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CLUSTERING IN WIRELESS SENSOR NETWORK

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Abstract

Wireless sensor network consists of many tiny sensor nodes. Energy, bandwidth, processing power and memory nodes are limited. Hence reducing power consumption, increasing the network lifetime and scalability are the main challenges in sensor networks. Cluster based routing protocols are the most useful schemes for extending Wireless Sensor Networks lifetime through dividing the nodes into several clusters and electing of a local cluster head for aggregating of data from cluster nodes and transmitting a packet to Base Station. However, there are several energy efficient cluster-based methods in the literature. In this paper, we will review clustering in wireless sensor networks and LEACH algorithm.

Keywords: wireless sensor network; clustering; lifetime; LEACH.

1. Introduction

Wireless sensor networks are a new generation of real-time embedded systems with limited computational and power and memory. Due to advances in electronics industry, use of inexpensive low power consumption wireless sensor networks increasingly take into consideration. This network consists of large number of small, low-cost communication devices and supplied by batteries that are called, sensor nodes. These nodes are distributed to control a physical space or inaccessible, with the aim of collecting data in the environment and sent to Base Station for further processing. The main task of these nodes is to gather data from the environment in which they are placed [1]. Nowadays, many applications have been proposed for sensor networks and their numbers are increasing day by day. These applications can be used in military field, maritime boundaries defence monitoring, identification of contaminated environments, environmental monitoring, investigating and analysing the status of the construction of buildings, intelligent roads and highways and various applications in the field of pointed [2], [3], [4]. Direct transfer of data from data sources to the central node, costly or impossible. Because the central sensor is usually located away from the sensor nodes that have limited energy supply. A wireless sensor network is composed of a large number of sensor nodes and a base station. The nodes in a wireless sensor network are usually deployed randomly inside the region of interest. The base station is engaged to give commands to all the sensor nodes and gather information from the sensor nodes. Typically, a sensor node is a tiny device that includes three basic components: a sensing subsystem for data acquisition from the physical surrounding environment, a processing subsystem for local data processing and storage, and a wireless communication subsystem for data transmission [5], [6], [7], [8]. Wireless sensor nodes have many limitations, including modest processing power, little storage, and limited power source. The base station is usually much more powerful than sensor nodes and has power supplied. On the other hand, the base

station needs to collect the sensed information from the sensor nodes and send it back to the user. Because wireless sensor nodes are low power, the constraint on the power consumption is an important issue when designing wireless sensor network protocols. Sensors in such environments are energy constrained and their batteries cannot be recharged. Therefore, designing energy-aware algorithms becomes an important factor for extending the lifetime of sensors. Communication protocols for wireless sensor networks play an essential role in the rising of efficiency and network lifetime. Therefore, the design of efficient protocols for wireless sensor networks energy Consumption is a necessity. In The protocols presented, Clustering protocols to save significantly on their energy consumption network. In these protocols, the entire network is partitioned into several clusters and each cluster selects one node as cluster head. The duty cluster heads collect information transmitted from the cluster nodes, remove duplicate data, the combination of data and send this data to the sink. If the load increases, or any other reason, this node fails the new cluster heads should be selected. The cluster heads play an important role so the cluster heads should be selected in the best way possible. The wrong selecting of cluster heads decreases network lifetime [9], [10].

2. CATEGORIZATION OF CLUSTERING ALGORITHM

Before Categorization of clustering algorithms in wireless sensor networks, it is advisable that are being introduced some important parameters in all clustering procedures. These parameters are used as basic tools for comparing and classifying clustering protocols.

A. Number of Clusters: Most of clustering algorithms, probabilistic selection of cluster heads and cluster formation process, naturally, would lead to the creation of different clusters. However, some published articles, pre-defined set of cluster heads and the number of clusters is predetermined. Usually, the issues related to the performance of routing protocols, the number of clusters is a critical parameter.

B. Intra cluster communication: Some Primary approaches to clustering, communication between sensors and cluster heads is directly; While Nowadays most cases, the communication within the cluster multi-hop is required. Such as in cases where the sensor nodes communication range is limited and numbers of sensor nodes is very high or numbers of cluster heads is low.

C. Mobile nodes and cluster heads: If we assume that the nodes and cluster heads are stationary and Immobile, Naturally we face with a balanced and stable clusters that intra-cluster and inter-cluster network management is easy. In contrast, if we consider the nodes and cluster heads are mobile, Membership in the cluster dynamically changes for each node and Clusters were forced to recruit at any moment, and probably in this case, it will require Permanent maintenance.

D. Types of nodes and their role: In some network models proposed such heterogeneous environments, it is assumed that the cluster heads, with respect to other nodes, are equipped with more computing and communications resources. However, in many typical network models, all nodes have the same capabilities, only a subset of the nodes as cluster heads are elected.

E. The method of cluster formation: In many approaches, the cluster heads are just ordinary sensor nodes and time efficiency are considered one of the main design criteria, Distributed clustering procedure is performed without coordination. However, some basic approaches is followed a centralized approach; This means that one or more nodes are used to the coordinator partition the network into disjoint clusters and control the membership,

F. Selecting cluster heads: Some proposed algorithms, especially for heterogeneous environments, cluster heads nodes can be pre-determined. While in many cases such as in homogeneous environments, cluster heads are selected from a set of scattered nodes, Probabilistic methods or other methods of random or based on specific criteria such as residual energy and connectivity.

G. Algorithm Complexity: Many recent algorithms protocols fast end is one of the main goals of the design. So today, most of the proposed procedures, time complexity either the convergence rate is constant and depends on the number of cluster heads or the number of steps. While some basic protocols, time complexity depends on the number of sensors in the network and on the other hand, the protocols, were focused on other criteria as the main priorities.

