An Energy Efficient Cluster based Data Collection in Wireless Sensor Networks

K. Hemagowri
PG Student
Department of Computer Science and Engineering
Anna University, Regional Campus-Coimbatore

T. Parameswaran
Assistant Professor
Department of Computer Science and Engineering
Anna University, Regional Campus-Coimbatore

Dr. C. Palanisamy
Professor and Head of Department
Department of Information Technology
Bannari Amman Institute of Technology- Sathyamangalam

Abstract

Wireless sensor networks (WSNs) have gained a great deal of attention in the past decade due to their wide range of application areas and formidable design challenges. Wireless sensor networks consist of tiny sensor nodes that communicate with each other over wireless channels, often in a hostile environment where nodes can be captured and compromised. There are two reasons behind the hierarchical routing Low Energy Adaptive Clustering Hierarchy (LEACH) protocol be in explored. One, the sensor networks are dense and a lot of redundancy is involved in communication. Second, in order to increase the scalability of the sensor network keeping in mind the security aspects of communication. Most existing geographic routing protocols on sensor networks concentrates on finding ways to guarantee data forwarding from the source to the destination, and not many protocols have been done on gathering and aggregating data of sources in a local and adjacent region. However, data generated from the sources in the region are often redundant and highly correlated. Accordingly, gathering and aggregating data from the region in the sensor networks is important and necessary to save the energy and wireless resources of sensor nodes. We introduce the concept of a local sink to address this issue in geographic routing.

Keywords: Wireless sensor networks (WSNs), data collection, Low Energy Adaptive Clustering Hierarchy, Cluster head, Anchor point

I. INTRODUCTION

Wireless sensor networks (WSNs) are composed of a large number of sensor nodes deployed in a field. They have wide-ranging applications, some of which include military, environment monitoring, agriculture, home automation, smart transportation, and health. Each sensor node has the capability to collect and process data, and to forward any sensed data back to one or more sink nodes via their wireless transceiver in a multi-hop manner. In addition, it is equipped with a battery, which may be difficult or impractical to replace, given the number of sensor nodes and deployed environment. These constraints have led to intensive research efforts on designing energy-efficient protocols. WSN are mainly powered by batteries. Due to limited energy storage capacity of a sensor battery, WSNs can usually remain operational only for a limited amount of time. However, in many applications, such as earthquake, soil monitoring and glacial movement monitoring, due to the harshness of the environment, a long period of unattended operability is required. Although there has been a flourish of research efforts on prolonging the lifetime of WSNs, network lifetime remains a performance bottleneck of WSNs and one of the key factors that hinder their large scale deployment.

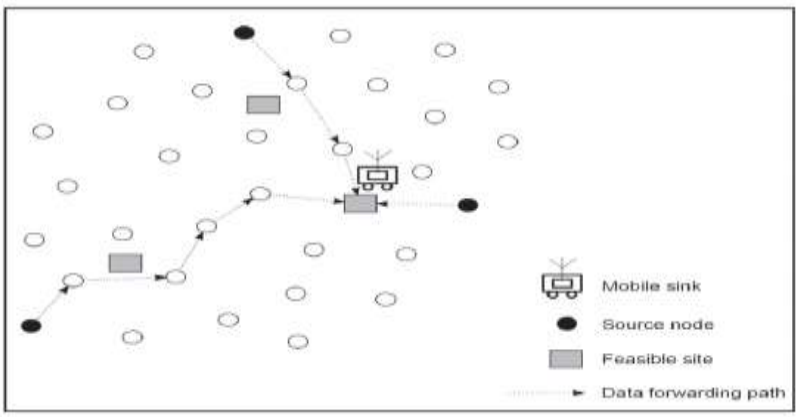

Fig. 1: components of WSN

The Fig 1. Shows the various components of wireless sensor networks like a sink, source node and feasible site etc

II. NETWORK CREATION OF WSN

In a network the nodes created are, Regular sensor nodes (or just nodes, for short) are the sources of information. Such nodes perform sensing as their main task. Sinks (base stations) are the destinations of information. They collect data sensed by sensor nodes either directly or indirectly. Special support nodes perform a specific task, such as acting as intermediate data collectors or mobile gateways. They are neither sources nor destinations of messages, but exploit mobility to support network operation or data collection. Some of the main nodes in the WSN are:

A. Re-Locatable Nodes:

These are mobile nodes which change their location to better characterize the sensing area, or to forward data from the source nodes to the sink.

