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Energy Optimization Hierarchical Clustering for WSN

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Abstract

Wireless Sensor Networks (WSN) are the networks with the highest degree of unpredictability. These networks connect with one another and pass on the data collected from each node. The vast majority of applications for these include any kind of environment, such as a heterogeneous natural setting. The term "energy consumption" is most frequently applied to the nodes. There has been a lot of research done on WSN. In the currently available methods, the energy efficiency between the nodes becomes the most challenging, and due to the adaptive and mobile character of these techniques, the amount of energy that is consumed is significantly higher. In this article, the problem that was present in the previously used system, namely the calculation of cluster head, was addressed by the approach that was proposed. In order to circumvent this problem, the EEHCA that was presented has been implemented in order to keep the energy levels stable amongst the nodes and calculate the cluster head in a more effective manner. The results demonstrate how well both the old and new EEHCA are working.

Keywords: - Sensor Networks, Clustering, LEACH, EEHCA.

1.Introduction

In recent years, Wireless Sensor Networks, also known as WSNs, have attracted a large number of analysers due to the potential vast applications that they offer as well as the multiple examination issues that they present. Earlier research on wireless sensor networks (WSNs) focused mostly on making breakthroughs based on the concept of a homogenous WSN, in which all hubs have the same infrastructure assets[1-3]. In spite of this, heterogeneous wireless sensor networks are winding up noticeably more mainstream. This is because the advantages of using heterogeneous WSNs with a scope of capacities with the end goal to satisfy the prerequisites of diverse applications have been presented in recent writing. Because of the limited battery capacities of sensor hubs and the impossibility of replacing the batteries, one of the most significant challenges that must be overcome in order to connect WSNs is ensuring the reliability and efficiency of the use of electrical power. Because of this, sensor hubs consume a significant amount of energy in the process of information transmission and collecting [4-6]. As a consequence of this, new steering conventions that are more energy efficient are required to reduce overall energy use [7-10].

In this paper, we present an original Energy- Efficient Clustering and Data Aggregation (EECDA) protocol for heterogeneous wireless sensor networks (WSN). In this strategy, an additional Cluster Head (CH) race and information correspondence component are brought into play in order to extend the system's lifetime and increase its level of security. Following the CHs race, the method of information transmission that utilizes the greatest aggregation of residual vitality will be selected rather than the method that makes the least amount of use of the energy resource. In this fashion, first each CH adds up the information it has obtained, and then it sends the entire information it has accumulated to the Base Station (BS)[11-13].

In comparison to Low-Energy Adaptive Clustering Hierarchy (LEACH), Energy-Efficient Hierarchical Clustering Algorithm (EEHCA), and Effective Data Gathering Algorithm (EDGA), the primary commitments of the EECDA convention are to provide the longest stability (when the primary hub is dead) and to enhance the system lifetime. This is in contrast to the other two algorithms mentioned earlier (EDGA). Fig1 shows the Wireless Sensor Network

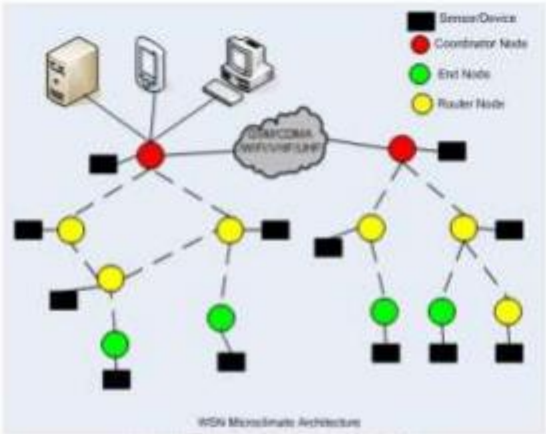

Fig.1: Wireless Sensor Network

2.LITERATURE REVIEW

Because of their adaptability in problem-solving across a variety of application domains, wireless sensor networks have recently seen a surge in popularity. These networks have the potential to make a significant impact on our lives in a variety of different ways.

