Literature Survey on Fuzzy C-means (FCM) used in Clustering Protocols

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Abstract:

Recently, Internet of Things is taking over the world and became the main source in the technology industry used in many appliances. IoT is based on wireless sensor nodes (WSN). WSN-based IoT network constraints the energy resources. Many protocols are used for saving the energy of nodes and increase the period of the network. For these nodes are organised in a cluster form. This reduces the transmission distance between the sensing element nodes and therefore the base station (BS). In the recent work, the clustering protocol are improved to increase the network lifetime of the WSN. Clustering protocols have many types and are used in different domains. Through this, we get to know which protocol is more useful and what is the role of the fuzzy c-means algorithm in clustering protocol and also in the wireless sensor nodes (WSN). Thus, the main aim of this literature paper is to enhance the clustering protocol by improving the FCM and find a way to improve it from the previous work.

Keywords: *clustering protocol, Wireless sensor network, energy consumption, Fuzzy c-means algorithm.*

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I. INTRODUCTION

Recently, Internet of Things (IoT) is taking over the world and gives all technological answers in numerous applications. The IoT is based with the aid of using a wi-fi sensor community (WSN) which decreases the value of the brand-new generation. A WSN consists of hundreds or more than that sensor nods spread over the large area and it comprises of many sinks that is also called as Base Stations (BS) which gathers information from the sensor nodes. From below diagram we will get brief review of WSN architecture [2].

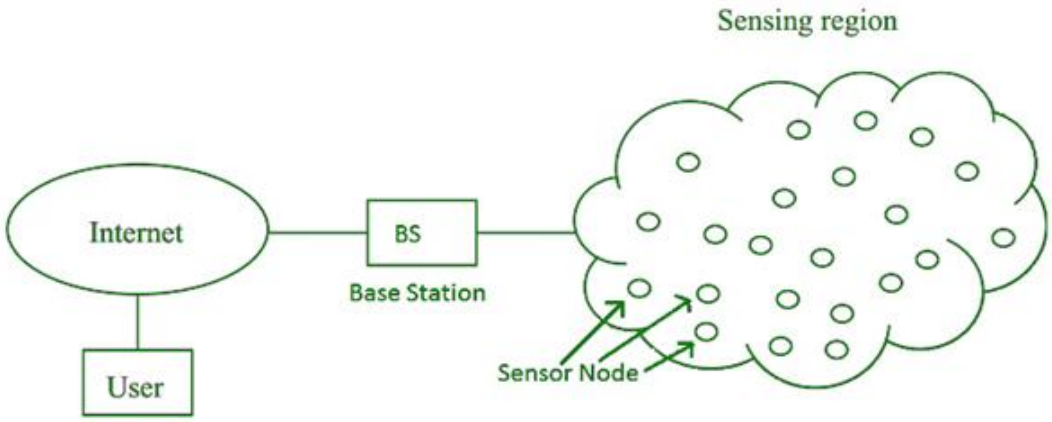

Figure 1. WSN environment

These sensor nodes have a low power supply, yet they feature data detection, data gathering, and wireless communication capabilities. The sensor nodes energy consumption determines the network's lifespan. Energy usage is a critical factor in extending the network's lifespan. A power source with low battery, micro-controller, transceiver, external memory, and some sensors are included in each sensor node in a network. The transceiver consumes the most energy, and each transceiver has four operating modes, transmit mode, receive mode, idle

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mode, and sleep mode. The same amount of power is used in idle mode as it is in receive mode [2]. Thus, to save energy, it is better to switch off the transceiver when there is no process is going i.e., it is neither transmitting nor receiving instead of leaving it in the idle mode.

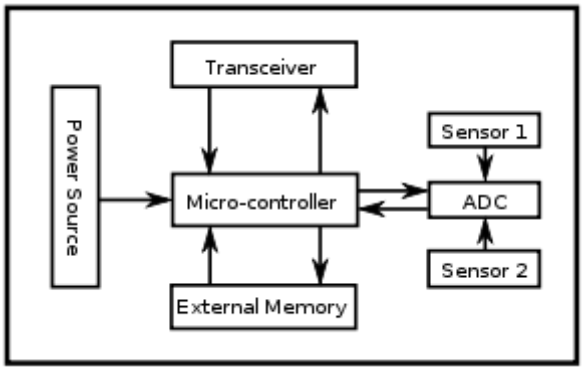

Figure 2. WSN components

This figure 2 shows the various components present in sensor node in WSN.