B. Mobile Data Collectors:

These are mobile elements which visit the network to collect data generated from source nodes.

C. Mobile Peers:

Mobile peers are ordinary mobile sensor nodes in WSN-MEs. Mobile peers can also be used for opportunistic data collection in urban sensing scenarios.

III. DATA COLLECTION IN WSN

Data collection has been an active research area in sensor networks for its ability to reduce energy consumption. Many works have focused on different aspects of data aggregation. Some focus on how to aggregate data from different nodes, some focus on how to construct and maintain a structure to facilitate data aggregation, and some focus on how to efficiently compress and aggregate data by taking the correlation of data into consideration. There is three approaches to collect data from WSN. They are,

A. Cluster Based Approach:

This cluster based approach is done by using LEACH protocol. To distribute energy consumption evenly among all nodes, the cluster-heads are randomly elected in each round. In, authors propose a modified version named LEACH-C. LEACH-C uses the base-station to broadcast the cluster-head assignment, thus further spreading out the cluster-heads evenly throughout the network and extending the network lifetime.

B. Tree Based Approaches:

Protocols in this family are built on traditional shortest path routing tree. The research is focused on how to choose a good routing metric based on data attributes to facilitate data aggregation. Based on Directed Diffusion, Greedy Incremental Tree (GIT) is proposed. GIT establishes an energy-efficient path and attaches other sources greedily onto the established path. Other approaches are also considered like Center at Nearest Source, Shortest Path Tree, and Tiny Aggregation Service. The collected data are then transfer to base station with the help of sencar, A mobile data observer, called SenCar, which could be a mobile robot or a vehicle equipped with a powerful transceiver and battery, SenCar starts the data gathering tour periodically from the static data processing center, uploads data to the data processing center.

IV. RELATED WORKS

Data aggregation is defined as the process of aggregating the data from multiple sensors to eliminate redundant transmission and provide fused information to the base station [1]. All the aggregation nodes collect data from their children nodes and calculate the aggregation value. Then only the aggregated values are forwarded towards the data sink. The data gathering process must be carefully designed to conserve energy and extend network lifetime because energy efficiency is critical for wireless sensor networks. Here the construction of a data gathering tree[2] should be noted, when there is a single base station in the network. The objective is to maximize the network lifetime, which is defined as the time until the first node depletes its energy. The problem is shown to be NP complete.

The sencar collects the data that aggregate from various nodes in the network and then the data are transferred to the mobile sink. The moving path of SenCar [3] can greatly affect network lifetime. So some heuristic algorithms for planning the moving path/circle of SenCar and balancing traffic load in the network are introduced. It Avoid obstacles while moving. The tour planning for mobile data gathering in wireless sensor node is introduced by introducing mobility into the network [4]. An M-collector starts the data-gathering tour periodically from the static data sink. Data gathering by M-collectors is perfectly suitable for applications and the M-collector will separate each zone that will reduce the network faults and greatly reduce the moving length, this is the major advantage of using M-collector.

V. SYSTEM MODEL

A. Topology Creation:

Topology creation is a method of creating nodes in a network. Maximum number of nodes can be created. For example, for 100*100 m field area it can deploy 100 nodes. Base station is located at outside the field and the co-ordinate can be vary at any time. Energy of Base Station is infinite and each node has initial energy lying between 0.25 and 1 Joule. The sensor node locations are fixed. Mobile sink nodes can move.