1) 2004 Proceedings of the 29th Annual IEEE International Conference on Local Computer Networks (LCN'04), "Distance-based energy efficient clustering for wireless sensor networks," by Lee, S. H., Yoo, J., and Chung, T. C. In this paper, the authors modified the Basic Low Energy adaptive clustering hierarchy (LEACH) protocol with their proposed LEACH-MAE (LEACH Mobile Average Energy based) protocol in order to overcome the shortcomings of the original protocol and support mobility along with the newly developed average energy-based Cluster Head selection technique. The author used LEACH-M as a reference and then changed it. LEACH-M allows mobile nodes to communicate with one another. They did this by introducing the mobility of nodes on the basis of energy. The received signal intensity of each node is used as the only criterion in this protocol for selecting the cluster head from among the mobile nodes in the network. The authors performed a simulation of the LEACH-MAE protocol in NS2, which demonstrates that the suggested algorithm not only extends the life of the network by up to 25 percent but also contributes to the equitable allocation of energy resources among the sensor nodes.

2) Effective Energy Management in Routing Protocol for Wireless Sensor Networks, written by Zibouda Aliouat and Makhlouf Aliouat and published in IEEE in 2012. PEGASIS-MH is a multihop routing protocol that the authors of this study propose using in order to reduce the amount of energy that is used and to increase the lifetime of the network. Hierarchical LEACH and PEGASIS are both well-known protocols, and this new protocol is a combination of those two efficient and well-known protocols. The results that were obtained through simulations that were run in an environment provided by the simulator NS2 demonstrated that the performances achieved by our proposal are noteworthy and surpass those of the original protocols. These results were obtained through simulations that were carried out in an environment provided by the simulator NS2.

3) "Mobility Metric based LEACH-Mobile Protocol," by M. V. Kumar and Jacob, published in ADCOM 2008, IEEE 2008. It was determined that cluster-based protocols such as LEACH were the most appropriate for use in the routing of wireless sensor networks. Within contexts that place a primary emphasis on mobility, various modifications to the fundamental plan were proposed. One example of this kind of protocol is called LEACH-Mobile. In the mobile scenario, the fundamental LEACH protocol is improved by checking to see if a sensor node is able to interact with its cluster head. Because all of the nodes, including the cluster head, are constantly moving, it will be preferable to select a node as the cluster head that has a lower degree of mobility in comparison to the nodes that are its neighbors. In this paper, an improvement to the LEACH-Mobile protocol for cluster head election is proposed, and it is based on a mobility metric called "remoteness." Because of this, a high success rate is maintained during data transfer between the cluster head and the collector nodes, despite the fact that the nodes are moving. The authors have performed a simulation and made a comparison between the LEACH-mobile enhanced protocol and the LEACH-mobile protocol. According to the findings, the routing protocol can be made better by including information about neighboring nodes.

4) "Energy- efficient Communication protocol for Wireless Micro sensor Networks," Heinazelman, Chandraksan, and Balakrishna, "In IEEE 2000 proceeding of the Hawaii International Conference on system Sciences," Jan2000. Microsensor networks that are wirelessly disseminated will make it possible to conduct dependable monitoring in a wide range of

situations for use in both civilian and military settings. The author of this study investigated various communication protocols, each of which has the potential to have a sizeable bearing on the total amount of energy that is lost through these networks. On the basis of their findings that the conventional protocols of direct transmission, minimum-transmission-energy, multi-hop routing, and static clustering may not be optimal for sensor networks, they proposed LEACH (Low-Energy Adaptive Clustering Hierarchy). LEACH is a clustering-based protocol that utilizes randomized rotation of local cluster based station (clusterheads) to evenly distribute the energy load among the sensors in the network. This was accomplished through the use of an adaptive clustering hierarchy. LEACH incorporates data fusion into its routing protocol in order to limit the amount of information that needs to be communicated to the base station. This is accomplished through the use of localized coordination, which enables scalability and robustness for dynamic network environments. The author's simulations and results demonstrated that conventional routing protocols can be outperformed by LEACH by as much as a factor of eight in terms of the amount of energy that is saved by utilizing LEACH. In addition to this, LEACH is able to ensure that the dissipation of energy is distributed uniformly over all of the sensors, which in turn doubles the useful system lifetime for the networks.

5) The Georgia Institute of Technology published "Wireless sensor networks: A Survey" by I.F. Akyildiz, W.SU, and E.Cayirci in 2001. This article provides an overview of the idea of sensor networks, which are now a practical possibility because to the convergence of technology in the fields of micro electro-mechanical systems, wireless communications, and digital electronics. In the beginning, the sensing tasks and the potential applications of sensor networks are investigated, and then a review of the elements that influence the design of sensor networks is presented. Following this, the communication architecture for sensor networks is described, and an examination of the algorithms and protocols that have been established for each layer in the relevant published research follows. There is also discussion of open research questions with the implementation of sensor networks.

