Cluster-Based Techniques in Ad-Hoc Networks for Health Care Monitoring Systems

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ABSTRACT: Modern technology has made it possible to gather vast quantities of medical data. It is crucial to create a healthcare system that can find and share pertinent medical information. The extraction of understandable knowledge from data relating to medical diagnoses is one of the fundamental issues in the medical field. A wireless ad hoc network is an infrastructure-less network that helps in making a healthcare system, it is made up of a massive number of nodes that are constantly linked. The amount of data rate produced during the process in these networks is significantly reduced by the clustering method deployment. In wireless ad hoc networks, clustering is a strategy for splitting large networks containing nodes into smaller groups, with each group consisting of a master node (cluster node), normal nodes (regular node), and doorway nodes. These network nodes can communicate with one another to monitor a variety of variables and are powered by batteries. As a result, energy utilization as well as the gathering of understandable data of healthcare diagnostic data are of the highest concern. This paper looks at the classification of clustering-based techniques as well as the challenges this face.

KEYWORDS: Cluster, Healthcare, LEACH, and Wireless Ad-Hoc Network.

1. INTRODUCTION

Medical diagnosis is viewed as a crucial yet challenging duty that must be completed precisely and effectively. The healthcare industry is still knowledge-poor but information-rich [1]. In real-time medical applications, clustering is used through a wireless ad-hoc network which is also known as a decentralized network which is affordable, light, low-power, and small wireless sensor nodes that collect and transmit data. For example, clustering is used in disease detection by recognizing the characteristics of patient data, clustering can be utilized to detect illnesses and medical disorders. It can be used to identify people who are at a higher risk of getting an illness according to their medical background, way of life, and additional risk factors. Patients in remote areas can be monitored by doctors simply and accurately with wireless ad hoc networks. At the event or close by, the nodes are either dispersed or tightly packed [2][3]. Each node detects an event, gathers the data related to it, analyses it, and then sends it to the head node or ground station (base station) for additional processing. Therefore, each node carries out three

tasks: detecting, processing, and transmission. The exploration of clues in the data used in the medical industry has a lot of promise. You can use these patterns to make a clinical diagnosis. Yet, the raw medical data that is readily accessible is enormous and extensively spread. These facts must be gathered methodical way. There have been multiple proposals for protocols. One method called clustering; involves the nodes forming a cluster, choosing a node's leader, and then transmitting data.

2. CLUSTERING

Clustering is an autonomous data harvesting strategy used to group data items without prior knowledge of the groupings' properties. A dendrogram is another name for it. The purpose of clustering is to find them in a set of unlabelled data. To minimize network energy consumption, we must design network algorithms, which give a set of principles that define how data packets travel from source and destination in a network in an efficient and energy-efficient manner. The tree diagram depicts the classification of protocols.

