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A Review on hierarchical unequal clustering based protocols in Wireless Sensor Network

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Abstract-Wireless Sensor Networks (WSNs) are drawing attention of various researchers in the area of wireless sensing technology. The one of the major constraint on WSNs is the limited battery resources. Due to this, the routing among sensor nodes plays a vital role in reducing the energy consumption of nodes. Clustering not only provides scalability to the network, but it also balances the energy consumption among nodes according to their roles in the cluster. Equal clustering creates the problem of Hot-Spot among those nodes that have to relay the data from the farther clusters. In this paper we have studied various routing protocols which follow unequal clustering. It is found after studying these protocols that unequal clustering help tremendously in saving the energy and avoids the problem of Hot-Spot.

Keywords: *WSN, Unequal Clustering, UCR, HUCL, Hot-Spot problem, EADUC.*

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1. INTRODUCTION

WSNs are exceptionally disseminated systems of little, lightweight, battery-installed sensor nodes. WSNs are turning out to be progressively alluring for various application territories, for example, military observation, debacle administration, security reconnaissance, environment checking, medicinal services and mechanical computerization. Data accumulation from these systems might be periodic based, question based or event based. In periodic based data assembling, the sensor nodes sense nature and transmit the detected worth to the sink at customary interims; the steering procedure assumes a vital part in dragging out the system lifetime in these applications.

A sensor node has very simple architecture as shown in Figure 1.

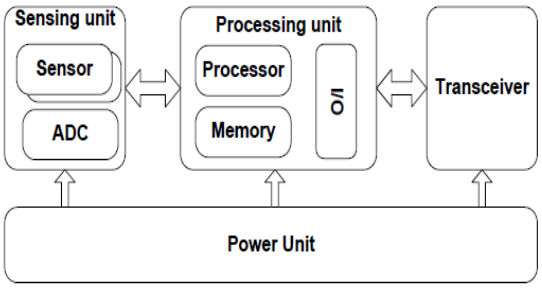

Figure1. Components of sensor node

The broadly recommended directing procedures are appropriated among various classes, including flat approach, hierarchical approach and location based approach. Numerous vitality proficient arrangements have been produced in every class of directing conventions. A methodology that is liable to succeed is the utilization of a hierarchical structure. The hierarchical association of sensor systems prompts three distinct sorts of directing conventions in light of how they impart information to the sink, which are the cluster based methodology, chain-based methodology and tree-based methodology.

All the applications that cover huge sensor fields and need continuous data collection also support the data aggregation as a prime contender for enhancing the lifetime of the network. Cluster based design has accomplished this with least overhead. In clustering plans, sensor nodes are gathered into clusters, a node is chosen as the cluster head (CH) and alternate nodes are called cluster members (CMs). Every node in the cluster gathers neighborhood information from the environment intermittently and sends it to its cluster head. After getting the data from all CMs, the CH aggregates the collected data and transmits to the sink by means of direct single hop correspondence or through a multi-hop steering way. The current clustering protocols can be static or dynamic relying upon the recurrence of clustering. In dynamic protocols, at each cycle, another cluster head is chosen and the clustering limit is remade, which expands the clustering overhead. In static calculations, the group is framed once, which lessens the clustering overhead, yet the group head is over-burden, diminishing the system lifetime.

2. UNEQUAL CLUSTERING PROTOCOLS

There are various clustering protocols; some of them are equal cluster sized protocols and some are unequal sized. Before knowing about unequal protocols, the first clustering protocols that brought the concept of clustering is LEACH.

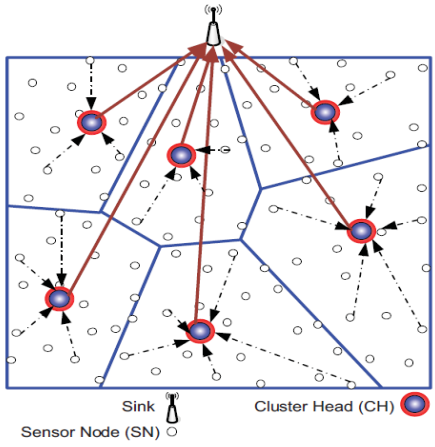

Figure2. LEACH

LEACH [1] stands for Low Energy Adaptive Clustering Hierarchy protocol. It is the first hierarchal clustering routing protocol for Wireless Sensor Networks. It was proposed by Heinzelman et. al. and has turned into the most prevalent in hierarchical clustering by diminishing power utilization. LEACH disseminates the vitality load uniformly among all the sensor nodes in a network by isolating the network into a few clusters and selecting cluster head from every cluster haphazardly. In the event that cluster head are picked as from the earlier and settled all through the network lifetime then nodes which are chosen as cluster heads pass on rapidly, this impacts the cluster members from cluster too. In LEACH algorithm cluster head obligation is haphazardly pivoted among every one of the sensors such that every one of the nodes deplete its battery similarly. For getting the meaningful information from the collected data the cluster head perform data aggregation then that information should be transfer to the sink which additionally delays network lifetime.