6) Jackson State University, Jackson, Mississippi, USA, 2010, Indu Shukla and Natarajan Meghanathan published an article titled "Impact of leader selection strategies on the PEGASIS data collection protocol for wireless sensor networks." PEGASIS, which stands for Power Efficient-Gathering in Sensor Information Systems, is a protocol that is considered to be one of the more traditional methods of data gathering in wireless sensor networks. In order for PEGASIS to function, a chain of sensor nodes is created, beginning with the node that is the most remote and working its way toward the sink. A hop-by-hop transmission and aggregation procedure brings data from either end of the chain closer to the leader node, which is picked for each round of data gathering. The data that has been aggregated are sent to the sink node by the leader node. The Author evaluated the influence of the following leader node selection procedures for each round in this particular paper: Random (a node is selected at random), Shuffle (a node is selected as leader only once per N rounds in a network with N nodes), High-energy (the node with the most energy), 2-block, and 4-block (the network is divided into 2 or 4 blocks and the leader node is the highest energy node in the randomly chosen block of a round). The author conducted research on the PEGASIS protocol for TDMA and CDMA communication systems. The author identified the leader selection strategy that results in the longest network lifetime (up to 5% node failures) and the minimum energy*delay per round for each possible combination of network topology (square, circular, and rectangular) and sink location (center, origin, and outside the network field). This was accomplished for each type of network topology.

7) Jackson State University in Jackson, Mississippi, USA, published Indu Shukla's work titled "Power Efficient Gathering in Sensor Information System (PEGASIS Protocol)" in 2010. In this research, the Author suggested PEGASIS (power-efficient gathering in sensor information systems), a chain-based protocol that is an enhancement over LEACH. PEGASIS is an acronym that stands for power-efficient collecting in sensor information systems. Because each node in PEGASIS only communicates with its immediate neighbor and takes turns sending to the base station, the amount of energy that is expended during each round is significantly decreased. Instead of forming clusters for the purpose of data transmission, these nodes instead connect with the nodes that are close. This procedure is analogous to moving a data packet from one location to another by passing it via a series of nodes located in between. When there are an excessive number of intermediate nodes in between, this strategy wastes a significant amount of energy.

8) 2004 Proceedings of the 29th Annual IEEE International Conference on Local Computer Networks (LCN'04), "Distance-based energy efficient clustering for wireless sensor networks," by Lee, S. H., Yoo, J., and Chung, T. C. CODA (cluster-based self-organizing data aggregation) is a new distributed clustering and data aggregation technique that was proposed by the Author in this study. The algorithm is based on the distance from the sink in ad-hoc wireless sensor networks. It might be challenging to cluster in an effective manner, despite the fact that data collecting based on clusters uses less bandwidth and energy. We make advantage of the distance vector from the sink, which plays a role in how quickly the network's energy is

depleted. The author focused the majority of their attention on the energy constraints, as well as the effective clustering of the nodes.

3.PRPOSED METHOD

The process of determining the most efficient way through a network is referred to as routing. Therefore, the responsibility for locating and managing effective paths via the network lies with the routing protocols. When it comes to WSN routing, energy efficiency is a crucial concern. As a result, the creation of a routing protocol that is efficient in terms of energy consumption has become a pressing concern in sensor networks. On the basis of the following four parameters, the energy efficient routing protocols (EERP) can be broadly characterized as follows: network. Fig 2. shows the Taxonomy of Energy Efficient Routing Protocols in WSNs.The hierarchical and cluster-based routing protocols are the primary topic of discussion in this section. Several researchers have presented hierarchical routing methods for wireless sensor networks (WSNs). LEACH is a prominent example of a protocol that falls into this category.

