with difficulties. Focusing on the rapidly developing technology and expanding number of sensor nodes in a network is crucial. The creation of an effective network should be our main focus; this is possible thanks to changes made throughout upgrades. The act of assembling many nodes into a cluster is one of the crucial aspects of clustering. Through a node chosen to be the CH, each cluster will connect with the sink (BS). The CH is in charge of tasks including data processing, transfer, and aggregation. In each cluster, every node gathers data from the real-time environment and sends it to the CH, who then has the duty of aggregating the data and sending it to the sink or the BS. The CH uses more energy than other nodes in the cluster since they are given extra tasks to do in addition to their regular duties.

Clustering's efficacy is influenced by a number of factors. Following are a handful of them: The total number of nodes in a network determines the number of clusters. When choosing the number of clusters for a network, nodes' positions are sometimes taken into account as well. Cluster size: The size of each cluster is essentially consistent. The node placements, however, have a role. Routing: The routing method used affects how well the network performs. In most cases, the cluster members and the CH have direct contact. While the transmission between the CH and the BS may employ direct or multi-hop routing. It has been shown that multi-hop routing is more energy efficient. Since data transmission consumes the most energy, establishing a good routing strategy will improve network efficiency as a whole. However, the majority of the energy is spent while choosing the CHs for a network. Higher energy use will ultimately result in a shorter total node operating time. Managing the duties amongst nodes in every cluster is crucial for ensuring the overall network's longevity. One of the most effective clustering-based techniques is LEACH, which has been shown. A designated approach is used to create clusters and choose a CH. LEACH is a very well-known and adaptable clustering method. The hierarchical routing protocol is often represented by the LEACH protocol. LEACH improves the framework's energy efficiency by organising clusters based on the intensity of the signal received. To extend the lifespan of resource-constrained sensor networks, there exist rules for grouping and choosing random CHs. A MAC protocol based on TDMA is the LEACH protocol. This protocol's major goal is to lengthen the lifetime of WSNs by reducing the energy needed to develop and sustain CH.

All nodes with energy over a certain threshold value that have not previously served as a CH in 'K' rounds will be qualified to be chosen as a CH of a certain cluster. Each node is likely to get a chance to be the CH at least once throughout the course of the overall network performance since the CH is chosen using a random method. A node that was previously chosen as the CH in one of the previous "K" rounds cannot be chosen as the CH once again in this round. The CHs gathers data from the individuals in its cluster, combines it, and then sends the combined data to the BS. Because of the higher energy drain caused by the CH's additional activities, CHs use energy more quickly than other nodes in the cluster. The whole cluster will not function if a CH passes away earlier than anticipated or inside the allotted period for a round, and the cluster will be unable to connect with the BS.

One of the WSN protocols that has been shown to be the most effective is LEACH. When compared to many clustering protocols, LEACH has a number of benefits, however the random selection of CH has certain drawbacks. The random selection of CH has been shown to be energy inefficient and may result in network failure. In this study, a novel SC-LEACH procedure is presented, where the CH selection is made energy-dependent. Any cluster's efficiency will increase when CH duty is distributed across its nodes. Small sensor nodes, processing power, and wireless communication capabilities make up wireless sensor networks. There are already a number of routing protocols designed expressly for WSNs, where energy responsiveness is a major strategic issue. To monitor physical or environmental factors such as temperature, sound, vibration, pressure, and motion at various places, a wireless sensor network (WSN) is made up of hundreds or even thousands of tiny, autonomously dispersed sensor nodes.