The operation of LEACH is isolated into rounds, where each round begins with a set-up stage where clusters are composed, cluster head promotion, transmission plan creation took after by steady stage for data aggregation technique, compression technique and transmission of data to the sink from cluster head.

Equal sized protocols suffer from the drawback of Hot-Spot Problem. Here are some of the unequal sized routing protocols.

2.1 UCR

To moderate the problem area issue, the nodes are gathered into the unequal clusters. It is intended for inter-cluster transfer movement, which comprises of two sections, one is EEUC (Energy Efficient Unequal Clustering) to alleviate the problem area issue and the other is a directing convention for inter-cluster relay traffic. In UCS, the vitality utilization is kept up consistently among all CH for long keep running by diminishing the quantity of nodes in cluster with high relay load burden close to the sink. At first, conditional CHs are arbitrarily chosen to vie for last CH. Each speculative cluster head has an opposition range. Distinctive rivalry reaches are utilized to create clusters of unequal size. At long last, one CH is permitted in every opposition range. After a CH has been chosen, each CH telecast notice message over the network. Every node picks its adjacent CH with biggest got signal quality and sending joining cluster message to the closest cluster head. At that point the voronoi of sensor node is developed. UCR expect that the rough separation starting with one sensor then onto the next in view of the got signal quality. In genuine environment, blunder will emerge because of the clamor.

In the UCR Convention, the nodes can be grouped into the clusters of unequal sizes. The cluster which are nearer to the sink are smaller cluster size than those more distant from the sink, consequently they can safeguard some vitality for sending the inter-cluster data.

The UCR [6] protocol has some disadvantages. At the point when cluster heads collaborate with each other to forward their information to the sink, the cluster head which is nearer to the sink are loaded with heavier relay traffic and it tend to die earlier, leaving regions of the system revealed and caused the division of the network, since node nearer to the sink sends information straightforwardly to the sink.

2.2 ECDC

ECDC [3] stands for Energy and Coverage aware Distributed clustering Protocol. It is a coordinated convention including both energy efficiency and coverage importance metrics. The various coverage importance metrics are designed or built for different practical applications. We select cluster heads taking into account the relative leftover vitality and the coverage importance metrics of nodes. For the inter-cluster communication approach the multi-hop mechanism can be used. While selecting the sending node, the cluster head considers both the remaining vitality and the coverage importance of nodes. Contrasted and past conventions, this protocol can build a superior clustering topology through less control data which has lower vitality dissemination and is demonstrated a superior coverage execution.

In this protocol, comparing coverage importance cost metrics CI going for various application coverage issues are presented. Just nodes with higher vitality and littler coverage importance are solid to be chosen as cluster heads and routers.

The entire operation is partitioned into rounds each of which contains a cluster set-up phase and a data transmission phase.

In the cluster set-up phase, ECDC is hurry to frame a clustering topology taking into account the neighborhood data that consolidates the relative residual energy and coverage importance of nodes.

In the data transmission phase, cluster members first gather all the local data from the environment and then send the collected data to the cluster heads. After collecting the data from all the cluster members then the cluster heads aggregate the data and after that send back to the following jump nodes on the developed directing tree. To decrease the overhead of the protocol and draw out the lifetime of the network, the transmission stage ought to be longer than the set-up stage.

2.3 EADUC

EADUC [7] stands for energy aware distributed unequal clustering protocol. It chooses cluster heads in view of the proportion between the normal remaining vitality of neighbor nodes and the leftover vitality of the node itself, and utilizations uneven rivalry extents to build clusters of uneven sizes. The cluster heads near the sink or base-station have small cluster sizes to safeguard some vitality for the inter-cluster data forwarding, which can adjust the vitality utilization among cluster heads and draw out the network lifetime. The entire operation is separated into rounds, where each round has a setup stage and a data transmission stage simply like LEACH protocol.

To frame a clustering topology, the setup stage is isolated into three sub-phases: neighbor node data gathering stage, cluster head rivalry stage, and cluster development stage; in the data transmission stage, cluster members gather nearby information from the environment, and send the gathered information to the cluster heads, cluster heads gather all the data from their cluster members and then aggregate the data, and afterward send the collected information to the following next-hop nodes taking into account the directing tree we have built.

Data transmission stage ought to be longer than setup stage to spare the overhead of the protocol and drag out the lifetime of the network.

