A STUDY OF VARIOUS CLUSTERING PROTOCOLS

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ABSTRACT

Network lifetime is crucial in Wireless Sensor Network systems since recharging or exchanging the sensors is difficult and expensive. Clustering techniques provide an interface for WSN topology management to extend network lifetime. Existing clustering algorithms, such as LEACH and HEED, can significantly reduce the power consumption on each sensor and thus prolong the network lifetime. In this paper, a survey on various clustering protocols has been done. From the survey, it has been found that most of the existing work fails to consider the coverage of the network when evaluating the lifetime of a network. Therefore the paper ends with the future scope to overcome these issues.

KEYWORDS: - WSN, CLUSTERING

1. INTRODUCTION

Wireless Sensor Network is a network of independent sensors to guide Physical or environmental conditions like pressure, temperature and sound to send the data to the destination. Wireless sensor network is made up of many nodes with sensors and each sensor node has many parts like:-

A radio transceiver, a micro-controller, a battery and an embedded form of power harvesting. A cluster is a group of sensor nodes where each cluster includes a leader named as cluster head and works the duty of mix and aggregation. The cluster head collects the information from most of the similar and lower nodes and deliver it to the base station. It is a two layered architecture in which the selected cluster heads forms the upper layer and the other sensor nodes forms the lower nodes.

The wireless sensor network is of two types:-

1. Proactive network- the nodes in this network continuously interact with the base station.

2. Reactive network- the nodes in this network communicate only when some particular event happens.

2. VARIOUS ROUTING PROTOCOLS

Hybrid Routing Protocols

Since proactive and reactive methods each function most readily useful in oppositely different situations, hybrid process uses both. It's used to find a balance between equally protocols. Practical operations are restricted to small domain, whereas, reactive methods are useful for locating nodes external these domains.

Examples of hybrid protocols are:

a) Zone Routing Protocol, (ZRP)

b) Wireless Ad hoc Routing Protocol, (WARP)

Hierarchical Routing Protocols

As the size of the wireless network increases, the flat routing protocols may produce too much overhead for the MANET. In this case a hierarchical solution may be preferable [8].

a) Hierarchical State Routing (HSR)

b) Zone Routing Protocol (ZRP)

c) Cluster-head Gateway Switch Routing Protocol (CGSR)

Geographical Routing Protocols

There are two approaches to geographic mobile ad hoc networks:

1. Actual geographic coordinates (as obtained through GPS – the Global Positioning System).

2. Reference points in some fixed coordinate system.

An advantage of geographic routing protocols [8] is that they prevent network-wide searches for destinations. If the recent geographical coordinates are known then control and data packets can be sent in the general direction of the destination. That cut
downs get a grip on expense in the network. A problem is that most nodes should have entry for their geographical coordinates all the time to really make the geographical routing protocols useful. The routing updates must certainly be performed quicker in evaluate of the network mobility rate to consider the location-based routing effective.

3. APPLICATIONS

There are various fields where wireless sensor network plays important role:

i) **Area monitoring**: In area monitoring, the wireless sensor network is deployed over an area to monitor the various changes that is happening inside. As an example, in military it is use for detecting the enemy intrusion.

ii) **Forest Fire Detection**: Sensor nodes are installed in a forest, these nodes can measure temperature, pressure, humidity and gases produced by the fire when it burns.

iii) **Landslide Detection**: With the help of Wireless sensor network, landslide can be detected very earlier. Small movements of the soil and the changes in the parameters can be detected.

iv) **Natural Disaster Prevention**: Sensor nodes are deployed in rivers by which the changes in the water level can be detected.

4. CLUSTER HEADS

Clustering is a method of grouping the nodes into groups. Hence, it is a group of patterns having similar nodes. Clustering algorithms has also developed not only for grouping but also for compressing the data sets and to construct the models. Cluster heads are opted for keeping in mind some parameters like the exact distance of the node from the base station, the rest of the energy, and power consumed as such like dependant on the algorithm used. Cluster heads are so shaped that it gathers the data from the sensor nodes in its cluster head and move the data to the base station. The base station changes the cluster head from time to time in order to conserve the energy.