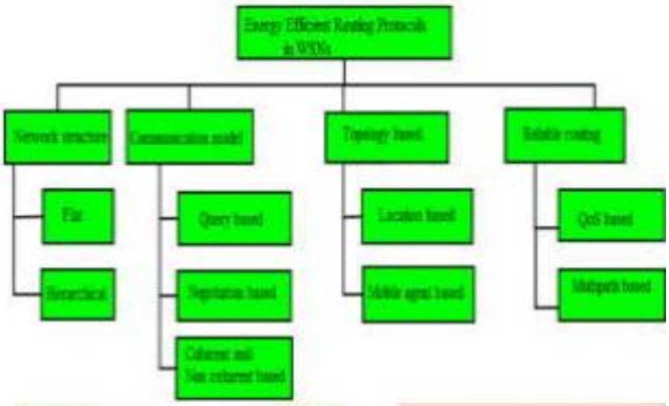

Fig.2. Taxonomy of Energy Efficient Routing Protocols in WSNs

LEACH is a hierarchical routing technology that lowers the amount of energy that a network needs to function properly. Because it employs an adaptive clustering strategy, the LEACH algorithm outperforms the traditional routing algorithm. However, if a CH is lost in the LEACH, the data collected at that CH will not be transmitted to the BS, rendering that cluster useless. LEACH is plagued by the issue of CH rotation overhead in each and every round. The CH that LEACH chooses to use is determined by a random number within the range [0,1]. If the number that was chosen is lower than the threshold T(n), then the node becomes CH for the current round. The Energy Efficient Hierarchical Clustering Algorithm (EEHCA) employs a novel procedure for CH election that incorporates the concept of backup CHs in order to improve the overall efficiency of the network [18]. For the selection of CH, the distributed energy efficient clustering (DEEC) algorithm takes into account both the initial and the residual energy level of each node. It was designed specifically for use in different kinds of wireless sensor networks.

Within the realm of wireless sensor networks, LEACH is the protocol that has the highest adoption rate. Calculating the energy efficiency and number of cluster heads between the nodes is the objective of the LEACH protocol. Because of the adaptable nature of the nodes and their mobility, the energy consumption between the nodes is quite significant. As a result, the nodes in the network stop very quickly, and the zero state, in which the nodes have no energy, is reached by the nodes. Hierarchical routing protocol is another name that can be used to refer to the LEACH protocol. The nodes that make up this protocol are combined, and some of those nodes serve as cluster chiefs. The amount of energy that is maintained by the nodes is what determines whether or not cluster heads are formed. In the first step, the cluster head notifies the cluster nodes that it has become a cluster head by sending an advertisement packet. This is done on the basis of the following formula. Fig 3 shows the Cluster head selection

$$T(n) = \frac{P}{1 - P \times (r \bmod P^{-1})} \qquad \forall n \in G$$

$$T(n) = 0 \qquad \forall n \notin G$$

Where n is a random number between 0 and 1
P is the cluster-head probability and
G is the set of nodes that weren't cluster-heads the previous rounds

Fig.3: Cluster head selection

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The threshold is denoted by T (n). If the number is lower than the threshold T, the node becomes the head of the cluster for the current round (n). If a node has previously held the position of cluster head, it will not be able to assume that role again until all of the other nodes in the cluster have had the opportunity to do so. The consumption of energy can be more effectively balanced as a result of this. In the second stage, non-cluster head nodes first get the cluster head advertisement and then send a join request to the cluster head, alerting that cluster head that they are members of the cluster that is led by that particular cluster head. All of the nodes in the network that are not the cluster head save a significant amount of energy by keeping their transmitters off all of the time and only turning them on when they have data to send to the cluster head [2]. The third phase involves the creation of transmission schedules for the member nodes of each cluster by the chosen cluster heads. The TDMA schedule is constructed with the number of nodes in the cluster being taken into consideration. After that, each node will broadcast its data according to the timetable that has been allotted [3]. B. The period of stability during the steady phase, nodes inside the cluster communicate their data to the cluster head. The individual sensors that make up each cluster are only able to have a single-hop transmission conversation with the head of the cluster. A cluster head is responsible for aggregating all of the data that has been collected and transmitting it to the base station either directly or indirectly via another cluster head, along with the static route that has been set in the source code. Following a period of time that has been previously determined, the network will restart in the set-up phase.

3.1 The performance of the LEACH show in the below

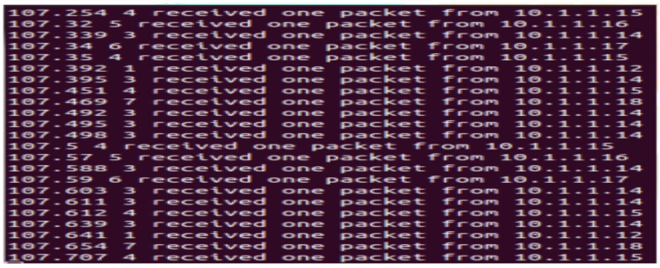

Fig.4. Shows the communication between the nodes.

Fig. 5. Shows the Cluster Head formation between the nodes.

It is known that for every one sec the cluster head is changing due to their mobility. For the 30 Nodes the total time taken to form cluster heads and energy consumption is given in table-1. Fig.4. Shows the communication between the nodes. Fig. 5. Shows the Cluster Head formation between the nodes.

