Energy Efficient Wireless Sensor Networks based on Clustering Techniques

Kiranjit Kaur
Department Of Computer science & Engineering
Guru Nanak dev university,
Punjab, India

Sandeep Waraich
Assistant Professor,
Department Of Computer science & Engineering
Guru Nanak dev university, Punjab, India

ABSTRACT

In WSNs, Energy is a scarcest resource of sensor nodes and it determines the lifetime of sensor nodes. These are battery powered sensor nodes. These small batteries have limited power and also may not easily rechargeable or removable. Long communication distance between sensors and a sink can greatly drain the energy of sensors and reduce the lifetime of a network. In WSNs, energy is a big factor to be considered. Various techniques are used to optimize energy level of sensor nodes of WSN. We will make a review of some of these wireless sensor network techniques which are used recently and are helpful in improving energy efficiency of wireless sensor nodes.

Keywords: WSNs, batteries, sensor nodes, communication, cluster, energy efficient.

1. INTRODUCTION

A WSN is a co-operative network with collection of sensor nodes which are self organised through the radio links [1]. In the network, each node has the capability of processing themselves individually which contains multiple memory, transceiver and power source. They can easily adopt with various sensor nodes based on their application. For introducing and developing new technologies in Internet application, Wireless Sensor Network plays an major role in various fields like military, medical, transports, environmental management, etc. In the WSNs, a lot of nodes operate on limited batteries, making energy resources the major bottleneck. Improving the maximizing lifetime of wireless sensor is important. Wireless sensor networks consist of sensor nodes equipped with their own battery having limited lifetime, which makes the operations of network available only within a limited amount of time [2]. It is crucial to examine and estimate how long the network is properly functioning, or network lifetime. In WSN field the various clustering techniques are used. Hierarchical clustering, Partitioned clustering [13]. In hierarchical, on the nesting cluster's characteristic, separation is based. Nested hierarchical clustering means that within bigger clusters it also clustered to exist. Partitioned clustering constructs Varieties of partitions and evaluate them. In clustering approach each cluster consists a cluster head (CH) and some regular nodes. Sensor nodes are source nodes. Sensor nodes take information from the regular nodes and send that information to their corresponding cluster head. From all the sensor nodes a cluster head is selected in a cluster and it has the responsibility for collecting sensing data from all source nods. After receiving of data from source nodes, the data aggregation is also performed by CH to reduce the data size before sending data to the sink, which further reduces the power expended for data transfer.

2. CLUSTERING PARAMETERS

In WSNs clustering algorithms, it is reporting on some important parameters related to the whole clustering procedure in WSN[14].

2.1 Number of clusters:

In clustering algorithms the CH selection and formation process lead to variable number of clusters. In some published approaches, however, the set of CHs are predetermined and thus the numbers of clusters are preset. The amount of clusters is generally a critical parameter pertaining to the efficiency of the total routing protocol.

2.2 Intra-cluster communication:

In some initial clustering approaches the communication between a sensor and its designated CH is assumed to be direct. However, multi-hop intra-cluster communication is often required, the number of CHs is bounded when the communication range of the sensor nodes is limited or the number of sensor nodes is very large.

2.3 Cluster formation methodology:

When CHs are regular nodes and time efficiency is a primary design criterion, clustering is being performed in a distributed manner without coordination. In few earlier approaches a centralized approach is followed; one or more coordinator nodes are used to partition the network off-line and control the cluster membership.

2.4 Cluster-head selection:

The cluster heads of the clusters in some proposed algorithms (mainly for heterogeneous environments) can be pre-assigned. Generally however in homogeneous environments, the CHs are picked from the deployed set of nodes either in a probabilistic or completely random way or based on other more specific criteria (residual energy, connectivity etc.).

2.5 Algorithm complexity:

In most recent algorithms the one of the primary design goals is fast termination of the executed protocol. Thus, the time complexity or convergence rate of most cluster formation procedures proposed nowadays is constant (or just dependent on the amount of CHs or the amount of hops). In some earlier protocols, however, the complexity time has been allowed to depend on the total number of sensors in the network, focusing in other criteria first.

2.6 Multiple levels:

In several published approaches the idea of a multi-level cluster hierarchy is introduced to achieve even better energy distribution and total energy consumption (instead of using only one cluster level). The improvements offered by multi-level clustering can be further studied, especially when we have very large networks and inter-CH communication efficiency is of high importance.

2.7 Overlapping:

Several protocols give also high importance on the idea of node overlapping within different clusters (either for better routing efficiency or for faster cluster formation protocol execution or for other reasons).

3. LITERATURE SURVEY

3.1 Combining Cooperative MIMO With Data Aggregation

In this paper to reduce the energy used by sensor nodes the cooperative MIMO and data aggregation techniques are combined. A new energy model that considers the relationship between data generated by nodes and the distance between them for a cluster-based sensor network by employing the combined techniques. By using this model, the analysis can be done to check the effect of the cluster size on the average energy consumption per node[1].