Because nodes in wireless sensor networks run on batteries, energy is a significant factor. As a result, several protocols have been put out to reduce these nodes' energy use. Energy plays a significant role in wireless sensor networks, and conserving the consumed energy of each node is an important goal that must be taken into account when developing a routing protocol for wireless sensor networks. Each node in a sensor network is typically equipped with one or more sensors, a radio transceiver or other wireless communications device, a small microcontroller, and an energy source. Numerous routing protocols, including LEACH and PAMAS, have been suggested in the literature. In this paper, we propose an enhancement to the Leach Protocol that further enhances the Power consumption. Simulation results show that our protocol outperforms Leach in terms of energy consumption and overall throughput. Leach is known as the most widely used routing protocol that uses cluster based routing to minimise the energy consumption. Nodes of heterogeneous WSNs may be handled by this design. EELEACH leverages the initial and residual liveliness of the nodes to choose the CH. Let Ni be the number of rounds the CH will be for node Si. The number of CHs that should be present in our network at all times is called poptN. The EELEACH CH selection criteria are based on the node vitality. As in a homogeneous network, setting pi = popt ensures that poptNCHs occur during each round when nodes have the same amount of energy throughout each epoch. In WSNs, nodes with high energy have a higher chance of becoming CHs than nodes with low energy, however poptN is added up by the net value of CHs for each round. A node with high energy has a greater value of pi as set beside the popt) signifies the network's average energy during round r, which may be specified. Pi is the chance for each node Si to become CH. In EELEACH, the selection of cluster heads is done using a probability based on the proportion of each node's residual energy to the network's average energy. The epochs that a node will be the cluster head depend on its initial and residual energy. In comparison to nodes with minimum energy, those with the highest initial and residual energy may have a greater chance of being cluster leaders. EELEACH calculates the optimal value of network life-time, which may be used to compute the reference energy that each and every node should burn throughout a round, removing the requirement for each node to be aware of the networks' overall familiarity. EELEACH designed a balanced and dynamic approach to divide the used energy more fairly across nodes in order to maximise the protocol's performance.

These nodes send the data to the sink node or bed base station. The data from the sensor nodes are combined by the sink node and sent to the internet. Data from the sink node is sent to the customer over the internet. So, the first use of wireless sensor networks was for combat observation. Prior to now, point-to-point communication was not necessary for the routing protocols. It is necessary to make routing protocols more efficient since the area is currently expanding with new opportunities in health, industrial, and other monitoring applications. When creating wireless sensor networks, programmers must take into account these two issues since memory is constrained and more power is required. WSNs are application-specific, and nodes are in charge of sensing, gathering, and sending data further in the direction of the destination. Therefore, the WSN routing protocol should be created in a fashion that accomplishes these goals. The key focus of creating a decent routing protocol is on energy awareness, scalability in environments with limited energy and bandwidth, and adaptation in environments with confined memory. Clustering routing systems are particularly crucial because of the restricted energy resources. Compared to flat routing protocols and direct communication, they are more energy-efficient, scalable, and manageable. LEACH is a routing technique that arranges the cluster such that the energy is distributed evenly across all of the network's sensor nodes. In the LEACH protocol, a number of sensor node clusters are created. One node is designated as the cluster head and serves as the routing node for every other node in the cluster. As with routing protocols, the cluster head is chosen before the entire communication begins, and the communication fails if the cluster head has any issues. Additionally, there are more chances that the battery will die than on the other nodes in the cluster because the fixed cluster head is performing his duties as the cluster's routing coordinator.

3. CONCLUSION

The LEACH protocol uses randomness, and the cluster head is chosen from a group of nodes. By choosing the cluster head from a group of nodes temporarily, this protocol is made to last longer since the battery of a single node is not overworked. In contrast to the LEACH technique, EE-LEACH (Energy Efficient Low Energy Adaptive Clustering Hierarchy) uses a distributed clustering strategy. There are equal sub-regions throughout the whole sensor field. The threshold technique used in the LEACH protocol is used to choose the cluster head (CH) from each sub-region. The algorithm for the EE-LEACH protocol is listed below. The major aim of increasing the lifespan of wireless sensor networks is energy saving since the sensor nodes in WSNs have limited battery life. The sensing region is primarily divided into clusters by networks based on clustering, and one cluster head is chosen from each cluster. Cluster members are the additional nodes in the cluster. LEACH, the first energy-efficient protocol used in WSNs, effectively extends the life of the network. This strategy is based on clustering. Along with its many benefits, the LEACH protocol also has some drawbacks, such as the fact that it does not consider the residual energy of the sensor nodes when picking the cluster head and that the distribution of the cluster heads is not uniform. The LEACH protocol is improved by the EE-LEACH MIMO technique. The network is split into equal-angle sectors in this design, and while selecting the cluster head and cooperative nodes for the MIMO system, the residual energy of the sensor nodes is also taken into account. Clustering is only performed once. By cutting the network at an angle of 2/Kopt Sink, clusters are formed, and nodes are instructed to join the cluster that is closest to them. In order to execute the EE-LEACH MIMO system, K opt is set to 5. The management of all activities occurs in rounds. The cluster leader and cooperating nodes are chosen for every cycle.

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