B. Cluster Head Selection:

The sensor nodes are grouped into clusters based on its connectivity to each other. Each sensor node chooses a random number, temp, between 0 and 1 and this number is then compared with threshold value, T (n), which depends on various parameters given below. If this random number is less than threshold value, then that node becomes the cluster-head for current round. The role of cluster is dynamic which means it rotates to other nodes also in continuous round and each node must be elected as cluster-head at-least once in their lifetime. The threshold value is calculated based on the following equation,

$$k(s) = \begin{pmatrix} \dfrac{p}{1 - p\left(r \bmod \dfrac{1}{p}\right)} \\ 0 \end{pmatrix} \quad \begin{matrix} \text{if } s \in G\_\_\_\_1 \\ \text{otherwise} \end{matrix}$$

C. Tour Planning Path for Mobile Sink:

The selection of anchor points falls into following two aspects. First, the sensors located at the selected anchor points should be those with most urgent needs of energy supplement. Second, as the mobile sink moves over the anchor points back and forth for data gatherings during a time interval, the length of each migration tour, which implies the data gathering latency, is expected to be short. Choosing anchor points is a crucial step of the data gathering process since it determines the efficiency of energy transferring and the latency of data gathering. Since if nodes are not visited by the mobile sink, their data packets would be buffered until these nodes are selected as anchor points.

D. Data Collection:

The aim of data gathering is to transmit data that has been collected by the sensor nodes to the base station. Data gathering algorithms aim to maximize the amount of rounds of communication between nodes and the base station, one round means that the base station has collected data from all sensor nodes. Data gathering may seem similar to data dissemination, but there are some differences. In data dissemination, also other nodes beside the base station can request the data while in data gathering all data is transmitted to the base station. In addition, in data gathering data can be transmitted periodically, while in data dissemination data is always transmitted on demand. EE-LEACH is a self-organizing, adaptive clustering protocol that uses randomization to distribute the energy load evenly among the sensors in the network. Each sensor transmits its data to the CH and once the CH collects all of the data it aggregates it and transmits it to the BS. Normally the BS is a great distance away, so it will be high energy transmission. Hence EE-LEACH protocol is used.

VI. PERFORMANCE EVOLUTION

The performance evolution is depending on the energy efficiency of the cluster heads formed and the data transferred through that to the base station. Thus it can be measured through the threshold value obtained. For cluster head formation LEACH protocol is used. For the energy efficiency cluster head EE-LEACH protocol will be used. The major advantages of this EE-LEACH is that the urgency nodes transmit to the base station the same number of times, the network lifetime and performance has been increased by allowing the individual nodes to transmit unequal number of times to the base station depending on their distances from it. . It reduce the number of full transmission by proposing that each cluster-head will transmit its data in its respective cluster and then all the cluster members will compute the difference between its own sensed data and received data. EE-LEACH saves energy by reducing the number of full transmissions without affecting the integrity of data collection at base station. Finally the data is aggregated and the fused data is transmitted to BS.

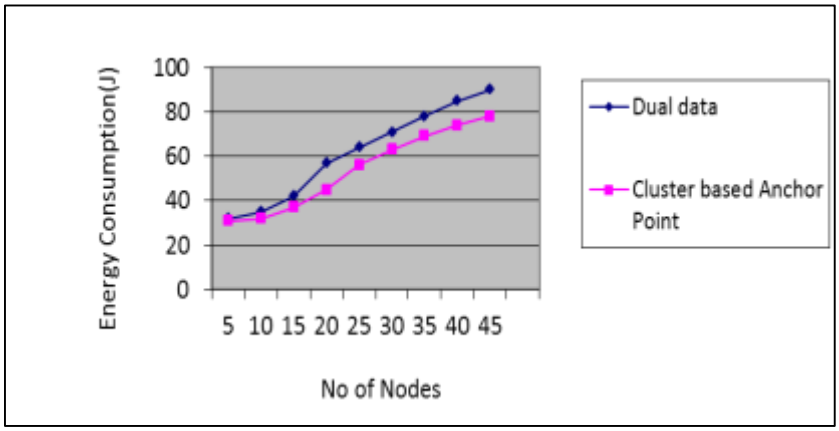

Fig. 2: Average Energy Consumption

Thus the energy efficiency is fully based on the number of nodes used in the network. It deals with nodes, how it collects the data from the neighbor nodes. Finally, the nodes are connected with the CH and the data are transmitted through CH to the base station, where latency is the time interval between the simulation and response. It is basically a term to define the time between sending and receiving data.