3.2 Cooperative Clustering Protocol for Energy Constrained Networks

In wireless sensor network, a wireless sensor node has a single antenna. Nodes can be grouped into virtual antenna arrays that act as virtual MIMO nodes. Divide the whole problem into two parts to minimize the imbalance in the residual energy at nodes: determine the optimal number of cluster nodes in each cluster and cluster node selection problem. With a novel cost metric a multi-hop energy-balanced routing mechanism proposed for clustered WSNs. Cooperative and Clustering Protocol has three phases: clustering, cooperation, and transmission. [2].

3.3 Mobility Aware Clustering for Energy Efficient Routing

The GROUTE algorithm proposed that based on genetic algorithm. The proposed algorithm considers the mobility of nodes and create optimal cluster in more efficient way in order to have energy efficient transmission of data across WSN. GAROUTE uses neighborhood information from all nodes to choose cluster heads and cluster members and broadcasts the decision back to the network[3].

3.4 Genetic Algorithm and Harmony Search Algorithm

In this paper two approaches are used, Genetic algorithm and Harmony search algorithm and combination of them. In this paper optimal cluster head selection is performed according to residual energy and node's position. In this paper ,first partitioned the network into optimal clusters and instead of choosing the node with remained power ,select node using genetic algorithm ,considering the distance and remaining energy that significantly reduces the energy consumption in every iteration .The large number of cluster head need to transmit more data to base station that leads to higher energy consumption. Thus in this work the number of cluster heads are constant, which in turn balance the energy consumption[4].

3.5 An Energy and Link Efficient Clustering Technique for Reliable Routing

The proposed technique known as Energy and link Efficient Clustering Technique for reliable routing (ELECT).This technique considers current status of node, link condition and uses a clustering metric, called Predicted Transmission Count(PTX) and gateway. The main motive of this technique is to establish persistent routing path by detecting the number of cluster head and gateways. This technique also considers an undirected graph. Cluster head candidate associate with stable link has preference to become a cluster head. This study considers a well known metric, called Expected Transmission Count[5].

3.6 Energy Consumption and Lifetime Analysis For Heterogeneous WSN

In heterogeneous WSNs, some percentage of nodes equipped more energy than all remaining nodes in wireless sensor network .Thus sensor nodes can be categorized as sensor nodes and super sensor nodes .Super sensor nodes have more energy capabilities .The cluster head is selected among super sensor nodes. Cluster head aggregate data from all sensor nodes and further send that data to base station or user. This process continues until the entire energy drains out. The TLHE protocol for HWSNs features periodic iteration in which each iteration is divided into three different phases - cluster-head selection, cluster-formation and data communication phases. In this paper energy consumption analysis is divided into two phases i.e. energy consumption model analyzes the energy consumed by each cluster head node, while data aggregation from other nodes and energy required for data transmission to base station[6].

3.7 Energy Efficient Cluster based Mobility Prediction

The proposed technique known as Energy Efficient Cluster Based Mobility Prediction Routing Protocol (EECMPR) is used. Kalman filters are used in this proposal .In this mechanism the cluster head selection is based upon the weight i.e. the node with high weight is selected as cluster head based upon residual energy and transmission range parameters. The position of each mobile node is carried at the respective nodes using Kalman filter which gives information about State Update that consists of acceleration and position. This information is sent to the cluster head which process the this information and send it to base station .The base station then predicts using this information of status update and compare all the received information taken from cluster head .At last base station will send data packets to sensor nodes after predicting the optimal nodes position[7].

3.8 A New Spectral Classification for Robust Clustering

Using various spectral clustering techniques a algorithm proposed, called Spectral Classification for Robust Clustering in Wireless Sensor Networks (SCRC-WSN).Here in this spectral partitioning method, graph theory is used partition the fixed network into clusters. All the nodes that form cluster send data to cluster head which is elected by them and cluster head further send data to base station .This proposed technique considers the node's residual energy to elect cluster head .The three main steps of the proposed SCRC-WSN protocol: 1. preprocessing, 2.clustering, 3. cluster head election, 4. steady state phase. SCRC-WSN algorithm

determines the clusters before specifying the cluster heads. SCRC-WSN uses the concept which offers a better use and optimization of the dissipated energy in the network. In this situation, the network base station (BS) computes the adjacency and the laplacian matrices of the network graph in order to run the SCRC-WSN protocol. The strategies introduced into the SCRC-WSN protocol allow it to out-perform its performances by saving more energy and enlarging more efficiently the network lifetime[8].

