Data Gathering for Wireless Sensor Network using PEGASIS Protocol

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Abstract

This paper deals with Wireless Sensor Network, is a set of sensor nodes which sense, process and transmit data regarding any sensing area. Various energy-efficient protocols are of extreme importance in order to increase network lifetime during data gathering. The parameter that is very important for protocols in a sensor network is its energy awareness. The factors that are creating unequal energy dissipation among the nodes are the distance of nodes from base station and inter nodal distances in the network. Thus the protocol designed should be energy efficient and robust to good deal with. The Wireless sensor network has number of applications but data gathering is the better application in which Wireless Sensor Network is used to collect periodically data from sensor field. Various numbers of protocols are used in order to enlarge the life time by efficient use of energy. Pegasis, Aco are discussed in this thesis work. We are using Pegasis technique for data gathering in our research work. And comparison of these algorithms and find out which one is best for data gathering.

Keywords: WSN, PEGASIS, ACO, energy consumption, data gathering etc.

1. Introduction to wireless sensor network (WSN)

Wireless sensor networks are widely distributed networks of small lightweight nodes that are arranged over large area. Sensor node has capability of sensing, first it sense the data and after that process that data. After processing it route that data to base station via a communication medium. Ad hoc networks are also similar to wireless networks. The sensor network has a large number of nodes. Due to more prone to failure, energy drains
rapidly. They have no different global IDs. Maintaining the lifetime of wireless sensor network is most important goal in sensor network research area. Sensor networks are deal with sensitive data, so there also need some security deliberation. There is few architectures overviewed and routing protocol suitable for Wireless Sensor Network (WSN).

![Diagram of wireless sensor node architecture]

Fig 1.1: Architecture of wireless sensor nodes

2. Description of Routing in Wireless Sensor Networks

Routing is a process of formative a path between source with destination upon request of data transmission. In WSNs the network layer is frequently used to implement the routing of the incoming data. It is known that usually in multi-hop networks the source node cannot reach the sink directly. Hence intermediate sensor nodes have to relay their packets. The performance of routing tables gives the solution. These contain the lists of node option for any given packet destination. Routing table is the task of the routing algorithm along with the help of the routing protocol for their construction and maintenance.

2.1 Routing Challenges and Design Issues

Depending on the application, different architectures and design goals/constraints have been considered for sensor networks.
Network dynamics: Most of the network architectures suppose that sensor nodes are stationary, as there are very few setups that use mobile sensors. It is sometimes necessary to maintain the mobility of sinks or cluster-heads (gateways). Route stability becomes an essential optimization factor, in addition to energy, bandwidth etc. As, routing messages from or to moving nodes is more challenging. Therefore, the sensed event can be either dynamic or static depending on the application.

Energy considerations: During the creation of an infrastructure, the process of setting up the routes is greatly influenced by energy considerations. Since the transmission power of a wireless radio is proportional to distance squared or even higher order in the presence of obstacles, multi-hop routing will consume less energy than direct communication. Most of the time sensors are scattered randomly over an area of interest and multihop routing becomes unavoidable.

Routing Techniques in Wireless Sensor Networks

WSN Routing Protocols can be classified in four ways, according to the way of routing paths are established, according to the network structure, according to the protocol operation and according to the initiator of communications. Fig. 3 shows the classification of WSN routing protocols.

![Fig 2: Classification of WSN Routing Protocols.](image)
Routing paths can be established in one of three ways, namely proactive, reactive or hybrid. Proactive protocols compute all the routes before they are really needed and then store these routes in a routing table in each node. When a route changes, the change has to be propagated throughout the network. Since a WSN could consist of thousands of nodes, the routing table that each node would have to keep could be huge and therefore proactive protocols are not suited to WSNs. Reactive protocols compute routes only when they are needed. Hybrid protocols use a combination of these two ideas. But in general, routing in WSNs can be divided into three categories named as flat-based routing, hierarchical-based routing and location-based routing depending on the network structure. In flat-based routing, all nodes play the same role. In hierarchical-based routing, however, nodes will play different roles in the network. In location-based routing, sensor nodes' positions are exploited to route data in the network. Furthermore, these protocols can be classified into multipath-based, query-based, negotiation-based, QoS-based, or coherent-based routing techniques depending on the protocol operation.

Flat Routing (Data Centric Routing protocols): It is not feasible to assign global identifiers to each node due to the sheer number of nodes deployed in many applications of sensor networks. Such lack of global identification along with random deployment of sensor nodes makes it hard to select a specific set of sensor nodes to be queried. Therefore, data is usually transmitted from every sensor node within the deployment region with significant redundancy. This consideration has led to data-centric routing. In data-centric routing, the sink sends queries to certain regions and waits for data from the sensors located in the selected regions.