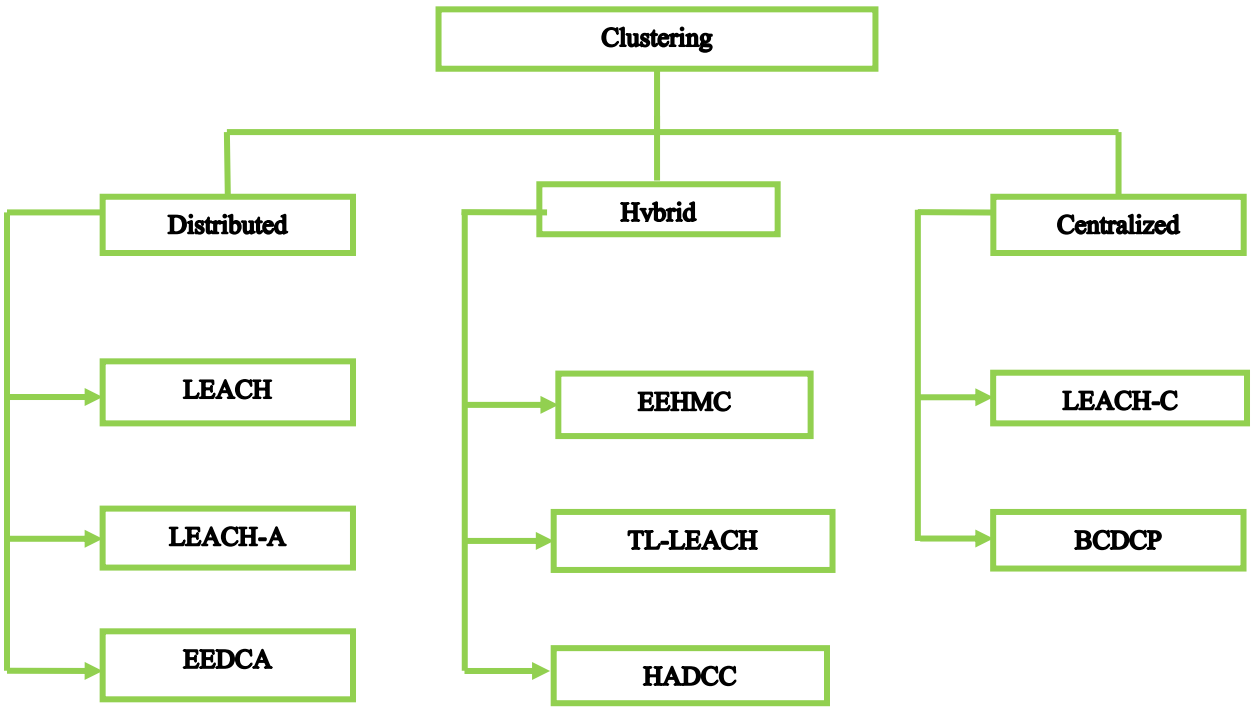

Figure: 1 Cluster-Based Protocols Tree Diagram

2.1 CLUSTERING VARIANTS

2.1.1 Distributed Clustering

The cluster head in distributed clustering is known for continuously moving from one node to another. A few distributed clustering techniques are explained here and categorized according to the sizes of their groupings. For sensors that are ignorant of their position, the distributed

clustering algorithm approach will be employed. This indicates that these sensors are ignorant of their position in relation to the network, and as a result, all of the routing decisions they must make are based on internal data. The distributions of a few clustering methods are listed below.

LEACH (Low-Energy Adaptive Clustering Hierarchy):

It uses a distributed clustering method and it is also a standard hierarchical clustering protocol. Cluster-Head rotation, aggregation of information, and data fusion technologies help to extend the network's lifespan [4][5]. Nodes are unilaterally and cyclically chosen as cluster heads to maximize energy in the network. Based on the proximity concept, the regular nodes known as cluster members join the matching CH nodes. The CH node receives data from cluster members, which normally deliver it to the ground station directly. The sensed info is received by the CHs, which then aggregate it to eliminate duplication and perform data fusion algorithms before sending the data to the client (or ground Station). LEACH reduces system energy usage but also the total amount of transmission packets, thereby extending network lifespan.

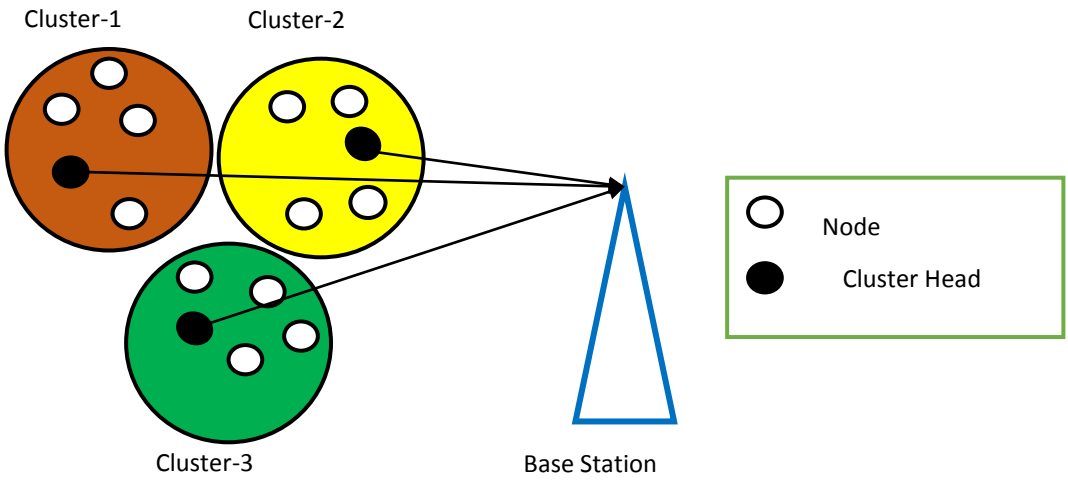

Figure: 2 LEACH

LEACH-A (Advanced Low Energy Adaptive Clustering Hierarchy):

The CH node uses more energy than other nodes, which is a vulnerability in the LEACH protocol. A heterogeneous technique for prolonging the duration prior to the initial node dies and lowering the likelihood of node failure is the LEACH-A protocol (called stability period). Using the synchronized clock, each sensor is aware of the beginning of each round [6]. Let p always be a proportion of q that is composed of CGA nodes, which have higher energy than some other nodes, with q being the total number of nodes (nodes chosen as CH). All remaining (1-p*q) nodes do normal node operations.