5. LITERATURE SURVEY

An, Jinget al. [1] proposed an improved weight based clustering algorithm (iWCA), the goals of the algorithm are to maintain the stable clustering structure, minimizing the overhead for the clustering set up, maximizing lifetime of nodes in the system, and achieving good performance. The simulation results demonstrate the superior performance of the proposed algorithm. Lung, Chung-Horng, and Chenjuan Zhou [2] adapted the well-understood hierarchical agglomerative clustering (HAC) algorithm by proposing a distributed HAC (DHAC) algorithm. DHAC provides a bottom-up clustering approach by grouping similar nodes together before the cluster head (CH) is selected. DHAC can accommodate both quantitative and qualitative information types. With automatic CH rotation and rescheduling, DHAC avoids reclustering and achieves uniform energy dissipation through the whole network lifetime. Simulation results in the NS2 platform demonstrate the longer network lifetime of the DHAC than the better-known clustering protocols, LEACH and LEACH-C. Kulkarni, Raghavendra V., and Ganesh Kumar Venayagamoorthy [3] explored an evolutionary algorithm to optimize the energy consumption, which is particle swarm optimization to find the optimal clusters based on residual energy and transmission distance. The simulation results demonstrated that their protocol considerably increases the network’s lifespan, compared with existing clustering protocols. Mamuny, M. A. et al. [4] aimed to build an energy-efficient multi-level clustering hierarchy for heterogeneous wireless sensor networks. Conventional clustering protocols assume that all the sensor nodes are equipped with the same amount of energy and as a result, they cannot take the full advantage of the presence of node heterogeneity. Moreover, other existing clustering algorithms in both heterogeneous and homogeneous environments form one hop intra and inter cluster topology where each cluster head node can transmit directly to processing center. Consequently, it is not applicable to networks deployed in large regions. Adapting these approaches, they proposed HEHC, a heterogeneous-aware enhanced hierarchical clustered scheme for wireless sensor networks based on weighted election probabilities of each node to become a cluster head according to the residual energy in each node, and then extend this algorithm to generate a multi-level hierarchical control of cluster head selection method based on Facility Location Problem (FLP) to gain better energy utilization. Finally, the simulation results demonstrate that their enhanced hierarchical clustering approach is more effective in prolonging the network life time. Lin, Zhenmin, and Jerzy W. Jaromczyk [5] developed privacy preserving spectral clustering protocols over vertically partitioned data sets. Such protocols allow various parties to analyze their data jointly while protecting their privacy. Neamatollahi, Peyman et al. [6] presented a Hybrid Clustering Approach (HCA).
Whenever a cluster head consumes a prespecified part of its energy, it indirectly informs all other nodes so, clustering will be done in the beginning of the upcoming round. Therefore, clustering is performed on demand. To evaluate the efficiency of proposal, the well known distributed clustering protocol, HEED, is used as baseline example. By means of simulation results, they demonstrated that significant energy saving can be achieved using HCA. Khan, Fazlullah et al. [7] proposed energy efficient Dual Head Clustering Scheme (DHCS) for WSNs. DHCS selects two different nodes within the cluster for cluster management and aggregation namely Cluster Head (CH) and Aggregator Head (AH) respectively. Simulation results show that the DHCS outperforms conventional clustering protocols in terms of energy conservation, network life time and network latency.