Location-based protocols: In most cases location information is needed in order to calculate the distance between two particular nodes so that energy consumption can be estimated. Generally two techniques are used to find location, one is to find the coordinate of the neighboring node and other is to use GPS (Global Positioning System). Since, there is no addressing scheme for sensor networks like IP-addresses and they are spatially deployed on a region, location information can be utilized in routing data in an energy efficient way.

Multipath routing protocols: Multiple paths are used to enhance the network performance. When the primary path fails between the source and the destination an
alternate path exists that measured the fault tolerance (resilience) of a protocol. This can be increased, by maintaining multiple paths between the source and the destination. This increases the cost of energy consumption and traffic generation. The alternate paths are kept alive by sending periodic messages. Due to this, network reliability can be increased. Also the overhead of maintaining the alternate paths increases.

3. Data Gathering Using ACO & PEGASIS

3.1 Ant Colony Optimization

Ant Colony Optimization (ACO) is one of the newly arrive swarm intelligence technologies. These technologies 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). The preliminary experimental results were very promising and supported more research efforts for this new optimization method. After AS, many different ACO algorithms have been proposed and successfully applied in different optimization problems including the TSP problem, scheduling, vehicle routing, etc. as well as the routing problem in telecommunication networks. Many of these algorithms provide the world-class performance. Further, it has been shown that Ant colony algorithms are not only suitable for static applications but also successfully applied in dynamic setting, such as wireless network communication where the traffic at different points keeps fluctuating with time.

3.2 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.

4. Proposed Algorithm for PEGASIS

- Randomly place n number of nodes.
- Each node will transmit and receive from its nearest neighbor and take turns in transmitting to the sink.
- The ith node will occupy some random position.
- An open chain starting from the node farthest from the base station is formed.
- The next nearest node is selected which have smaller inter-nodal distance with the present node and so on full chain construction takes place.
- This approach is known as greedy approach.
- A simple token passing approach which is initiated by the leader to start data transmission from the ends of the chain.
- The leader elected in a particular round receives the fused data packets of the nodes in the network from its two neighbors, fuses it with its own data packet and finally this single data packet is transmitted to the base station.
- When a node dies, the chain is reconstructed bypassing the dead node.
- The network lifetime depends upon the alive nodes. As the node starts dying, the network performance degrades.
- Number of rounds are calculated after 20%, 30%, 60%, 90% node deaths. The more the number of rounds, more is the network lifetime.

5. Simulation Results and Discussions

The description of the results of wireless sensor network. To increase the network lifetime and data gathering process for wireless sensor networks, ACO routing protocol is used. The data are selected and transferred from the source to the destination via the nodes. In this result we implemented the simulation of PEGASIS protocol and ACO and
also calculated its performance such as throughput and energy level. All simulations were
done on a 100m*100m area and nodes were randomly distributed in this region. The
implemented protocol PEGASIS is simulated using 100 nodes. The chain construction is
done in PEGASIS using greedy approach. The simulations are done to determine the
number of nodes when 10%, 30%, 60%, 90% of nodes die. Each node has same initial
energy level. The final results obtained after the simulation are as given below:

In Fig.3.1 we use PEGASIS with parameters given below:

- Initial energy = 0.25
- No. of Nodes = 100
- Maximum no. of rounds = 5000
- Transmit factor = 512*0.000000001;
- Packet Length = 32;
- sink distance x-axis = 100;
- sink distance y-axis = 100;

![PEGASIS Graph between Network Life time and Total No of alive Nodes with initial energy 0.25](image)

- In Fig.3.2 we use PEGASIS with parameters given below:
• Initial energy = 0.5
• No. of Nodes = 100
• Maximum no. of rounds = 5000
• Transmit factor = 512*0.000000001;
• Packet Length = 32;
• Sink distance x-axis = 100;
• Sink distance y-axis = 100;

Fig. 3.2 PEGASIS Graph between Network Lifetime and Total No of alive Nodes with initial energy 0.5.

5 Conclusion:

Data gathering is the process of collecting information from sensor nodes at the Base Station. This research describes various data dissemination methods and data gathering methods. PEGASIS is most efficient as compared to both Direct and LEACH. In PEGASIS chain construction is done by using Greedy algorithm. By using ACO it gives better performance as compared to previous one.

6 References