The clustering in WSN, from figure 3 we can see that there is sink i.e., base station where all the data is gathered together which was send through different clusters. Every cluster formed by many sensor nodes and each cluster has its own cluster head (CH) which collects data from all the nodes and send to the Base Station.

There are many methods have been introduced to deal with WSN constraints. Hierarchical routing i.e., clustering-based algorithm is one of the approaches which is introduced to minimize energy consumption in WSN.

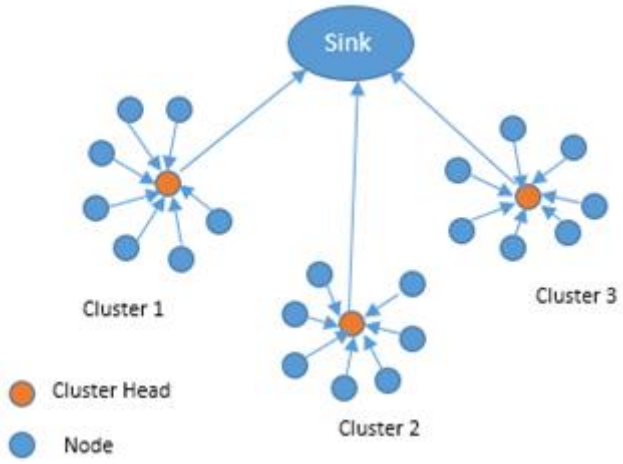

Figure 3, Clustering in WSN

Clustering, especially in WSN, is the process of grouping sensory nodes in a n/w into small disjoint clusters. Every cluster has its own cluster head (CH), remaining nodes in every cluster are termed as Member Nodes (MN). In most cases, cluster head is selected based on the highest residual or balance energy in the n/w. The sensory nodes collects environmental data and sends it to the cluster heads in their respective clusters. The cluster heads (CH) then gather data from all of the sensory nodes and do the next process like, aggregate it, and send it to the base station. Data collection by CHs decreases traffic near the base station by lowering energy consumed by them. This clustering-based algorithms are divided into two parts. Cluster formation occurs in the first step, followed by data transmission in the second.

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II. Applications of WSN

Various applications of wireless sensor networks are present in different fields:

A. **Military Applications:** WSNs has greatest use in military intelligence, frontline surveillance, communications, computing, facility, control, investigation and targeting systems.

B. **Area monitoring:** One of the most typical applications of WSN. Those zones where situation is observed, WSN is used in area monitoring. Several military examples use sensors to detect enemy intrusions, and the civilian example is geofence an oil or gas pipeline.

C. **Transport Applications**: Instantaneous traffic statistics is being composed by WSNs to later forage transportation models and keep the drivers inform all the doable congestion and traffic difficulties.

D. **Health-Care Monitoring:** There are two types of applications for medical care. Wearable medical devices are those that are placed on a human's body surface or in close contact to the user, while implantable medical devices are placed inside the human body. This may collect data on a person's fitness, health, and energy expenditure.

E. **Forest Fire Detection:** You can place a wireless sensor node in the forest to find out when a fire broke out. Sensor nodes measures the temperature and detects harmful gases produced by fire.

F. **Landslide Detection:** In landslide detection systems, wireless sensor networks are used to track changes in various parameters and subtle ground motions that may occur before or during a landslide. This gathered information may give us an idea of when the landslide occurred long before it actually occurred.

III. Clustering in WSN

There is different cluster-based algorithm are used in routing protocols [2].

Clustering is a most important technique. In wireless sensor networks, network longevity and scalability are important considerations. Clustering is the process of grouping sensor nodes into clusters and electing cluster heads (CHs) for all of the clusters in the network. To choose appropriate CHs, many routing techniques have been developed. The selection of proper cluster heads is a difficulty in WSN. The classification of cluster-based routing protocols in WSN is shown below in Figure 4.

