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Research paper

An energy minimizing score based optimal data gathering in wireless sensor networks

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Abstract

In wireless sensor networks, Sensor nodes are arranged randomly in unkind physical surroundings to collect data and distribute the data to the remote base station. However the sensor nodes have to preserve the power source that has restricted estimation competence. The sensed information is difficult to be transmitted over the sensor network for a long period of time in an energy efficient manner. In this paper, it finds the problem of communication data between sink nodes and remote data sources via intermediate nodes in sensor field. So this paper proposes a score based data gathering algorithm in wireless sensor networks. The high-level contribution of this study is the enhancement of a score- based data gathering algorithm and the impact of energy entity for Wireless Sensor Networks. Then the energy and delay of data gathering are evaluated. Unlike PEGASIS and LEACH, the delay for every process of data gathering is considerably lower when SBDG is employed. The energy consumed per round of data gathering for both SBDG and EE-SBDG is less than half of that incurred with PEGASIS and LEACH. Compared with LEACH and PEGASIS, SBDG and EE-SBDG are fair with node usage because of the scoring system and residual energy respectively. Overall, the Score-based data gathering algorithm provides a significant solution to maximize the network lifetime as well as minimum delay per round of data gathering.

1. Introduction

Nowadays People at present world are very much interested in monitoring every entity in and around them. In their peering action sensor networks are the one which are widely used in large numbers to monitor the environment in which physical parameters such as temperature, sound, vibration, pressure, motion or pollutants are measured with an aid of sensors networks [1]. For instance, one of the famous German company namely ENOcean has offered the following harvesting devices for smart building lighting and air monitoring applications.

- Light energy harvesting devices
- Vibration energy harvesting devices
- Temperature-based energy harvesting devices

In sensor network each sensor node sends the sensed data to the sink (Base station). In WSN, it considers the problem of communicating data between the base station and sensor nodes which are located remotely in a hierarchical sensor network.

2. Related works

Wendi Heinzelman et al (2000) have expressed Low Energy Adaptive Clustering Hierarchy (LEACH), a clustering based routing protocol.

These systems minimize global energy usage by dispensing the load to all the nodes at dissimilar points in time. LEACH protocol outperforms static clustering algorithms by necessitate nodes to volunteer to be high-energy cluster heads and adapting the equivalent clusters based on the nodes that prefer to be cluster heads at a given time. The performance is high when the energy is distributed among the various nodes in the network thereby reducing the energy dissipation.

Stephanie Lindsey et al (2001) have considered the difficulty of gathering the data from a sensor web having a group of N nodes. The purpose is to find collection of data balances the energy and delay cost.

Stephanie Lindsey et al (2002) have presented an enhanced method, called Power Efficient Gathering in Sensor Information System (PEGASIS), which also resembles the near-optimal chain-based protocol that decreases the energy consumption [3].

Siva D.Muruganantham et al (2005) have proposed a centralized clustering-based routing protocol, Base-station Controlled Dynamic Clustering Protocol (BCDCP) that employ the high energy base station to execute the majority power- demanding tasks. The sensor nodes are reassured of computing the energy intensive computational tasks by using the base station such as cluster setup, Picking of cluster head, Creation of routing path, and Designing of TDMA schedule [5].

Xin Liu, Quanyu Wang et al (2008) have proposed a distributed, energy-aware data gathering and routing protocol for wireless sensor networks [6].

Indu shukla et al (2009) have proposed the traditional data gathering protocols for wireless sensor networks. PEGASIS works by forming a chain of the sensor nodes starting from the node farthest away to the sink. It studies the PEGASIS protocol for both Time Division Multiple Access (TDMA) and CDMA systems.

Natarajan Meghanathan (2010) has developed an Energy-aware Maximal Leaf Nodes Data Gathering (EMLN-DG) algorithm that reduces the wastage of energy loss in each iteration of data gathering as well as maximizing the number of rounds of communication [6].

Bencan Gong et al (2011) have proposed a power-aware tree-based routing protocol (TRP) for wireless sensor networks. All network nodes are controlled into a tree rooted on sink according to the announcement cost and the outstanding energy of neighbor nodes [7].

