Data Gathering of Wireless Sensor Network using Ant colony optimization

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Abstract—Wireless sensor networks are spreading over large area. There are some constraints on sensor network. Especially on data gathering that is main function or we can say backbone of wireless sensor network. In this paper study the concept of data gathering in the wireless sensor network. The focus of our work lies on making the process of data gathering to be efficient. We are using PEGASIS, LEACH and ACO (ant colony optimization) techniques for data gathering. And compare these algorithms and find out which one is best for data gathering.

Keywords—wireless sensor network; LEACH, ACO, PEGASIS.

I. INTRODUCTION

Wireless sensor network is the collection of mobile or static nodes which are capable of communicating with each other in order to collect data accurately, autonomously. Each node deployed is capable of sensing, processing and communicating. Manufacturing of inexpensive low power sensors having computational capability is possible with the help of recent advances in field of technology. Wireless sensor network is used to collect reliable and accurate information from distant and hazardous environment such as battle field, volcano monitoring etc., major applications of wireless sensor network is monitoring and tracking. In National Defense, Military affairs, environment monitoring, traffic monitoring, industry monitoring, manufacturing monitoring etc. wireless sensor network is widely used. Wireless sensor network has four basic components: processing unit, sensing unit, radio unit(communication unit), battery(power source). In order to monitoring and tracking purposes sensor nodes are expected to be deployed in large area. Data Gathering is the major application of wireless sensor network. In data gathering nodes are deployed at different specified locations which continuously collect different type of data such as temperature, light and vibration at different sampling rates[1]. Sensor nodes send back data to Base Station(BS) which is usually location at distant locations where further processing can be done. Life time of network is determined from energy consumption by sensor nodes. So, in order to enhance life time network energy must be consumed efficiently by using efficient protocols.

Clustering Algorithms for Wireless Sensor Networks (WSNs) consists of mainly following components:

• Sensor Node: A sensor node is the main component of a WSN. Sensor nodes performs multiple roles in a network, such as sensing, data storage, data routing and data processing.

• Clusters: Clusters are the basic unit for WSNs. It is required that WSNs should be divided into WSNs. It is required that WSNs should be divided into clusters to simplify tasks such a communication.

• Cluster heads: Cluster heads are the leader of a cluster. They are required to organize various activities in the cluster. These include data-aggregation and organizing the communication schedule of a cluster. They sends useful data to base station.

• Base Station: The base station(BS) is at the heart of the Hierarchical Wireless Sensor Network (HWSN). It provides the communication link between the sensor network and the end-user.

• End User: It is the last component of Network. End user may be civil, governmental, commercial or industrial entity. The data in a sensor network can be used for a wide-range of applications. Therefore, a particular application may make use of the network data over the internet, using a PDA, or even a desktop computer. In a queried sensor network (where the required data is gathered from a query sent through the network), this query is generated by the end user.

Limited Energy: Wireless sensor nodes are “off-grid”, meaning that they have limited energy storage and the efficient use of this energy will be vital in determining the range of suitable applications for these networks. The limited energy in sensor nodes must be consumed with proper clustering algorithm which can reduce the overall energy usage in a network.

• Network Lifetime: The energy limitation on nodes results in a limited network lifespan for nodes in a network. Proper clustering algorithm should attempt to reduce the energy usage, and also increases overall network lifetime.

• Limited Abilities: The small physical size and small amount of stored energy in a sensor node limits many of the abilities of nodes in terms of processing and communication abilities. If good clustering algorithm is used it can be able to provide better abilities.
II. RELATED WORKS

Analysis of clustering protocol for System Optimization in Heterogeneous Sensor Network: Optimization of Wireless sensor network, means to develop a system in that way so that its throughput and life time of the system will increased. For optimization of system various parameters are used i.e. energy efficiency, routing, data aggregation and load balancing. In this paper they focus on energy efficiency and load balancing in heterogeneous wireless sensor network. They analyze clustering protocol Low energy adaptive clustering hierarchy (LEACH) and Hybrid energy efficient distributed clustering (HEED) how they effectively work for system optimization[2].

Hierarchical cluster based routing protocol with high throughput for Wireless Sensor Networks: Hierarchical routing having cluster based topology is a very efficient approach for improving throughput[3]. Wireless Sensor Networks (WSNs) are distributed networks consisting of various sensors deployed randomly in an area. Sensors operate on limited battery-power. The goal of WSN is to improve network lifetime and reliability with improved throughput. Limited energy resource is the main driving factor behind increasing the throughput[4]. LEACH is one of the eminent hierarchical routing protocol in WSN. In this paper, an improvement of LEACH has been suggested. In our proposed algorithm, we adopt static clustering with dynamic selection of clusterheads within each cluster. It prevents random and concentrated selection of clusterheads. A negligible increase in energy leads to prominent improvement in the throughput. The protocol has been simulated in Castalia-3.2 and results show improvement in throughput when compared to LEACH and LCTS protocol.