2.4 UHEED

UHEED [5] stands for Unequal Hybrid Energy Efficient Distributed protocol. It is a hierarchal unequal clustering based routing protocol. UHEED is the proposed version of the HEED protocol. On the basis of the distance from the cluster head to the base station the unequal size clusters are formed. The UHEED has the same competition radius calculation as the EEUC (Energy Efficient Unequal Clustering) protocol. In this protocol the small size clusters are formed nearer to the base station. To form the small size clusters closer to the base station the competition radius formula can be used from EEUC. The measure of intra-cluster traffic is extensively decreased closer to the BS, by making unequal estimated clusters.

UHEED make the accompanying suppositions about node.

(i) All nodes are homogeneous regarding vitality, communicating and handling capabilities.
(ii) Every node has their own unique id and it can be identified with help of unique id.
(iii) Nodes can transmit at different power levels relying upon the distance of the recipients.
(iv) Nodes are not versatile i.e. they stay stationary.
(v) The Communicating nodes can set up the distance among them.
(vi) The distance from the base station can be known by the all nodes. The BS is found far from the detecting framework with no vitality worries by any stretch of the imagination, and it is thought to be a node with upgraded correspondence and calculation abilities. The BS is not compact. The information caught in a cluster is exceptionally connected; in this way it can be accumulated before being transmitted to the base station. The problem area issue is successfully moderated in UHEED than equivalent estimated clusters and adjusts the vitality utilization among the sensor nodes in the network.

2.5 HUCL

HUCL [2] stands for Hybrid Unequal Clustering with layering protocol. The HUCL is a combination of both static and dynamic approaches. In this protocol, the network is partitioned into layers and clusters of different sizes. The cluster heads are chosen in view of accessible vitality, the distance to the base station and the no. of neighbors. The various sizes of clusters are built which are locally relying upon the distance from the base station. Once the cluster is built, the same structure is kept up for a couple rounds. The data are sent to the base station through a multi-hop layer-based communication with an in-network data compression algorithm. The entire operation of HUCL is partitioned into rounds; each round has a setup stage and an information transmission stage.

In **setup stage**, the nodes are assembled into layers taking into account the distance from the base station, and a unique-id can be allotted to all the nodes according to their layer. The base station broadcast WELCOME message with a layer-id utilizing the less power, the nodes that get this message structure layer-1 and compute the distance from base station utilizing the got signal quality. At that point, the base station increases the power level and communicates the Welcome message once more. This layering is utilized for just inter-cluster communication. The clusters are free of the layers.

The **data transmission stage** is partitioned into ‘M’ i.e. major slots, and every major slot contains ‘m’ i.e. mini slots. A mini slot is the real data transmission, which covers the TDMA plan dissemination, data gathering from sensors by CH, the data aggregation by CH and transmitting the data to the base station. Major slots perform CH pivot inside the cluster limit and handover the cluster members and the data sending way to the new CH.

(i) Each round of data transmission is isolated into major slots, and every major slots is partitioned into a few mini slots.
(ii) In every small mini slot, the CMs sense nature and send the data to the CH; the CH aggregates all the data and transmits the data to the base station through a multi-hop transmission chain.
(iii) In each major slot, the current CH chooses a node as the new CH inside the same cluster limit contingent upon the vitality. The current CH illuminates the new CH about its ancestor and successor in the data transmission way.
(iv) In each round, the clusters are changed to keep away from early deplete of a few nodes.
(v) An in-network data compression algorithm is utilized to improve the lifetime of the network. Therefore, the proposed approach least the clustering overhead and enhances the network lifetime.

Table 1. Comparison of various Hierarchical Unequal Clustering Routing Algorithms

Routing Algorithm	Classification	Approach	Type of Node	Node Deployment Field	Mobility	Base-Station Location Awareness	Data Aggregation
LEACH	Hierarchical	Cluster Based	Homo	Square field	Stationary	No	Yes
HUCL	Hierarchical	Cluster Based	Homo	Square field	Stationary	Yes	Yes
UCR	Hierarchical	Cluster Based	Homo	Circular field	Stationary	No	Yes
UHEED	Hierarchical	Cluster Based	Homo	Square field	Stationary	No	Yes
EADUC	Hierarchical	Cluster Based	Hetero	Square field	Stationary	No	Yes
ECDC	Hierarchical	Cluster Based	Hetero	Square field	Stationary	Yes	Yes

Homo: Homogeneous, Hetero: Heterogeneous.

3. CONCLUSION

WSNs have dispersed almost in every field of technology. The advancements in the routing techniques have been tremendous. Clustering makes data forwarding very efficient. In this paper, we have introduced very efficient unequal clustering protocols. UCR being the first protocol which mitigated the problem of Hot-Spot. It introduced the concept of unequal clustering. However, it is still left with unequal energy balancing in the network. It is found after studying these protocols, that HUCL outperforms the other protocols in terms of network lifetime and other performance metrics.

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