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AN OPTIMIZED ENERGYEFFICIENT HIERARCHICAL CLUSTER ROUTING ALGORITHM IN WIRELESS SENSOR NETWORK(OOEHC)

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ABSTRACT:

Wireless Sensor Network has a wide range of applications which continuously increasing despite various limitations of the sensor nodes. The different solution proposed for scaling down the large size of network, one of the most intrinsic approaches is clustering techniques in wireless sensor networks (WSNs). It involves grouping sensor nodes into clusters and selecting cluster heads (CHs) for each cluster. CHs collect the information from the respective cluster nodes and forward the aggregated data to the base station, then forward the data to the sink node. A major challenge in WSNs is to select an appropriate cluster head and energy consumption is the most crucial design issue in WSN. In order to resolve the problem and prolong the network lifetime, the energy resources of every node in WSN ought to be effectively managed. To reduce the traffic congestion in the network and to improve the system performance in the transmission delay and throughput, we proposed an optimized energy-efficient hierarchical cluster routing algorithm (OEEHC). The simulation results showed that our OEEHC method outperforms the LEACH protocol.

Keywords: Wireless Sensor Network, Cluster head, aggregated data, cluster head, hierarchical clustering, energy consumption

1. INTRODUCTION

A wireless sensor network is a spatially distributed autonomous system of sensor nodes and a base station connected through wireless links that are densely deployed in a real-time environment. Sensor nodes having the ability of sensing data, capturing data, processing data, and transmitting the information to the sink(storage element)or main base station. Sensor nodes are usually dispersed and operate on a set of limited resources. Due to the limited transmission range of sensor nodes, communication between any two nodes might require the packet to traverse multiple hops. Nodes within range can communicate directly with each other and outside the transmission,

the range must communicate indirectly using a multi-hop routing protocol.

A cluster is a group of linked nodes working together closely for the same purpose and belongs to the same topological structure. Each cluster comprises one cluster head to manage the clusters and co-ordinate with other clusters through inter or intracluster communication. A cluster gateway is a non-cluster head node with inter-cluster links, so it can easily access the neighboring cluster nodes and forwards the information or data between clusters. The clustering technique provides scaling and eases in routing with efficient optimized energy consumption in wireless sensor networks. The hierarchical clustering algorithm in WSN should be able to maintain its three-layered cluster structure as stable as possible while the topology changes.

In this paper, we design a novel real-time routing protocol for wireless sensor networks, which is composed of different phases. At first, nodes are created. In the next step, the cluster formation process has been presented. In the third stage, the Cluster head is selected based on the node which has the highest number of neighboring nodes. In the next step, hierarchical clustering is used which creates a three-level hierarchy for improving energy consumption. After a hierarchical clustering algorithm is implemented, inter and intracluster communication is presented and an optimal route is created. The rest of the paper is organized as follows: A comprehensive survey of related works of different routing techniques in WSN is presented in Section 2.In Section 3 we have implemented the Hierarchical Clustering Algorithm which consists of a three-level hierarchy to prolong the network lifetime. Simulation results of the proposed algorithm is presented in Section 4. Finally, we conclude our paper with final remarks in Section 5.

APPLICATION

WSN applications are many and varied in data transferring. These applications are utilized in commercial and industrial applications to observe data that might be difficult and it is expensive to watch using wired sensor networks. They could be deployed in wilderness areas, where they might remain for several years (monitoring some environmental variable) without the necessity to recharge/replace their power supplies.

Typical applications of WSNs include monitoring, tracking objects, and controlling energy loss. Some of the actual applications are habitat monitoring, tracking of objects, controlling reactor, detection of fire, monitoring traffic, etc. In a typical application, a WSN is scattered during a region where it's meant to gather data through its sensor nodes.

• Environmental monitoring

• Habitat monitoring

• Acoustic detection

• Seismic Detection

• Military surveillance

• Medical monitoring

• Smart spaces

• Inventory tracking

CHALLENGES

In WSN, the capabilities (battery power, transmission range, processing hardware and memory used, etc.) of the sensor nodes combined with the special location-based conditions met (not easily accessed to recharge the batteries or replace the entire sensors) make the energy efficiency, reduce the traffic congestion and the scalability factors even more crucial. The challenge of increasing network lifetime under the above restrictions is difficult to be met by using only traditional techniques. So we can be using a cluster routing algorithm for improving energy efficiency.