There is no information available regarding the development of cluster heads between the individual nodes that make up the network. The cluster head may pass away for no discernible reason, and the cluster itself could become inaccessible to the network. The development of clusters is done in a random fashion, which may contribute to the uneven results. Additionally, some clusters have a greater number of nodes than others, while other clusters have a lower total number of nodes. Because of where they are located, the cluster can sometimes form in the middle of the network, but other times it can form on the edges of it. This may result in a greater consumption of energy, which in turn may result in a loss for the network.

3.2. Research Methodology

The algorithm known as Energy Efficiency hierarchical clustering is the one that is utilized the most frequently in WSN. This protocol offers a number of benefits, the most notable of which are the preservation of energy between the nodes and an improvement in the development of cluster heads. All of the sensors that are within k hops of the cluster head are notified of the information after it has been transmitted. Any sensor that is not itself a cluster head but gets such advertisements is added to the cluster of the cluster head that is geographically nearest to it. A sensor is considered to be a cluster head if it is neither already a cluster head nor has joined any other cluster itself. These cluster heads have been given the name forced cluster heads by us. Because we have restricted the advertisement forwarding to k hops, if a sensor does not receive a CH advertisement within the time duration t (where t units is the time required for data to reach the cluster head from any sensor k hops away), the sensor can deduce that it is not within k hops of any volunteer cluster head and consequently become a forced cluster head. This is because we have limited the advertisement forwarding to k hops. Fig.6.shows Flowchart of EEHCA

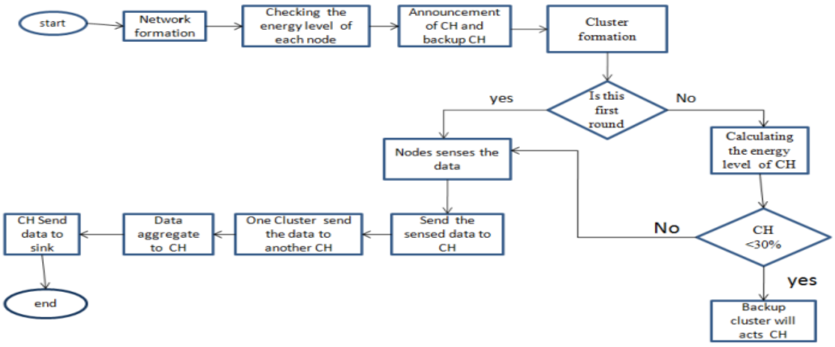

Fig.6. Flowchart of EEHCA

In addition, given that all of the sensors that make up a cluster are located no more than k hops away from the cluster head, the cluster head is in a position to send the aggregated information to the processing canter at regular intervals of t units of time. Due to the fact that there is a cap on the total number of hops, the cluster heads are able to schedule their transmissions. Note that this is a distributed approach, which means that it does not require the sensors to maintain clock synchronization with one another. Fig.7. shows Basic Energy Model in NS-3.

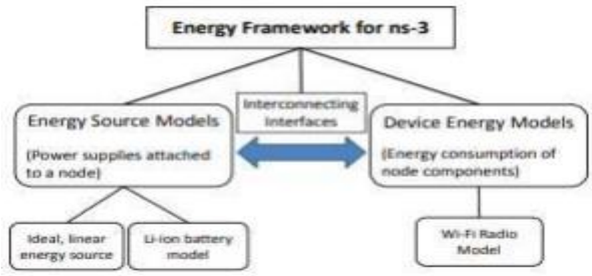

Fig.7. Basic Energy Model in NS-3.

The amount of power consumed by the network in order to process the information The values of the parameters p and k that our algorithm uses will determine the amount of energy that must be used by the network in order for the data that has been acquired by the sensors to be sent to the processing canter. Since the goal of our work is to reduce the amount of energy that is consumed by organizing the sensors into clusters, we need to determine the values for the parameters p and k of our algorithm that will guarantee that the amount of energy consumed will be reduced to the least amount possible. In the following part, we will derive formulae for the best possible values of p and k. Fig.8. shows Cluster Head Formation & time taking to form Cluster Head between the nodes.