A Study of Power and Energy Efficient Clustering Protocols in Wireless Sensor Network: Clustering plays a vital role in any wireless sensor network (WSN). By adapting clustering in WSN the performance of the WSN can be improved. Performance is related to amount of power and energy consumed in any WSN. These two parameters are interlinked with the lifetime of the WSN. If a WSN consumes less power means, the energy stored in the sensor node (SN) has been maintained for longer time. Clusters create hierarchical WSN, which incorporate efficient utilization of limited resources of sensor nodes thus extends network life time. The energy that is stored in the battery of the SN decreases when more amount of power is consumed by the SN. So care has to be taken by considering these parameters while designing the WSN. In this paper, power and energy efficient clustering protocols are discussed.

III. PROBLEM FORMULATION AND PROPOSED WORK

There are some constraints on sensor network. Especially on data gathering that is main function or we can say backbone of wireless sensor network. In this paper study the concept of data gathering in the wireless sensor network. The focus of our work lies on making the process of data gathering to be efficient. We are using PEGASIS, LEACH and ACO (ant colony optimization) techniques for data gathering. And compare these algorithms and find out which one is best for data gathering.

DATA GATHERING

The sensor nodes are deployed in the area continually collect data from area and forward to Base Station. The main purposes of data gathering algorithm is efficient use of energy in order to maximize the life time of network by increasing number of rounds (When BS collects data from all nodes is one round). Various protocols are used for efficient use of energy in order to maximize life time of network. Various protocols for data gathering are

A. DIRECT TRANSMISSION: Number of nodes is deployed in filed and there is a Base Station to which they send the sensed data .In the direct transmission method the nodes directly send sensed data to BS. The Scenario of Direct transmission is as shown in figure. The sensing nodes are at different location from BS so this scenario will cause different amount of energy dissipation. Every time when nodes have data to send to BS, BS have to communicate with each and every node which leads large amount of energy consumption of BS as compared to others So this method is not efficient when life time of BS is critical. This Method is useful BS lies in the Sensor network and when BS is at distant location then this method will leads to shorter life time of the network.

B. BINARY SCHEME: This is chained based scheme in which nodes are classified into different levels. In this all nodes receive the message and forward to other .At each level number of nodes reduced by half. Figure describes the scenario in which we have 7 nodes and each level number of nodes are reduced by

Fig1: Direct Transmission
half at each level and at last level 4 node N7 send data to Base Station

<table>
<thead>
<tr>
<th>Level</th>
<th>Nodes</th>
</tr>
</thead>
<tbody>
<tr>
<td>1</td>
<td>N0 → N1 → N2 → N3 → N4</td>
</tr>
<tr>
<td>2</td>
<td>N1 → N3 → N5 → N7</td>
</tr>
<tr>
<td>3</td>
<td>N3 → N7</td>
</tr>
<tr>
<td>4</td>
<td>N7 → B5</td>
</tr>
</tbody>
</table>

C. LEACH

LEACH is Low Energy Adaptive Clustering method. In this each clusters and cluster heads are formed. Clusters are collection of nodes. Clusters collects data from the cluster nodes within the cluster and then forwards the collected data to Base Station. Cluster Head can be Static or Dynamic. The static Cluster Heads which does not change for different rounds it remains same and dynamic cluster head is which changes with time. In static cluster heads scheme energy consumption of single CH will be more because Static CH have to communicate with whole cluster nodes throughout the network life but in dynamic cluster clusters are randomly selected which leads to balanced energy dissipation. Various scheduling schemes can be adopted such as ACTIVE and. By using these scheduling schemes energy efficient is increased near to 50% than LEACH protocol. LEACH algorithm detail: The steps in the LEACH are

- Advertisement Phase
- Cluster Setup Phase
- Schedule Creation
- Data Transmission

Set-up phase

In LEACH, nodes take autonomous decisions to form clusters by using a distributed algorithm without any centralized control. Here no long-distance communication with the base station is required and distributed cluster formation can be done without knowing the exact location of any of the nodes in the network. In addition, no global communication is needed to set up the clusters. The cluster formation algorithm should be designed such that nodes are cluster-heads approximately the same number of time, assuming all the nodes start with the same amount of energy. Finally, the cluster-head nodes should be spread throughout

the network, as this will minimize the distance the non-cluster head nodes need to send their data. A sensor node chooses a random number, r, between 0 and 1. Let a threshold value be T(n) : T(n) = p/1- p × (r mod p 1). If this random number is less than a threshold value, T(n), the node becomes a cluster-head for the current round. The threshold value is calculated based on the above given equation that incorporates the desired percentage to become a cluster head, the current round, and the set of nodes that have not been selected as a cluster-head in the last (1/P) rounds, p is cluster head probability. After the nodes have elected themselves to be cluster-heads, it broadcasts an advertisement message (ADV). This message is a small message containing the node's ID and a header that distinguishes this message as an announcement message. Each non-cluster-head node determines to which cluster it belongs by choosing the cluster-head that requires the minimum communication energy, based on the received signal strength of the advertisement from each cluster-head. After each node has decided to which cluster it belongs, it must inform the cluster-head node that it will be a member of the cluster. Each node transmits a join-request message (Join-REQ) back to the chosen cluster-head. The cluster heads in LEACH act as local control centers to co-ordinate the data transmissions in their cluster. The cluster-head node sets up a TDMA schedule and transmits this schedule to the nodes in the cluster. This ensures that there are no collisions among data messages and also allows the radio components of each non-cluster-head node to be turned off at all times except during their transmit time, thus minimizing the energy dissipated by the individual.