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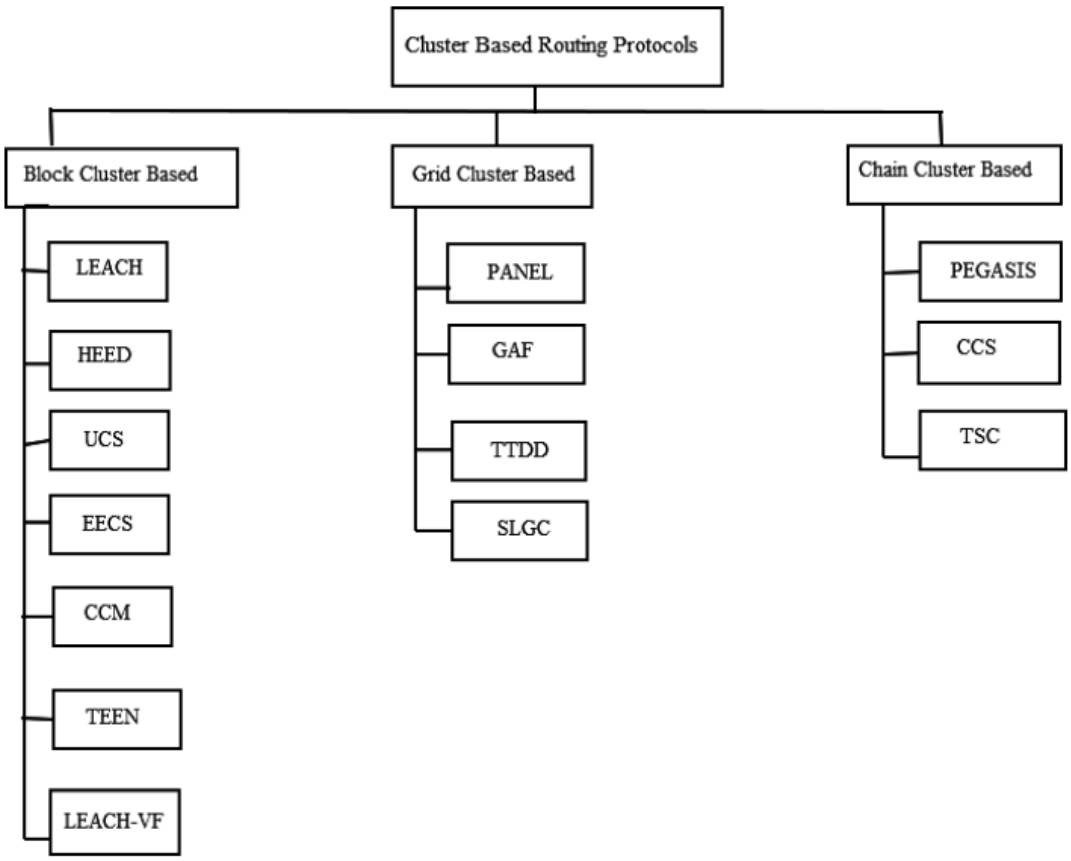

Figure 4. Clustering based routing protocols

Clustering-based routing techniques have accounted for nearly all of the research. But it has some drawbacks. To remove these drawbacks caused in clustering techniques, some issues in clustering that should be considered in future researches such as Degree of node and Cluster Head Rotation, Scalability, Redundancy Management, Reliability.

One of the main features is accuracy which means from sensor nodes we must gate accurate data. That's why FCM i.e., Fuzzy C-means algorithm improves the accuracy of clustering. Earlier FCM algorithm are mostly used in image processing but from last few years FCM is popularly used in Wireless sensor networks.

IV. Fuzzy c-means (FCM) algorithm

For diagnosing similar data in various clusters, the FCM clustering technique is the most commonly utilised approach. Clustering entails unsupervised division. Clustering data into groups that are similar in the preferred characteristics is a well-known FCM method; They are dependent on the first condition associated favour a best native purpose, quickly clump N kn owledge into a C cluster. The FCM algorithm is the foundation for many clustering approaches [1] [6-12].

The group objective function algorithms include clustering methods that require minimising some objective function. C-means algorithms are used when an algorithm can minimise an error function [16]. It is known to be FCM if the number of classes or clusters utilised is c, and the employed classes are using the fuzzy approach or simply fuzzy. The FCM method employs a fuzzy membership system that assigns each class a degree of membership. In fuzzy clustering, the importance of degree of membership is comparable to the pixel probability in a mixture. Assumption in modelling FCM has the advantage of forming new

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clusters from data points with similar membership values to current classes.

