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A Survey on Different Types of Clustering Based Routing Protocols in Wireless Sensor Networks

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Abstract

In most of today's application the wireless sensor network (WSN) play an important role.WSN is an autonomous system to monitor physical and environmental conditions. It can sense and compute the information or data or message that transmitted through it. Important design issue of the Wireless sensor networks energy consumption and lifetime of the network. The design of different routing protocol is another important design issue in WSN. There are mainly broad types of routing protocols in wireless sensor networks. This paper mainly deals with different types of cluster based routing protocols in WSN. Clustering algorithms are mainly defined to reduce the energy consumption and improves the life time of the network.
Keywords: Clusters, Cluster Head, Energy Efficiency, Routing Algorithms, Sensor nodes, Wireless sensor networks

I. INTRODUCTION

Wireless sensor networks (WSN) is a self-configured and infrastructure-less wireless networks. It is also called wireless sensor and actuator networks (WSAN) [1][18], to monitor physical or environmental conditions, such as temperature, sound, pressure, etc [2]. WSNs are special networks that sense and compute the data or information that is transmitted between the networks. [20] The major design issues [3] of the WSN are energy consumption and life time of the network. Design of routing protocols is also an important challenge in wireless sensor networks.

The specific choice of routes is provided by the routing algorithm [4] [19]. Essentially routing protocols determines how the different routers between the source and sink in a network are communicated [5] [21]. The design of a routing protocol must ensures the energy and resource limitation , large life time, less packet loss, and delay, dynamic adaptability of networks.

Clustering is one of the best methods used in wireless sensor networks to achieve better energy efficiency and longer life time. Based on clustering algorithm the network is divided into different clusters. In each cluster there is special or a root node called cluster head and the remaining nodes are the members of the cluster. The clustering protocol performs mainly two types of operations:

Intra-cluster communication – Communication between different clusters

Inter-cluster communication – Communication within a cluster

The Following Section Briefly Discuss About [22][23]Different Types Of Cluster Based Routing Protocols Such As LEACH, EEHC, HEED, TEEN, APTEEN, EEICCP And Also Merits And Demerits Of Them Clearly.

II. LITERATURE REVIEW

A. Leach – Low Energy Adaptive Clustering Hierarchy:

The first and significant hierarchical routing protocol which provide the data fusion is the LEACH protocol [7]. It is a round based protocol and is self adaptive and self organized. Each is organized as two phases: Setup phase and Steady state phase. The setup phase is smaller than the steady state phase [8] [9]. The setup stage is important than steady state phase, because in which the sensor nodes itself randomly elect as the cluster heads and form the network ass different clusters then these cluster head schedule a TDMA schedule for its cluster member nodes.

Advantages:

The various advantages of LEACH protocol are [8][9]:

- Improves the lifetime
- Balance the energy consumption
- Reduce the traffic in the network
- Does not require a co-ordinator or central node
- Location information of nodes to create the cluster is do not require
- It does not require any global knowledge of the network and is completely distributed

- It successfully distributes the energy load to all the sensor nodes

Disadvantages:

The main drawbacks of the LEACH are [10]:

- Does not know the number of cluster heads in the entire network
- The cluster become headless or useless if the cluster head is die due to any reason
- Uneven distribution of clusters

B. EEHC – Energy Efficient Hierarchical Clustering Algorithm for Wireless Sensor Networks:

EEHC is a fast distributed randomized clustering algorithm [11], for dividing a network into different hierarchical clusters to achieve better energy efficiency. In this the cluster head is known as a volunteer cluster heads.

Here in which there are 'h' hierarchical levels with level1 is the lowest level and level 'h' is the highest level. In the clusters the sensors communicate its gathered data to level1 cluster heads (CH's) and level1 CH's communicate it level2 CH's and so on. At last level h aggregate the overall data from all its lower levels and transmit it to the processing centre.

Advantages:

- Minimize the energy
- Algorithm is suitable for networks of large n of number nodes

Disadvantage:

- Only consider the contention free and error free environment

C. Heed – Hybrid Energy Efficient Distributed Clustering Protocol:

HEED is a hybrid approach it is developed as a distributed, energy efficient clustering approach for ad-hoc networks [12]. An important feature of HEED protocol is it exploits the availability of multiple transmission power levels at sensor nodes.