• Dynamic Topology of Network: The variability of network topologies due to node failures, the introduction of additional nodes, variations in sensor location, and changes to cluster allocations in response to network demands requires the adaptability of network structures and operations.

• Limitations of Resources: Battery power, memory, processing power, and lifetime are physical constraints that impact every aspect of networks.

• Failure Prone: Each sensor are unreliable in harsh and unpredictable environments.

• Network congestion: The quantity of data gathered may exceed the requirements of the wireless network and so evaluation of the data or information and transmission of only relevant and adequate information needs to be performed in WSN.

The WSNs with high performance will inherit practice if the subsequent requirements are satisfied

• Low power

• memory usage is efficient

• Self-organizing

• Collaborative processing of data

• Ability to query

• Scalable

• Reliable

• Fault tolerance

2. RELATED WORKS

The recent research efforts in clustering techniques are used to increase the efficiency of wireless sensor networks. Hierarchical cluster-based routing schemes provide the solution by organizing the sensor nodes into clusters to reduce the communication and control overhead. In this section, we have studied some prior works on cluster-based routing schemes in WSN.

Existing research work in LEACH protocol mostly aims at improving the stability of nodes and collaborative environment between nodes. Kaur Jaspreet and Rai Dr.M.K[4], described that the dynamic clustering protocol focused on cluster head selection, member solicitation of the cluster, and reorganization of the cluster. Khediri, S. E., Nasri, N., Wei, A., &Kachouri, A. (2014) proposed an optimization low energy adaptive clustering hierarchy(O-LEACH) to increasing the LEACH based on the selection of cluster according to residual energy of nodes dynamically[5].

In [6] Li, C., Ye, M., Chen, G., & Wu, J. proposed an energy-efficient unequal clustering mechanism for wireless sensor networks. EEUC[6] is based on a multihop routing protocol that is used for periodical data gathering in wireless sensor networks. It partitions the nodes into the unequal size of clusters and clusters which are present closes to the base station preserve the energy. Mehmood A, Khan S, Bilal S, Lloret J, proposed an energy-efficient multi-level and distance-aware clustering mechanism for WSNs deployed in hostile environments. In EEMDC[7], the network area is divided into logical layers which depend upon the hop count based distance from BS.

Mehmood, A., Lloret, J., &Sendra, S. proposed a secure and low energy zone-based wireless sensor networks routing protocol for pollution monitoring. In SeLeZoR [9], the goal of this research is WSN is divided into zones, and each zone is split into clusters that are controlled by the cluster head. Using the secret key data is sent to the zone head securely and it sends data to the base station using an energy-efficient mechanism.

Nikolidakis S. A., Kandris D., Vergados D. D., Douligeris C.,[11] proposed an energy-efficient routing in wireless sensor networks through balanced clustering. ECHERP[11] designs the network as a linear structure and using the Gaussian elimination algorithm calculates nodes combination that can be taken as cluster head.

In the next section, we are going to propose a new hierarchical cluster routing protocol and try to reduce the problems of previously discussed protocols and also improving energy efficiency with optimal routing.

3.PROPOSED SYSTEM

We present a new Optimized Energy Efficient Hierarchical Clustering algorithm. First of all, the cluster model is presented, based on the node having a large

number of neighbor nodes, node nearest to the base station, and having the highest residual energy, We get the optimal Cluster Leader (CL) for each cluster which is deployed in the large area of the wireless sensor network. Secondly, we adopt the cluster head selection mechanism to select the optimal cluster head. Then, we adopt the hierarchical clustering strategy in which level-3 hierarchy is achieved. (i.e) Cluster Leader(CL) to each cluster(Level 1), Cluster head (CH) for each Cluster Leader(Level 2) and each Cluster Head (CH) will send the aggregated sensed data to the Base Station(BS) (level 3), which in turn transmit the data to the Sink (Storage element) to form a stable cluster. This strategy can improve the stability of clusters and reduce the cost of clustering effectively. Finally, the Optimized Energy Efficient Hierarchical Clustering mechanism (OEEHC) not only improves the stability of the cluster but also increases the coverage of the cluster. And the hierarchical clustering mechanism effectively reduces the inter-cluster interference because of the occurrence of cluster overlap. Based on our experiments, we can see that our proposed algorithm can improve the stability and reliability of the Wireless Sensor network.