Steady-State Phase

The steady-state operation is broken into frames where nodes send their data to the cluster-head at most once per frame during their allocated transmission slot. The set-up phase does not guarantee that nodes are evenly distributed among the cluster head nodes. Therefore, the number of nodes per cluster is highly variable in LEACH, and the amount of data each node can send to the cluster-head varies depending on the number of nodes in the cluster. To reduce energy dissipation, each non-cluster-head node uses power control to set the amount of transmits power based on the received strength of the cluster-head advertisement. The radio of each non-cluster-head node is turned off until its allocated transmission time. Since all the nodes have data to send to the cluster-head and the total bandwidth is fixed, using a TDMA schedule is efficient use of bandwidth and represents a low latency approach, in addition to being energy-efficient. The cluster-head must keep its receiver on to receive all the data from the nodes in the cluster. Once the cluster-head receives all the data, it can operate on the data and then the resultant data are sent from the cluster-head to the base station.

D. PEGASIS

PEGASIS is Power-Efficient Gathering in Sensor Information Systems. PEGASIS form open chain staring from node which is farthest from Base Station. PEGASIS assume that global information is available. This algorithm uses greedy algorithm for chain construction. Before first round of communication chain formation is done. During formation of chain care must be taken so that nodes already in chain should not revisited. When a node die then chain is reconstructed by bypassing that node. In
data gathering cycle each node forms a data packet of its own in network. For each data gathering cycle leader is elected among all nodes in network. Each node in network receives a data packet and fuses it with its own data and forwards it to other neighboring node. PEGASIS uses a simple token passing approach which is initiated by leader to start data transmission from ends of chain.

E. Data Gathering Using Ant Colony Optimization

Ant Colony Optimization (ACO) is one of newly emerged swarm intelligence technologies [Dorigo & Gambardella, 1997]. Inspired from a famous ant experiment in 1989, in which ants were found to be always able to find the shortest path between the food source and their colony, the first ACO algorithm, Ant System (AS), was proposed in 1991 to solve the traveling salesman problem (TSP) [Dorigo et al., 1991]. The preliminary experimental results were very promising and encouraged more research efforts for this new optimization method. After AS, many different ACO algorithms have been proposed and successfully applied in different discrete optimization problems including the TSP problem, scheduling, vehicle routing, etc. as well as the routing problem in telecommunication networks [Dorigo & Gambardella, 1997]. Many of these algorithms provide world-class performance. Further, it has been shown that ACO algorithms are not only suitable for static applications but also successfully applied in dynamic setting, such as network communication where the traffic at different points keeps fluctuating with time. Bi-direction AntChain and uni-direction AntChain For the AntChain algorithm, all the participating nodes are formed into a chain structure during data-gathering and communication, providing two different types of chains in order to fit different data queries.

Unidirectional AntChain is a simple chain structure, in which each node transmits data to its neighbor at the same direction during the data gathering process. starting from the first node (node 0), data are transferred to the next node (right-side neighbor) in the chain until reach the end of the chain (node n). The last node (node n) acts as the chain head and it sends data directly to the base station. The data gathering process repeats in the same TDMA (Time-Division Multiple Access) schedule in each datagathering round. When a temporary chain is formed for a specific query, the application can choose the simple unidirectional AntChain for the data-gathering process.

Bi-direction AntChain is an adaptive chain structure in which sensor nodes can transmit to both its neighbors in the chain. in the first round of data-gathering process, the operation is the same as that in the uni-direction AntChain algorithm. in the following round, however, data gathering starts from the end of the chain (node n), transmitting the data to its left-side node until reaching the chain head (node 0). Then node 0 transmits the data to the base station directly.

IV. SIMULATION AND RESULTS

Data gathering is the process of collecting information from sensor nodes at the Base Station. This paper describes various data dissemination methods and data gathering methods.

![Total no. of Alive Nodes/Performance Analysis](Image)

Fig 2: Total no. of Alive Nodes/Performance Analysis

LEACH uses clusters and more efficiently consume energy as compared to direct method. PEGASIS is most efficient as compared to both Direct and LEACH. In PEGASIS chain construction is done by using Greedy algorithm. By using ACO and PSO it also gives better performance as compared to previous one.

REFERENCES