The HEED terminates in a constant number of iterations that is independent of networks diameter. It only assumes the sensor nodes can control there transmission power level and not consider the distribution of nodes or about node capabilities.

Advantages:

- Prolongs network life time
- Clusters that exhibit several appealing characteristics
- Scalable data aggregation
- Fault tolerance
- Load balancing

Disadvantage:

- Support only two level hierarchy

D. TEEN – Threshold Sensitive Energy Efficient Sensor Network Protocol:

TEEN is a first protocol developed for re-active networks. It is a data centric method. In which [13] at every cluster change, the cluster head broadcast to its members in addition to the attributes are, Hard threshold (HT) Soft threshold (ST). Each time node [14], sense there environment continuously. By this the sensed values are stored in an internal variable in a node called sensed value (sv). Then the node sends the data only when one of the following conditions is satisfied:

1) The current value of the sensed attribute is larger than HT.
2) The current value of the sensed attribute differs from sv by an amount equal to greater than the ST.

Advantages:

- Eminently suited for time critical data sensing applications
- Less energy consumption
- Time critical data reaches the user almost instantaneously
- Depending on the criticality of the sensed attribute and the target application the soft threshold can be varied
- Smaller value of the soft threshold gives a good picture of network

Disadvantage:

- The nodes will not communicate if the threshold are not reached

E. APTEEN – Adaptive Periodic Threshold Sensitive Energy Efficient Sensor Network Protocol:

APTEEN is the improved version of TEEN protocol [] developed to hybrid networks. It can enable both reactive and proactive networks. The main purpose of extending TEEN to APTEEN is network to handle different types of queries and analyze the delays that occur during process them [15].

APTEEN mainly supports 3 types of queries depends on the type of data [15]. They are,

Historic query: To analyze past data value

One time query: To view the whole network

Persistent query: To monitor an event for a period of time [1]

It uses an enhanced TDMA schedule to efficiently incorporate query handling with a querying mechanism for heavy loads. It has an additional flexibility feature that can query the network through any node in the network.

Advantages:

- Improves the life time of the network
- Guarantees energy efficiency and large number of sensor alive

F. Eeiccp – Energy Efficient Inter- Cluster Coordination Protocol:

EEICCP is a clustering routing protocol [main] use the multi hop approach for the cluster heads and evenly distribute distributes the energy or power load between the sensor nodes in the network. It uses homogeneous type of nodes.

The protocol [16] mainly depends on the idea that the cluster head can may send data directly to the base station that means single hop or it can send by multi hop. But in single hop, it takes lots of energy. It mainly deals with multi hop. The protocol mainly [17] consist two phases:

1) Election phase
2) Transmission phase

Election phase is the start phase in which the clusters are formed by different layers and each cluster have a different cluster heads and there is only one cluster coordinator (CCO) for each lower cluster. In which the number of clusters is fixed. Thus each CH's elected the cluster coordinator and cluster ids are assigned to cluster heads and cluster coordinator. This id is transmitted as an advertisement message between the nodes.

In the transmission the data or information's are collected by each cluster head from the corresponding cluster. Then, in next iteration these data are passed to the base station through the cluster coordinator and the coordinators id's is used to set the path of the transmission.

Advantages:

- The main merits of EEICCP are [16]:
- High energy efficiency
- Distribute energy loads among sensor nodes

Disadvantages:

- Medium cluster stability
- Limited scalability
- If the number of nodes is increased, it will increase the size of cluster, it will also increase the power consumption of CCO.

III. CONCLUSION

Another important research of wireless sensor network is design of routing algorithms. This survey provide a comparative study of different types of cluster based routing protocols in wireless sensor networks such as LEACH, HEED, TEEN, APTEEN, EEHC, EEICCP. All of them same goal such that trying to extend the lifetime of network in an energy efficient way without affecting the data or message delivery. Also it will discuss the important merits and demerits of each protocol separating.

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