Based on this survey, the need for reliable and efficient data gathering in Wireless Sensor Networks using Data Gathering and Delay Computing Algorithm to increase the network lifetime and reducing delay during data collection from downstream node to upstream node (sink or Head node) is required.

3. Problem finding and proposed method description

The aim of the data congregation is to send the logical data that are exactly sensed from sensor nodes to a base station (BS). One round is distinct as the base station collecting data from all the sensor nodes once. The target of proposed protocols which execute data assembling is to take full advantage of the number of rounds of interactions earlier than the nodes expire and the network become untreatable. This means the minimum amount of energy should be consumed and the transmission of the data between two nodes should happen with minimum delays. Therefore, the energy and delay metrics are used to compare protocols, since this metric measures speedy and energy-efficient data gathering.

Low-Energy Adaptive Clustering Hierarchy (LEACH) is the one of the popular protocol for data gathering where, the nodes organize themselves into local clusters, with a node acting as cluster head. If the cluster heads are chosen a priori and fixed throughout the system lifetime as like the concepts of conservative clustering algorithms. The conservative clustering methods are very simple to observe that the unsuccessful sensors chosen to be cluster heads would die quickly, ending the useful lifetime of all nodes belonging to those clusters. However, the LEACH's head nodes may be wasted the considerable energy during collecting and transmit the data to the base station.

Power-Efficient Gathering in Sensor Information System (PEGASIS) is another improved protocol where only one node will be chosen as head node which sends the merged data to the BS per round. This achieves a factor of improvement of 2 compared to LEACH protocol. However PEGASIS is used only one head node so it may be the bottle neck of the network causing delay. PEGASIS is not considered the distance of BS from the head node while choosing a head node. When a head node is selected its energy level is also not considered.

This paper proposes a Score-Based Data Gathering (SBDG) for wireless sensor networks, and plans to provide reliable and efficient data gathering algorithm. The objective of this protocol is to preserve the use of energy of these sensor nodes and increase the network lifetime, minimizing delay at the same time and gathering the data efficiently.

A permanent amount of power is exhausted in getting and sending a packet. The cost of energy and delay for data gathering in a network of N nodes and it will also depend on the node distribution in the playing field, gathering data efficiently and energetically using Score based data gathering algorithms. This protocol is also used to minimizes delays for time critical data while retrieving all other data on demand basis and ensure the constant quantity of power used up in getting and broadcasting a packet.

4. Score based data gathering protocols

This method works based on the procedure that the nodes which contacts with one another within its transmission ranges would form a graph. An identifier of some integer value is generated by each node in sequential order. Before first round starts to involve in activity random generator assigns a score to each sensor node. In this work Head node will act as root or head node so Selections of Head nodes for first round are done by random generator on the basis of highest score value because all nodes have equal energy during first round of data gathering.

Every time a request is made to sink node, a new score is assigned to each node. For gathering data in first round, the coordinates of nodes are generated based on random values created by random generator. In subsequent rounds, the node's coordinators are determined based on score value. Euclidean distance formula is used to identify the distance between two nodes. If their distance is less than or equal to the preset transmission range, then an edge is placed in such manner that it lies between the first node and second node.

After all the edges are placed, within the graph, a tree map data structure is used to form an adjacency list.

In subsequent rounds, node's scores are based on the residual energy available in the sensor node.

It is unfair if the same node remains as an Head node, because Head node has additional responsibility and also loses a bit more energy during gathering data. This calculation will be continued for gathering data until first node dies in any sub graphs. Figure 1 shows a picture of a network topology that compress of 16 sensor node.

In the graph the identifier is assigned to each node for identifying the nodes easily. The score values are indicated outside the circle after some rounds of gathering process and also sub networks are shown in figure 2.