In this segment, we will introduce an Optimized Energy Efficient Hierarchical Cluster Routing approach for Wireless sensor network. In this directing plan, we have introduced various leveled group-based strategies (clusters), which by and large create less routing overhead than flat routing for WSNs. Our proposed convention is partitioned into three subsections. In section I, the Cluster Leader selection strategy has been presented. In section II, Cluster Head for each group and Cluster arrangement method is portrayed. In section III, the transmission of detected accumulated information correspondence is examined.

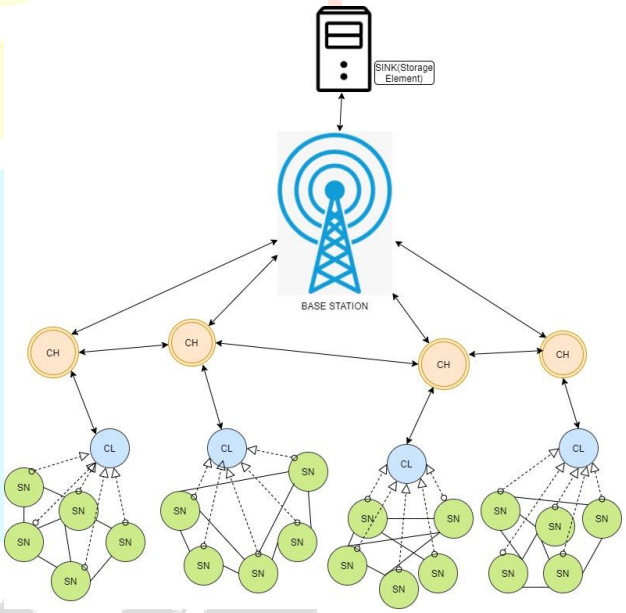

Figure 3.1 System Architecture

3.1CLUSTER FORMATION TECHNIQUE

The clustering approach is that the most generally used technique for energy efficiency to attain scalability and effective communication. Sensor nodes coexisting with a BS that has an abundant power supply and is capable of transmitting with high enough

energy to the whole network. The groups of sensor nodes are distributed arbitrarily within an outlined region of interest and therefore the BS is situated statically at a distant location, far away from the sensor field. The network is dynamically divided into sub-zones called clusters. Different clusters are formed each with a specific Cluster leader (CL). The communication of sensed data from sensor nodes to Cluster Leader (CL) takes place (Intracluster communication) and successively Cluster Leader (CL) will send the info to Cluster head (CH) from CHs to BS takes place using an optimal routing path.

Each Cluster head preserves a precedence list that contains the ClusterHead IDand neighbourhood ID a routing table and a counter which counts the number of its cluster individuals. Every node maintains a similar counter and has the capacity of manipulating nodes up to the top of twice its transmission range. The counter is perhaps enabled when the node chosen as a Cluster head. After chosen as Cluster head it needs to maintain data about its cluster individuals. This method is portrayed in the accompanying calculation.

CLUSTER FORMATION CALCULATION

q=count

k2=source

T2=hopcount

r=h

l2 =val size=qk2T2r/l2;

W=a1*N+(-a2*stability+a3*load/N)

3.2 CLUSTER HEAD SELECTION

In general, a cluster head is able to perform two main tasks; data processing and data transmission in the best way. Data is transmitted fast to other clusters; this is called higher power mode. While data is transmitted normally to other clusters; this is called lower power mode. However, voting the optimal cluster head is taken into account a retardant of the sort NP-hard. Sensor nodes are required to capture certain data of the encompassing. For this purpose, the sensor may additionally be tagged to things that are in motion. For example, a sensor node may be attached to an animal in a sanctuary to identify its location. Doing so, the energy of the node isn't utilized so there's no effect on the energy state of the node. But because of the movement of nodes, the movement can also be inter-cluster and not just intra-cluster. So the nodes must identify the CH based on certain parameters; node nearest to the base station, the energy of each node, the data transmission power, ideal node degree, the mobility and send the datapackets to the Base Station.