V. FCM algorithm in clustering protocols

A. LEACH Protocol

The most critical factor in WSN is energy efficiency. According to current research, grouping network nodes into clusters boosts energy efficiency and network longevity. Controlling the number and placement of cluster heads (CHs), as well as the size of clusters in relation to the number of nodes, results in a balance in CH energy use and an increase in network longevity. Clustering protocols are low-energy methods for improving the life of a wireless sensor network (WSN). Clustering reduces overall transmission power by combining multiple paths into a single path, allowing the network to last longer. For WSNs, a number of studies introduced the Fuzzy c-means clustering approach based on FL. In this architecture, the sensor nodes are organised in a series of clusters, with one node marked as CH. The election of the proper cluster heads (CH) in this method significantly reduces the network's energy consumption, resulting in an increase in the lifetime of network. In their study, the clustering approach based on FL incorporates three essential steps: energy, network lifetime, and node centre scheme. Sharma and Kumar (2012) employ a fuzzy-based master CH election leach (F-MCHEL)-based approach for clustering nodes to extend the network longevity, which is a key metric in sensor networks. Different aspects such as the balance between the size of the clusters and their energy are heavily considered in this clustering process. Another technique is EATM, which divides the network into clusters and uses facility location theory principles in a distributed way to minimise the energy dissipation of the event monitoring nodes by reducing their average transmission distance. Also, according to FL, Other researchers have developed a WSN communication protocol based on grouping network sensors depending on each node's remaining energy and distance from the BS. When compared to the LEACH algorithm, the quality loss of the network's services over time is acceptable since the sensor nodes in this protocol use more balanced energy [1]. The sensors on the network are supposed to produce data at the rates specified in the protocol. Data will be available for the sensor nodes to send to the BS. It is attempting to reduce energy consumption in the specified protocol. The FL was utilised by researchers to develop a WSN protocol that is both efficient and scalable, clustering is used to reduce data transmission overflow and, as a result, energy consumption and clustering interference among nodes [1][26]. The clustering is useful option for clustering nodes near each other to leverage related data and eliminate single-step pathways in many applications. A combination of nodes in the CH has increased the data volume delivered to the station, while the energy use of resources has lowered. They proposed a new protocol for reducing energy consumption in WSNs based on a hybrid of the LEACH Protocol and FCM algorithm, this serves as the foundation for the hybrid protocol of clustering sensors depending on each node's remaining energy and the

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distance between nodes and the BS. Compared to the LEACH, the sensor nodes in the hybrid protocol consume more balanced energy, which improvs the network lifetime. The findings of this study reveal that the hybrid protocol is more energy efficient and increases the network's lifetime [1].

B. EECH Protocol

This is energy-efficient clustering protocol. In the research, an improved energy-efficient clustering protocol (IEECP) is used to extend or improve the lifetime of WSN in IoT sensor networks by addressing clustering structural issues that degrade protocol performance. By optimising the clustering structure, the suggested technique minimises and balances the nodes energy consumption. As a result, the IEECP is suggested for networks that need to last longer. Overall, the IEECP outperforms the previous protocols. The suggested protocol gives important contribution to the field by improving daily operations in a variety of fields that use wireless sensor network in the IoT. In the case of overlapping clusters, the consumption of energy in the network is examined to determine the appropriate number of clusters according to the distance to the CH [4]. The modified FCM algorithm (M-FCM) is proposed to develop forming static and balanced clusters by merging it with a centralised mechanism [17-20][23]. Finally, by combining the back-off timing mechanism for CH selection with the rotation mechanism for CH rotation, a new CH selection-rotation algorithm (CHSRA) is proposed. To balance the clusters' energy use among CHs, the CHSRA used a novel goal function to choose CHs in ideal locations. To balance the energy consumption of the cluster's subsequent CHs, it relied on a novel dynamic threshold for CH rotation within cluster members [4].

VI. Conclusion

In this paper we have seen the importance of wireless sensor networks and its applications used in various fields. Also seen the different routing protocol used in clustering. The clustering protocol where FCM algorithm is used and the algorithms proposed in it. From the review, it is seen so far that using FCM algorithm can improve the lifetime of sensor nodes. It is also useful in terms of energy efficiency. These results will be helpful in the various fields. This will improve day-to-day operations in many spheres of life and will give good performance, which uses WSN in the IoT world.

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