As, Latency for the dual data and cluster head is defined below. It shows that the number of nodes increases then the latency between the nodes also increases.

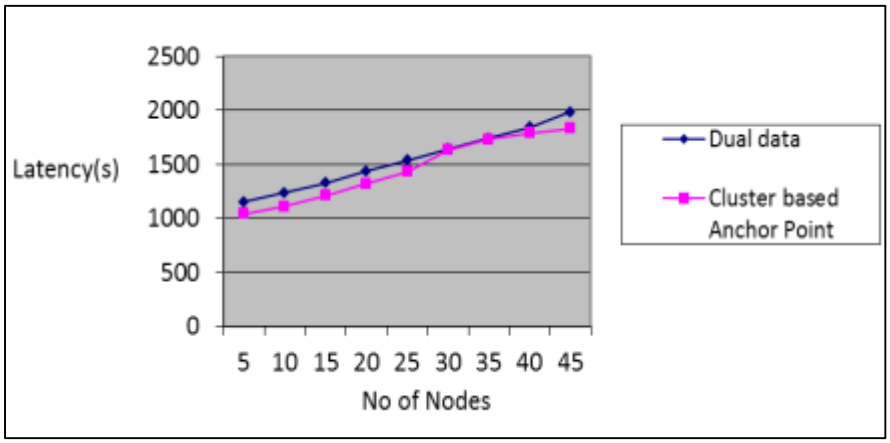

Fig. 3: Data Latency

VII. Conclusion And Future Work

The result of simulations conducted indicates that the proposed clustering approach is more energy efficient and scalable and hence effective in prolonging also outperforms LEACH with respect to throughput of the network and that improvement of LEACH routing protocol helped to improve the performance of WSNs in Intrusion detection, Weather monitoring, distributed computing, Detecting ambient conditions such as temperature, movement, sound, light, or presence of certain objects. The results show that LBC-DDU can greatly reduce energy consumptions by alleviating routing burdens on nodes and balancing workload among cluster heads.

There are some interesting problems that may be studied in future work. The problem is how to schedule MIMO uploading from multiple clusters. An algorithm that adapts to the current MIMO-based transmission scheduling algorithms should be studied in future.

References

[1] Lee, S. Park, F. Yu, and S.-H. Kim, "Data gathering mechanism with local sink in geographic routing for wireless sensor networks," IEEE Trans. Consum. Electron., vol. 56, no. 3, pp. 1433–1441, Aug. 2010.

[2] Y. Wu, Z. Mao, S. Fahmy, and N. Shroff, "Constructing maximum- lifetime data-gathering forests in sensor networks," IEEE/ ACM Trans. Netw., vol. 18, no. 5, pp. 1571–1584, Oct. 2010.

[3] M. Ma and Y. Yang, "SenCar: An energy-efficient data gathering mechanism for large-scale multihop sensor networks," IEEE Trans. Parallel Distrib. Syst., vol. 18, no. 10, pp. 1476–1488, Oct. 2007.

[4] M. Ma, Y. Yang, and M. Zhao, "Tour planning for mobile data gathering mechanisms in wireless sensor networks," IEEE Trans. Veh. Technol., vol. 62, no. 4, pp. 1472–1483, May 2013.

[5] Liu, K. Wu, and J. Pei, "An energy-efficient data collection framework for wireless sensor networks by exploiting spatiotemporal correlation," IEEE Trans. Parallel Distrib. Syst., vol. 18, no. 7, pp. 1010–1023, Jul. 2007.