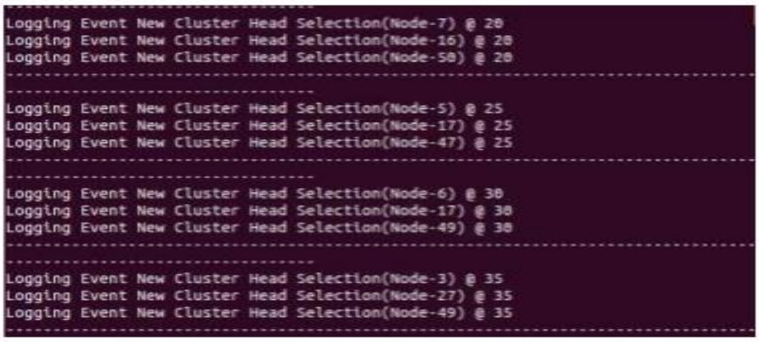

Fig.8. Cluster Head Formation & time taking to form Cluster Head between the nodes.

EEHCA Algorithm:
Step-1: Initialize Nodes N.
Step-2: N=30;
Step-3: Energy at each node E=7.5 (initial energy)
Step-4: Start Communication
Step-5: Calculating Cluster Heads 1-3 &1 backup
Step-6: time taken to calculate the cluster heads are t=4-6 sec.
Step-7: Consider 35 Sec total time taken for this cluster head calculation.
Step-8: then the energy at each node is E>7.5.
Step-9: this shows that EEHCA is maintain the energy.
Step-10: Stop.

The algorithm's ideal values for its parameters In order to identify the parameters that should be optimized for the algorithm that was just presented, we assume the following assumptions:
a) The sensors that make up the wireless sensor network are dispersed across the space according to a homogenous spatial Poisson process of intensity. This process takes place in two dimensions.
b) Every sensor uses the same amount of power for transmission, and as a result, they all have the same radio range r.
c) The data that is being communicated between two sensors that are not within radio range of one another is being relayed by other sensors.
e) In order to send or receive a single unit of data, each sensor consumes one unit of energy.
f) A routing infrastructure has been established; consequently, only the sensors that are located along the routing path forward the data when one sensor transmits data to another sensor.
g) Because there is neither conflict nor error in the communication environment, sensors do not need to retransmit any data at any time. The fundamental concept behind the process of deriving the values of the optimal parameters is to first define a function for the amount of energy that is consumed in the network in order to communicate information to the information processing center, and then to locate the values of the parameters that would minimize that amount of energy consumption.

4.RESULTS

NS-3 is utilized in order to carry out the simulations. Extensive research is being conducted in order to evaluate how well the proposed EEHC performs in comparison to both traditional and up-to-date clustering methods. Fig.9. shows the Performances of LEACH & EEHCA

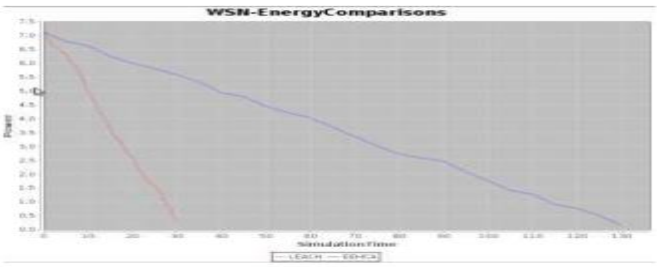

Fig.9. Performances of LEACH & EEHCA

Comparison table

Table: 1 Shows the Performance of the LEACH & EEHACE

Algorithm	LEACH	EEHCA
No of Nodes	30	30
Total Energy for all nodes	15 Sec	35 Sec
Time for cluster head	1 Sec	4-6 Sec

5.CONCLUSION

In this paper, a novel routing protocol called EEHCA that is based on multi-hop clustering has been developed. This protocol reduces the amount of energy that is consumed and further extends the lifetime of the network by evenly dividing the load of energy over all of the sensor nodes. Conventional protocols, which deliver data to the BS by way of their respective CHs, are outperformed by EEHCA, which sends data directly to the BS. It has been demonstrated that layering the clusters inside the network is an effective strategy for lowering the amount of energy used in a significant manner. Every single node in the cluster is equally responsible for sending the aggregating signal to the base station as well as receiving data from all of the other nodes in the cluster. The results of simulations reveal that EEHCA is superior to HCR and LEACH in terms of start energy reduction by 151 times, energy of one iteration by 0.2926 104 times, and energy reduction by 0.3169

104 times than LEACH. This results in a 43% overall reduction in energy consumption compared to LEACH. Through the use of simulations in NS3, we were able to better take advantage of the benefits offered by the propagation channels in order to ensure the lifespan of the energy-constrained network.

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