3.3HIERARCHICAL CLUSTERING

In hierarchical approaches, nodes are clustered into groups, and, by some criteria, a

cluster head is selected that is responsible for routing. In hierarchical routing, usually layered approach is used, where one layer is used for sensing the physical environment and the other is used for routing. The low energy nodes are used for sensing while high energy nodes are often used for collecting, aggregating, and forwarding data. A three-layered hierarchical architecture is created, such as Sensor node (SN) to Cluster Leader(CL)(Level 1), Cluster Leader(CL) to Cluster Head(CH)(Level 2) and Cluster Head(CH) to Base Station(BS)(Level 3). Cluster-based hierarchical approaches have some advantages such as increasing scalability; efficient data aggregation and channel bandwidth. Clustering algorithms are responsible for constructing; maintaining clusters and keeping connections among all the nodes. The hierarchal routing provides reduced size of the routing tables, better scalability, lower traffic overhead and lower routers' CPU processing. In general, the hierarchical model is simple to build and control. It makes it easy to add, remove or retrieve records.

4. PERFORMANCEANALYSIS AND RESULTS

The simulation of the wireless sensor network (WSN) is depicted in a clustered environment and the nodes are addressed hierarchically and are placed in a flat topography. Being a flat topography, the coordinates of the nodes are in the form (x,y,0) boundaries and if a node lies within these boundaries then it is enlisted in that respective cluster. Graphical clusters are differentiated by their respective colors. As usual, in a hierarchical addressing scheme, an end node communicates with its CH, and all the CHs communicate with the BS which in turn connects the WSN to the Internet. So initially, all the nodes depending on their position are divided into clusters. The node which is nearest to the BS is selected as the CH of that cluster. Communication is set up between the end nodes and their respective CH and also all the CH aggregates the data and after a certain interval, reports that data to the BS. Sensor nodes are dynamic in nature. They make inter or intracluster communication. It is also observed that the whole network works with more efficiency and stability under this Optimized Energy-efficient hierarchical clustering scheme.Here we have introduced an Optimal Energy-Efficient Hierarchical Cluster (OEEHC) based Routing Algorithm for Wireless Sensor Networks. Some criteria are chosen for Cluster head Selection, as the highest-degree node (HD), less mobility factor (LMF), and huge transmission range (LTR). Considering the important criteria, the degree of a node is the significant critical measure for the decision of cluster head. It shows the number of neighbor nodes to which the sensor node can communicate. A Cluster head ought to

communicate with enormous quantities of neighbor nodes. Relies on these standards, a node with the most significant level should select as a Cluster head. Mobility is the essential attribute of a sensor node and just as it is the principal challenge for routing in Wireless Sensor Network. A node with high mobility regularly changes its position, assuming any profound sensor node will choose as cluster head, its part and another cluster heads will confront huge overhead for keeping up information about the node. Subsequently, node mobility is taken as one of the qualities for clustering computation. Transmission range is a vital boundary for sensor nodes. Nodes with a high transmission range can communicate with a huge number of neighbor nodes. Consequently, the high transmission range is taken as the significant rule for Cluster head selection. By utilizing the above-discussed boundaries Cluster head selection has been executed and all of these limits are autonomous with each other. A node that has high transmission range can have high mobility. Thus, we have allocated precedence to every selection criteria. The highest precedence is allocated to a large transmission range and the least precedence is allocated to the least mobility factor. Since it is a Hierarchical methodology it will decrease the overhead of information maintenance and saves transmission capacity and energy by decreasing message communication for routing protocols.