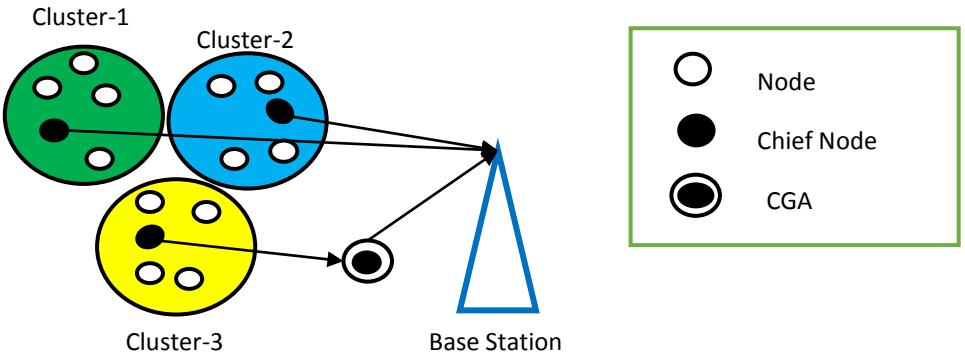

Figure: 3 LEACH-A

EEDCA (Energy Efficient and Density Control Clustering Algorithm):
Clustering with controlled density and energy. where the top nodes on the network are picked to lead their respective clusters. Clustering the system is the next stage. Power rating, distance, and volume all have an impact on this method's choice of CH or chief node [19]. Each node assesses the leftover energy concerning other nodes within its field of view. The EEDCA algorithm's results demonstrate that it extends the lifetime and makes the network more effective.

2.1.2 Hybrid Clustering

The development of algorithms for clustering that combine the characteristics of many algorithms into one is of great interest to academics. We discuss a few of the most popular hybrid classification clustering algorithms that have been presented in the following section.

TL-LEACH (Two Level Low Energy Adaptive Clustering Hierarchy):
The TL-LEACH protocol operates in a two-level hierarchy, in contrast to the LEACH protocol, which sends data from CHs to the BS in a single hop. Instead of being delivered directly to the base station, A chief node that is situated between CH and the BS collects the data from each cluster head [6]. The creation of this protocol reduces the amount of energy required for transmitting data. Because of their limited lifespan than other nodes and their distance from the BS. In TL-LEACH, CHs are utilized as a courier node across clusters to boost efficiency in energy use.