Table 1- Comparison table

Sr. no	Paper name	Technique used	Based	Scheme
1.	**Improving Energy Efficiency in a Wireless Sensor Network by Combining Cooperative MIMO With Data Aggregation**	Cooperative MIMO with data aggregation	Energy model	Centralized and distributed data aggregation scheme
2.	**A Cooperative Clustering Protocol for Energy Constrained Networks**	Cooperative Clustering Protocol	multi-hop energy-balanced routing	ONC
3.	**Genetic Algorithm based Mobility Aware Clustering for Energy Efficient Routing in Wireless Sensor Networks**	Garoute algorithm	Mobility Aware Clustering of nodes	Genetic algorithm
4.	**Optimizing Cluster-Head selection in Wireless Sensor Networks using Genetic Algorithm and Harmony Search Algorithm**	GP-LEACH and HS-LEACH	Network partition	Miscellaneous Scheme
5.	**An Energy and Link Efficient Clustering Technique for Reliable Routing in Wireless Sensor Networks**	ELECT	establish persistent routing path by determining cluster heads and gateways	predicted transmission count (PTX) metric
6.	**Energy Consumption and Lifetime Analysis For Heterogeneous WSN**	TLHE routing protocol	weighted election probabilities of each node	Clustering
7.	**Energy Efficient Cluster based Mobility Prediction for Wireless Sensor Networks**	EECMPR	Kalman filter	Mobility Prediction
8.	**A New Spectral Classification for Robust Clustering in Wireless Sensor Networks**	SCRC	separate the network in a fixed optimal number of clusters	Graph theory

4. CONCLUSION

Energy constraint in WSN is a major challenge. A wireless sensor node is equipped with very limited power source due to its hardware constraint. The lifetime of wireless sensor node dependent upon battery lifetime .These batteries may not be easily rechargeable and removable. Optimal clustering of nodes can guarantee the minimum power consumption. In this paper, a review of some of these energy efficient techniques is done using various research papers in this field. In this paper, we compare various types of energy efficient techniques which are used in wireless sensor networks. This review of various techniques will be helpful for better study and inventing new ideas for even better energy efficient techniques.

5. REFERENCES

[1] D.Sharmila, R.Sujitha & G.Rajkumar "On Improving the Lifetime of Wireless Sensor Networks Using Virtual Scheduling Backbone Replacement" Proceedings of 2013 IEEE Conference on Information and Communication Technologies (ICT 2013).

[2] M.Akilandeswari & Umarani Srikanth "Metaheuristic Approach for Maximizing the Lifetime of Heterogeneous Wireless Sensor Networks "International Conference on Computer Communication and Informatics (ICCCI - 2012).

[3] Gao Qiang,Zuo Yi,Zhang Jun, and Peng Xiao-Hong "Improving Energy Efficiency in a Wireless Sensor Network by Combining Cooperative MIMO With Data Aggregation" (IEEE Transactions On Vehicular Technology), Vol. 59, No. 8, October 2010.

[4] Nguyen Diep N. and Krunz Marwan "A Cooperative Clustering Protocol for Energy Constrained Networks" (IEEE), 2011.

[5] Wang Sheng-Shih, Chen Hung-Chang, Chen Ze-Ping " An Energy and Link Efficient Clustering Technique for Reliable Routing in Wireless Sensor Networks"(IEEE), 2012.

[6] Karimi Mohammad, Naji Hamid Reza and Golestani Shahrzad ," Optimizing Cluster-Head selection in Wireless Sensor Networks using Genetic Algorithm and Harmony Search Algorithm", (IEEE(20th Iranian Conference on Electrical Engineering, (ICEE2012)), May 15-17,2012, Tehran, Iran.

[7] Mathapati Basavaraj S., Patil Dr. Siddarama. R., Mytri Dr. V D. "Energy Efficient Cluster based Mobility Prediction for Wireless Sensor Networks" (IEEE International Conference on Circuits, Power and Computing Technologies (ICCPCT)), 2013.

[8] Tuah Norah, Ismail Mahamood and Haron Ahmad Razani, "Energy Consumption and Lifetime Analysis for Heterogeneous Wireless Sensor Network" (IEEE), 2013 Tencon – Spring.

[9] Mathapati Basavaraj S., Patil Dr. Siddarama. R., Mytri Dr. V D. "Energy Efficient Cluster based Mobility Prediction for Wireless Sensor Networks" (IEEE (International Conference on Circuits, Power and Computing Technologies (ICCPCT)), 2013.

[10] Brahim Elbhiri, Sanaa El Fkihi, Rachid Saadane "A New Spectral Classification for Robust Clustering in Wireless Sensor Networks" IFIP WMNC'2013.

[11] Syed Jawad Ali and Partha Roy, Energy Saving Methods in Wireless Sensor Networks, IDE0814, May 2008.

[12] Mohit Saini and Rakesh Kumar Saini, Solution of Energy-Efficiency of sensor nodes in Wireless sensor Networks, Volume 3, Issue 5, May 2013.

[13] A Tutorial on Clustering Algorithms. http://home.deib.polimi.it/matteucc/Clustering/tutorial_html/

[14] Vural, Serdar, PirabakaranNavaratnam, Ning Wang, and Rahim Tafazolli. "Asynchronous clustering of multihop Wireless Sensor Networks." In Communications (ICC), 2014 IEEE International Conference on, pp. 472-477. IEEE, 2014.