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Comparison of Clustering Algorithms to Design New Clustering Approach

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Abstract

Wireless Sensor Network (WSN) is a multi-hop sensor network system in which sensor nodes are deployed in monitoring area to sense some environmental parameters. WSN is used to bridge the gap between physical world of humans and virtual world of electronics. WSNs have number of applications in daily life such as remote monitoring of environment, habitat, agriculture, health care, automobiles, and disaster prone zones. WSNs have characteristics such as limited resources, multi-hop routing and dynamic network topology. Clustering is introduced in WSN because it has proven to be an effective approach to provide better data aggregation and scalability for large WSNs. Clustering also conserves the limited energy resources of the sensors. This paper does comparative study of existing clustering algorithms in WSNs based on centralized, distributed or hybrid method and highlights the challenges in clustering. In addition we proposed a new clustering system which uses at most two-hop for intra-cluster communication. Reduction in number of clusters and CHs prolongs network lifetime.

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Keywords:Wireless Sensor Networks, Clustering, Energy Efficiency, Network Lifetime.

1. Introduction

In wireless sensor network (WSN) the sensor nodes are often grouped into individual disjoint sets called a cluster. Each cluster comprises of Cluster Head (CH) and its members [1]. CHs are nodes that consume more energy than cluster members when they involve in aggregating, processing and routing data. CHs collect data from the sensors. Clustering is especially important for sensor network applications where a large number of ad-hoc sensors are deployed for sensing purpose. In the network if each and every sensor node starts to communicate then all sensors will be engaged in data transmission hence network will enter into enormous congestion and data collisions. This

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situation will lead to drain limited energy from the network. Clustering of node will address these issues. Scalability feature of the Wireless Sensor Networks (WSN) is used to meet load balancing and efficient resource utilization constraints. Use of clustering in a hierarchical WSN facilitates efficient utilization of limited energy of sensor nodes and hence extends network lifetime. Although sensor nodes in clusters transmit messages over a short distance (within clusters), more energy is drained from CHs due to message transmission over long distances (CHs to the base Station) compared to other sensor nodes in the cluster. Periodic re-election of CHs within clusters based on their residual energy is carried out to balance the power consumption of each cluster. In addition, clustering increases the efficiency of data transmission by reducing number of sensors that are attempting to transmit data in the WSN, aggregating data at CHs via intra-cluster communication and reducing total data packet loses.

1.1. Components of a clustering in WSN

The following are the components of a clustered WSN [5] as shown in figure 1:
Sensor node: A sensor node is the main component of a WSN. Sensor nodes perform functions such as sensing; data storage; routing; and data processing.
Clusters: Clusters are the hierarchical units for WSNs. Large sensor networks need to be broken down into clusters to simplify tasks such as communication between the base station and the cluster heads.
Cluster heads: Cluster heads (CHs) are the leader of a cluster. CHs are often required to organize activities in the cluster. These tasks include data aggregation, organizing and relaying the communication schedule of a cluster.
Base Station: The base station (BS) provides the communication link between the sensor network and the end-user. It is normally the sink in a WSN.

In this paper we present some existing clustering algorithms for WSNs. We also compare these algorithms based on metrics such as residual energy, uniformity of CH distribution, cluster size, number of hops and cluster formation methodology. The rest of the paper is divided as follows:
Section II presents the challenges for clustering algorithms and the working process of clustering. In Section III, we present the comparison, advantages and limitations of some clustering algorithms. Section IV concludes the paper.

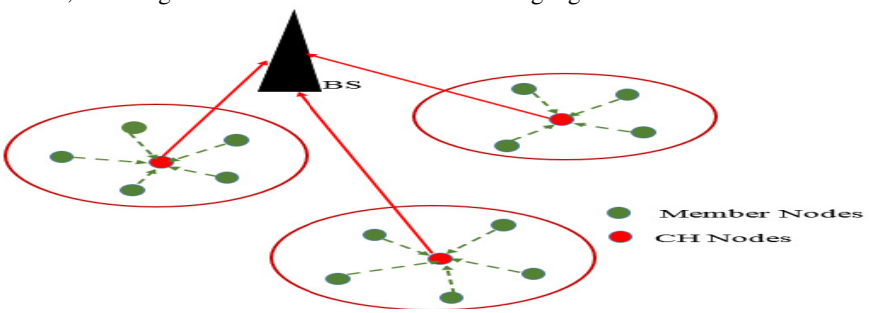

Fig. 1.Clustering in wireless sensor network

2.Related work

2.1. Challenges for Clustering Algorithms

Clustering schemes play an important role in WSN;these can effectively improve the network performance. Following are key limitations of clustering algorithms [7]:
• Limited Energy: Wireless sensor nodes are small size battery operated sensors, so they have limited energy storage. It is not practicable to recharge or replace their batteries after exhaustion. The clustering algorithms are more energy efficient compared to the direct routing algorithms. This can be achieved by balancing the energy consumption in sensor nodes by optimizing the cluster formation, periodically re-electing CHs based on their residual energy, and efficient intra-cluster and inter-cluster communications.
• Network Lifetime*:* The energy limitation on nodes results in a limited network lifetime for nodes in a network. Clustering schemes help to prolong the network lifetime of WSNs by reducing the energy usage in the communication within and outside clusters