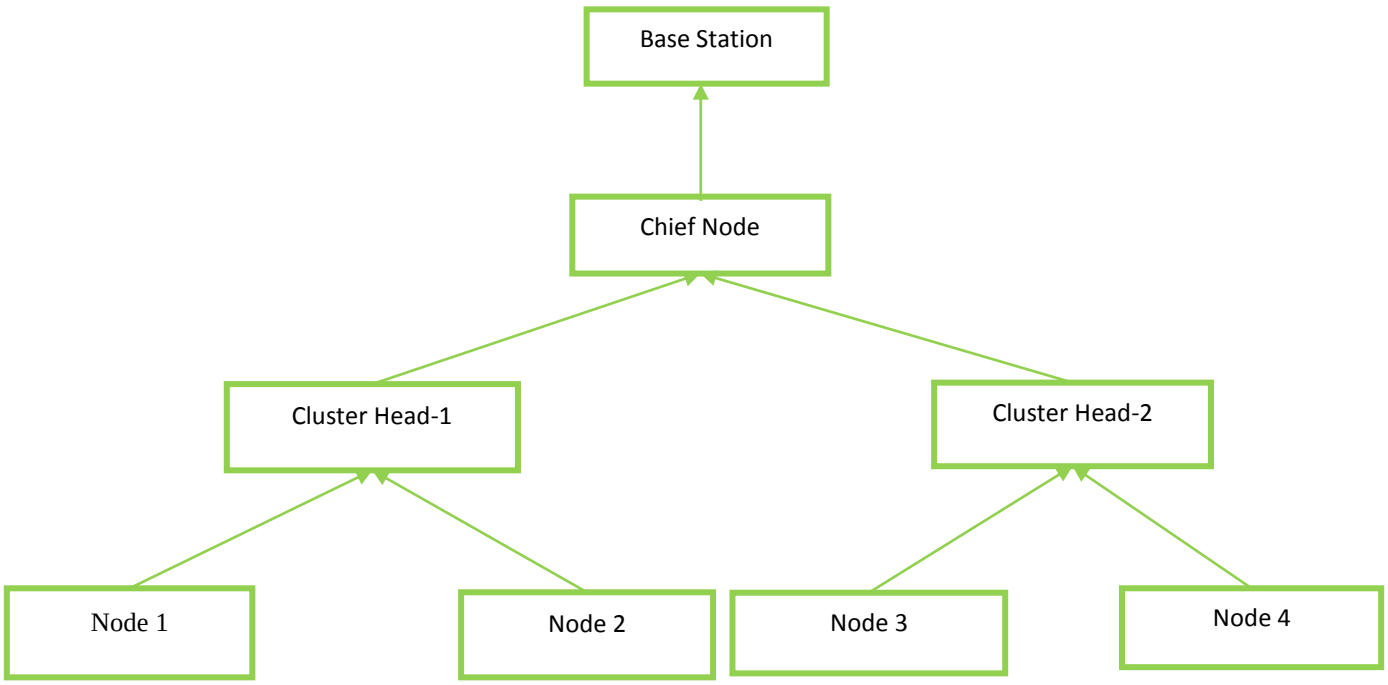

Figure: 4 TL-LEACH

EEHMC (Energy Efficient Hybrid Multi-Hop Clustering):

EEHMC has suggested employing a hybrid communication of multi-hop between BS and CH to extend the life of the network. In the suggested design, choices about the CH are made centrally at the BS, whereas decisions regarding the cluster's creation, sensors dynamically acquire information on the selection of the relay node and the transport of data [12]. Base stations employ the remaining energy of the nodes, inside a transmitter's range, and the gap between the CHs as decision factors to choose the CH. The CH selection, allocation, and multi-hop transmission scenario were given by the algorithm. An EEHMC extended the network's lifespan by up to 27.63% in comparison to LEACH-C.

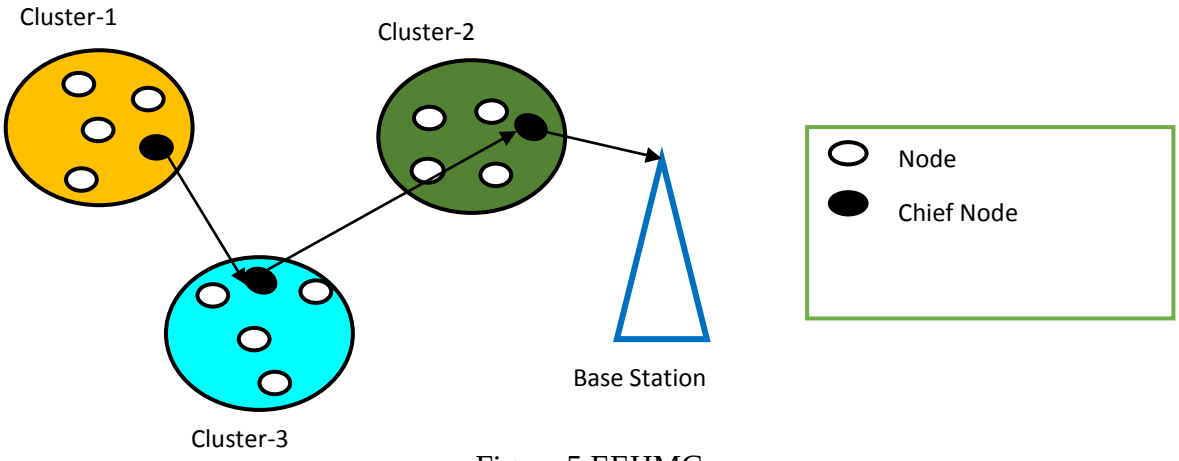

Figure 5 EEHMC

HADCC (Hybrid Advanced Distributed and Centralized Clustering):

This method allows the base station to be positioned in the algorithm's center. The Middle and the network operate on two layers [11]. At the second level, the network cluster formation is finished, and dispersed cluster leaders are chosen. Node location and residual make up the choice of CH parameters.

2.1.3 Centralized Clustering

The concept behind centralized clustering is that all nodes are aware of their network places and that the number of nodes and locations of CHs are optimally determined. These sensors are designed to be conscious of network positioning and routing choices made in a central location, such as the base station. Fewer networks are noted as centralized cluster methods and are mentioned below.