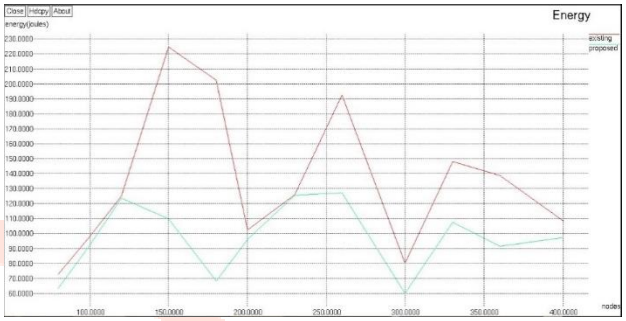

Figure 4.1 Energy Consumption

Figure 4.1 represents the variation in the time of survival nodes in the network, for LEACH and our proposed OEEHC. The results show that our OEEHC performs better than LEACH which saves energy consumption and extends the lifetime of the network.

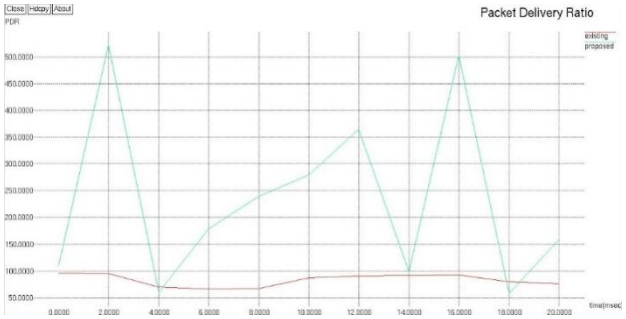

Figure 4.2 Packet Delivery Ratio graph

Figure 4.2 represents the Packet Delivery ratio of nodes in the network, for LEACH and our proposed OEEHC. The results show that our OEEHC performs better than LEACH which packets are sent to the base station (sink) through the cluster head for each cluster.

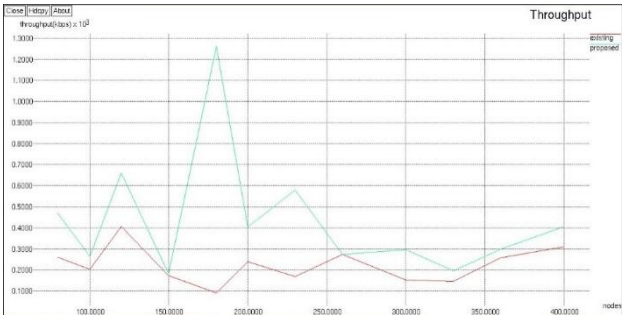

Figure 4.3 Throughput graph

Figure 4.3 represents the throughput (performance) for LEACH and our proposed OEEHC. The results show that our OEEHC performs better than LEACH.

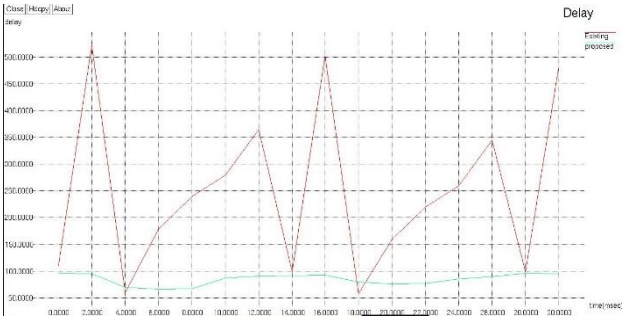

Figure 4.4 Delay in transmission graph

Figure 4.4 represents the Delay in the network, the results showed that our proposed OEEHC performs better than LEACH.

5.CONCLUSION

In this paper, we have summed up the nonexclusive qualities of notable group-based routing protocols and Hierarchical routing protocols and proposed a new routing protocol named, Optimized Energy Efficient Hierarchical Cluster Routing algorithm in Wireless Sensor Network. This recently proposed approach depends on the load adjusting approach among Cluster Head (CH) in wireless sensor networks. Cluster Head selection relies upon the most significant level, huge transmission range, and least mobility factor. Dependent upon these limits, the weight factor is determined for every sensor node, and the most noteworthy weighted node is picked as Cluster Head. The Cluster Head of each cluster goes about as a nearby co-ordinator for its cluster, performing between inter-cluster routing, data sending, and responsible for intra-cluster and inter-cluster communication. Some result assessment is also additionally fused to show, in what direction the proposed method (OEEHC) work to accomplish the scalability, the robustness to increase the lifetime of the wireless sensor network.

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