Li, Qian et al. [8] evaluated and compared four state-of-the-art clustering protocols, i.e., LEACH, GENLEACH, HEED and PANEL, with full state space exploration. Within analytical framework that consists of a network configuration and an energy consumption model, they aimed at analyzing the correctness and performance of the investigated protocols. The analysis is conducted formally through probabilistic model checking using PRISM and has its focus on the quantitative aspects of the protocols. Tripathy, Asis Kumar, and Suchismita Chinar [9] proposed a staggered clustering protocol to prolong the stable region of wireless sensor networks is being proposed. Compared with classical clustering protocols, this protocol can maintain efficient load balancing of networks, and extremely prolong the network lifetime. Bhowmik, Shimul et al. [10] proposed Mean neighbor clustering algorithm that evenly distributes the nodes around the clusters and form well balanced clusters in the system. The proposed Mean neighbor clustering protocol uses the local neighborhood information to form balanced clusters in sensor networks. The proposed method is also compared with various existing clustering protocols in sensor networks. Comparison is done based on parameters like cluster number, average cluster, cluster range, circularity and hop distance. Simulations show that their proposed algorithm performs better than other neighborhood aware clustering techniques. Alnuaimi, Mariam et al. [11] highlighted the challenges in clustering a large scale WSN, discuss some of clustering protocols, and classify them based on the clusters technique formation and the way that data is aggregated to the base station. They further considered the case of border monitoring and simulate these protocols and compare their performance results using different scenarios. Sivakumar, B., and D. Sivakumar [12] discussed a short survey on the existing clustering algorithms utilized for routing in MANETs. This paper also proposes mobility based clustering for critical node detection. The evaluation of proposed Mobility based NClustering (MNN) protocols for critical node detection is on par with other unequal clustering protocols. The results show a promising improvement in network performance ignoring the efficiency of cluster head. Zhu, Jiang et al. [13] proposed a hybrid clustering protocol - Hybrid Distributed Hierarchical Agglomerative Clustering (H-DHAC) - which uses both quantitative location data and binary qualitative connectivity data in clustering for WSNs. Their simulation results show that H-DHAC has a lower percentage of compromise in performance in terms of network life time and total transmitted data compared to similar approaches that use complete location data. However, H-DHAC still outperforms the well known clustering protocols, e.g., LEACH and LEACH-C. Liu, Jingjing, and Yanjun Hu [14] proposed an improved clustering protocol BEEC for heterogeneous wireless sensor networks. In BEEC, it optimizes the threshold for selecting cluster heads and uses coverage radius to balance the distribution of cluster heads. It also introduces a novel approach to choose cluster head for cluster members so as to take full advantage of energy heterogeneity. Simulation results show that this improved clustering algorithm can effectively prolong network lifetime and enlarge network throughput when compared with other existing clustering protocols in heterogeneous environments. Said, Jihed Eddin et al. [15] introduced a velocity-based clustering algorithm and implement a relay placement technique in order to maintain seamless network connectivity. Simulation results show that the packet loss rate of the proposed algorithm is much lower than the existing LEACH and HEED clustering protocols. Kumar, Dilip [16] proposed and evaluated two new clustering-based protocols for heterogeneous WSNs, which are called single-hop energy-efficient clustering protocol (S-EECP) and multi-hop energy-efficient clustering protocol (M-EECP). In S-EECP, the cluster heads (CHs) are elected by a weighted probability based on the ratio between residual energy of each node and average energy of the network. The nodes with high initial energy and residual energy will have more chances to be elected as CHs than nodes with low energy whereas in M-EECP, the elected CHs communicate the data packets to the base station via multi-hop communication approach. To analyse the lifetime of the network, the authors assume three types of sensor nodes equipped with different battery energy. Finally, simulation results indicate that the author’s protocols prolong network lifetime, and
achieve load balance among the CHs better than the existing clustering protocols. Shahram Babaie et al., [16] in this paper they proposed an algorithm called as cluster head choice algorithm where the cluster heads are selected from the live and the dead nodes according to their threshold value. Thus more nodes will become cluster heads. The main focus was on network energy consumption. Vivek Katiyar et al., [17] the algorithm devised by them are more efficient then LEACH because it saves 30% of energy. In addition, it overcomes the situation of far locations which is a group of sensor nodes which are situated at a lower level then a threshold. Desalegn Getachew Melose et al. [18] stated that to increase the lifetime of a wireless sensor network we must focus on the energy consumed for selecting the cluster head in spite of the residual energy. MATLAB is hence developed which increases the lifetime by 47%-57%. Reetika Manjal et al. [19] stated that cluster head must be chosen whose current power and the length from the sink node is maximum. This overcomes the problem of LEACH. Hence, the lifetime of the network and the energy is increased. Shuo Shi et al., [20] stated that there must be an algorithm that achieves energy compaction and the lifetime of the network. So they work on an algorithm so called as LEACH-C, which calculate the quadratic sum of distances from the cluster head to its member nodes. Simulation results shows that it minimizes the total power consumption of the network. Ma Chaw Mon Thein et al., [21] stated that the cluster heads are randomly chosen in LEACH algorithm. So he stated that the sensor nodes should communicate with the cluster heads and then the cluster-heads further with base stations and also these cluster-heads should be rotated so as to distribute the energy. They modified the algorithm by choosing the cluster heads on the basis of the residual energy. Guisheng Yin et al., [22] they stated a routing algorithm which is a combination of hierarchical routing and geographical routing. In this routing algorithm the packets are forwards from source node to the base station. It has two phases: inter cluster routing and the intra cluster routing. Qi Wang et al., [23] this paper purposes a fuzzy based simulation system for wireless sensor networks in order to calculate the lifetime of a sensor by considering the battery power, sleep time rate and transmission time rate. They use MATLAB for calculating the lifetime of the sensors. Jyoti Yadav et al., [24] they focused on analytical categorization of various proposed cluster heads selection schemes. They analyzed the various previous developed algorithms and has analysed that to increase the energy efficiency of the network by doing more work on single cluster head selection in a process. New procedures have been developing to select single cluster head such as availability and responsiveness. Amrita Ruperee et al. [25] their main focus is also on increasing the lifetime of network. As the main problem of the wireless sensor network is the battery power and to increase the efficiency more power is needed. In most of the algorithms proposed before, the processing of data is done at the cluster head, hence consumes most of the energy. The formula developed in this paper reduces the size of the packet by running the data at the node itself applying Delta Modulation. That reduces how the size of the packet and hence the power consumption. Yuhua Liu et al. [26] they proved with the help of simulation that the previous methods of selecting the cluster head is inefficient as the new technique is more efficient and prolongs the network lifetime by 65%. The technique is so called as M-LEACH. Aarti Jain et al., [27] as the clustering is an important part in getting good scalability, efficiency and effective routing in wireless sensor network, so to select the cluster head a new method has been developed which is based on the “cluster optimal degree centrality”. This method has been compared with the LEACH, LEACH-ERE and gives better result in lifetime of the network and the intra-cluster communication.

6. GAPS IN LITERATURE

1. The use of the hard and soft thresholding has been ignored by the most of the existing researchers.

2. In EEMA a node might not become cluster head for a long time so will result in load misbalancing.

3. The effect of the nodes scalability has been ignored in the EEMA.

7. CONCLUSION AND FUTURE SCOPE

In this paper, a survey on various clustering protocols has been done. From the survey it has been concluded that none of the technique performs efficiently in all fields. Therefore, an advanced clustering algorithm is needed that not only be able to extend the longevity, but also maintain the coverage. Although it is hard to achieve perfectly balanced load, the sensors that are still alive should be well distributed over the sensing area.

In near future, adaptive Energy-Efficient Multi-layered Architecture (EEMA) protocol can be proposed to overcome these issues.

REFERENCES


[6] develop privacy preserving spectral clustering protocols over vertically partitioned data sets. Such protocols allow various parties to analyze their data jointly while protecting their privacy.