H. Multi-level: Some approaches have been published to be seen the concept of multi-level cluster hierarchy and against the single-level clustering. The purpose of this approach, better distribution and consumption of energy. Use of multi-level clustering has been more attention, particularly when faced with a large network, because the Inter-cluster communication efficiency between cluster heads in the network is very important.

I. Overlapping: Some protocols particular attention to the overlap between nodes in different clusters, in order to improve routing protocols performance or to run faster forming clusters or for other reasons. Still the most well-known protocols, try to minimize overlapping.

There are many ways to distinguish and classify clustering algorithms for wireless sensor networks. Tow initial categorization and common references are as follows:

- Clustering algorithms in homogeneous networks and Clustering algorithms in heterogeneous networks.
- Clustering algorithms are centralized and distributed clustering algorithms.

The first category is based on the characteristics and performance of sensor nodes in a cluster, Whereas Other Implies to The method used to form clusters. In heterogeneous sensor networks, in general, there are two types of sensor, type I sensors with high processing capabilities and complex hardware; Generally have been used inside wireless sensor networks to create a backbone. These sensors have already been selected as cluster heads nodes and tasks are as a collector of data and as received data from other sensor nodes processing centres. The second types are common nodes with less capabilities that used for sensing the desired properties of the environment. But homogeneous sensor networks, all the nodes have the same hardware specification and same processing capabilities; such as nodes distributed in war environments. In this network, that are common in today's applications, each nodes can be cluster heads. In addition, in this network, the cluster head periodically can be exchange between the nodes.
When the nodes have the same capabilities, Cluster formation process and choose distributed cluster heads, is the most accurate technique for greater gain, flexibility and faster run times or convergence independent of the number of nodes. In contrast, the few approach are used focused or combination techniques in which one or more coordinator or the base station is responsible for separation network disconnected and control membership in the clusters. However, these networks are not suited for all purpose and large scale network practical applications of wireless sensor networks; only are used for a special purpose small networks is required high quality and resolution of network connectivity.
Other conventional classification, clustering is static or dynamic. A dynamic Cluster formation process is include regular periodic reelection of cluster heads or cluster reorganization procedures. This procedure is possible in order to react efficiently to changes in the network topology or with the purpose of proper circulation of cluster heads among the nodes As a result, designing for to obtain energy efficiency. Dynamic cluster architectures, Causes better use of the sensors and naturally lead to improvements in energy management and network lifetime.
More known clustering algorithms can be divided into two main categories; Classification is done based on Criteria for cluster formation and the parameters used to select the cluster heads. And in this way, clustering algorithms are either probabilistic or non-probabilistic.
In probabilistic clustering algorithm to determine initial cluster head, a probability is assigned to each node. However, other procedures may be, are planned for Random selection But what is certain is that
The initial probabilities assigned to the nodes, as is often the main criteria in determining the selection of cluster heads the help of a flexible, integrated, fast, and completely distributed method. However, the There may be other secondary criteria. In the selection process as residual energy cluster heads or during the process of cluster formation, such as proximity or connection cost. All in order to achieve better energy consumption and network lifetime. In other clustering algorithms non-probabilistic, in principle, more particularly decisive criteria for the selection of cluster heads and cluster formation are considered.
These criteria are based on the proximity or adjacent nodes like connectivity and the degree and received information from the closer nodes. In this case, the cluster formation process based on the nodes communicate with their neighbours and generally requires intensive exchange of messages and in some cases the graph traversal. So in some cases lead to worse time complexity than the probabilistic clustering algorithms. However, typically, these algorithms when facing unexpected situations and also about balancing clusters, are more reliable. In addition, some non-probabilistic algorithms, the combined measure metrics such as residual energy, power transmission and mobile standards (forming clusters based on the combined weights), in order to achieve broader goals than a single criteria they use protocols.

3. Leach algorithm

LEACH is one of the most popular clustering algorithms for WSNs [20]. It forms clusters based on the received signal strength and uses the CH nodes as routers to the base-station. Operation of LEACH is divided into rounds and each round separated into two phases, the set-up phase and the steady-state phase. In the set-up phase, each node decides whether or not to become a cluster head for the current round. This decision is based on the threshold Pi(t) given by:

$$p_i = \begin{cases} 0 & , C_i(t) = 0 \\ \dfrac{k}{n - k * (r \bmod \frac{n}{k})} & , C_i(t) = 1 \end{cases} \quad (1)$$

Where k is the number of cluster heads, N is the number of nodes in the network, r is the current number of rounds, Ci(t) = 0 if node i has already been a cluster head and 1 otherwise. In LEACH, every node I generates a uniform random number in the interval [0,1] at the beginning of each round, if this number is less than the threshold Pi(t), then this node elects itself to be a cluster head.
The cluster head creates a Time Division Multiple Access (TDMA) scheme and assigns each node a time slot. In the steady-state phase, the cluster heads collect data from sensor nodes, aggregate the data and send it to the base station. If a node with little residual energy is chosen, it will run out of energy quickly and this is not good for the network lifetime. Therefore, the level of the residual energy of the nodes should be considered, making nodes with higher residual energy level have the bigger probability to elect itself to be cluster head, so that it can ensure the equilibrium level of overall network energy consumption and prolong network lifetime. Since the decision to change the CH is probabilistic, there is a good chance that a node with very low energy gets selected as a CH. When this node dies, the whole cell becomes dysfunctional.

4. Conclusion

The LEACH algorithm uses the random rotation of cluster heads, without Regardless Residual energy of nodes. So it may node with less energy be the head cluster. In this paper we review the parameters of clustering. Therefore we will propose an algorithm according to these parameters that uses the energy of nodes on the probability of cluster heads, without extra overhead on the network. We've taken an approach to be able to guess the correct energy consumption of nodes to increase the network lifetime.

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