LEACH-C (Centralized Low Energy Adaptive Clustering Hierarchy):

Centralized LEACH differs in the setup phase but has a stable state that is similar to the basic LEACH strategy. The BS selects the leader nodes. Each node transmits its position and power levels to the ground station, which then utilizes this information to create better clusters that consume less communication energy [9][16] by using GPS or other tracking techniques. Only nodes with sufficient energy levels will be chosen by the base station to serve as cluster leaders, and this information will be broadcast to every node in the network.

This protocol has an advantage over basic LEACH in that it uses a reliable method for selecting some cluster leaders in each round that is defined at the moment of deployment. CHs are distributed more evenly over the network as a result of LEACH-C. Yet, LEACH-C demands that all nodes provide accurate, real-time GPS position data.

BCDCP (Base Station Controlled Dynamic Clustering Protocol):

Every CH serves approximately the same number of sensors when employing multi-level clustering. The sensed data is conveyed by the CM (cluster member) 2 CH (cluster head) in the suggested BCDCP, and a CH (cluster head) 2 CH (cluster head) multi-hop routing is carried out by the packet being transmitted to greater levels of CH, which are picked at random. Lastly, the sink (base station) will only directly communicate with one CH [10]. The BCDCP protocol beat LEACH and LEACH-C in the perspective of increasing the network's lifespan and enhancing energy conservation.

3. Comparative study of Clustering Algorithms

Clustering Algorithm	Cluster size	Advantages	Clustering Type	Connectivity	Nodes Capability	Nodes Deployment
LEACH	**Equal size**	**spread out the energy loss across sensors to increase their lifetime**	**Distributed**	**Single Hop**	**Homogeneous**	**Random**
LEACH-A	**Equal size**	**The connection of nodes will continue even if all conventional nodes fail.**	**Distributed**	**Single Hop**	**Heterogeneous**	**Random**
EEDCA	**Equal size**	**Improves lifetime and efficiency**	**Distributed**	**Multi-Hop**	**Homogeneous**	**Random**
EEHMC	**Unequal size**	**Up to 27.63% more network lifespan is added, and LEACH-C performs twice in addition to**	**Hybrid**	**Multi-Hop**	**Heterogeneous**	**Random**

		the first node failure.				
TL-LEACH	**Equal size**	**Increases the network lifetime**	**Hybrid**	**Multi-Hop**	**Homogeneous**	**Random**
HADCC	**Unequal size**	**prolongs the network's lifetime**	**Hybrid**	**Single Hop**	**Heterogeneous**	**Random**
LEACH-C	**Unequal size**	**improve system lifetime**	**Centralized**	**Multi-Hop**	**Homogeneous**	**Random**
BCDCP	**Unequal size**	**decreases total energy use and lengthens network lifetime**	**Centralized**	**Multi-Hop**	**Homogeneous**	**Random**

Table: 1 Comparison of Clustering-Based Algorithms

As the BS needs to know each node's position before making a choice, and since virtually all nodes in the centralized method are homogeneous, it is clear from the comparison table above that the majority of centralized methods rely on location and energy to choose the CHs in the network. On the other hand, the distributed algorithms choose the cluster head mostly based on the energy and the distance from the BS, along with other factors. In the hybrid technique, the majority of algorithms initially assigned the cluster head using a centralized way, then after formulating the side cluster, they rotated the cluster head among

those nodes in the side cluster using a distributed method, combining a few of the complexities in CH selection.

Future topics will include a study of the selection of cluster head characteristics and how they affect the selection process, as well as a comparison of the position of the BS in the sensing region's center vs outside of it, and a research of data aggregation processes.

Conclusion:

This study of clustering techniques is mostly concerned with how clustering techniques are used in the medical industry. Each clustering is appropriate for certain medicinal uses. The choice of data and techniques for clustering is a crucial issue in specific diagnoses that necessitates domain expertise. The effective utilization of energy in the network has been a major concern in wireless ad hoc networks for increasing their network's lifetime. The LEACH is also one of the current regimens with the lowest energy efficiency. The LEACH procedure has been addressed in this paper, along with its limitations and how these disadvantages are overcome by its successors. To differentiate the performance of the successors from classical LEACH, a quick review of the different LEACH protocol improvements, as well as a few other protocols, was conducted. According to the results of the study, there is a need to investigate more resilient, dependable, and effective methods in the future.

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