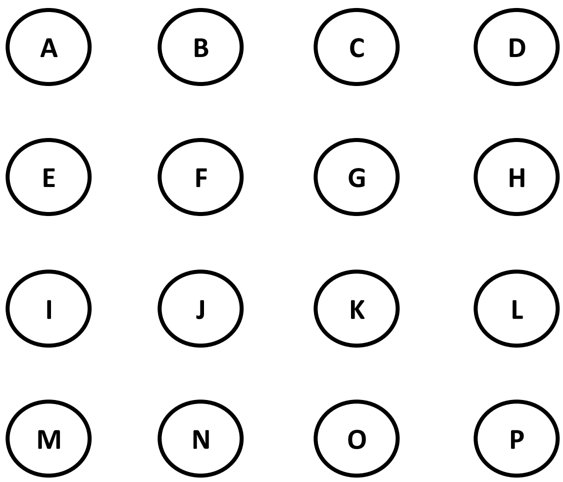

Figure 1: Proposed Network Structure

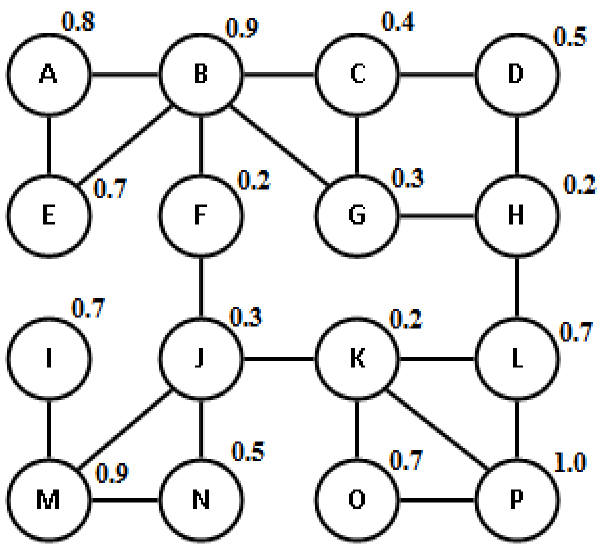

Figure 2: Score values and sub networks

Finding Head and Leaf Nodes: The assembling of the graph is completed to find the associates and leaf nodes by using the SBDG algorithm.

- **Step 1:** It starts with selecting Head node which has the highest score among all its neighbours.
- **Step 2:** If every node **h** is not selected as Head node in step1 then it can choose the neighbouring node **ln** as Head node, then node **h** becomes leaf node for **ln.**
- **Step 3:** If a node is not able to assigned as a leaf node for any Head Node selected in Step 1, then the node's score value is to be increased using random generator as Head Node and is added to the list of Head Nodes.
- **Step 4:** Every pair of nodes should be linked in a complete graph including involving the Head Nodes formed from Steps 1 to 3.
- **Step 5:** Then the complete graph formed in Step 4 and the complete graph which is executing by Kruskal's algorithm.
- **Step 6:** The Minimum Spanning Tree (MST) formed in Step 5 which is transformed to a Rooted Directed Tree (RDT) with the root being the Head Node with the largest available energy.

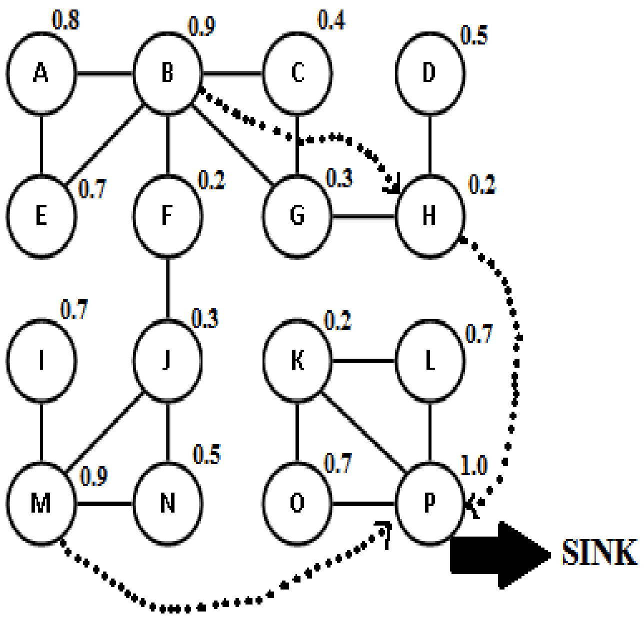

Figure 3: Score Based Data Gathering Tree

The Score Based Data Gathering tree is shown in figure 3. In this tree it consists of 16 nodes and one sink. It has 12 leaf nodes and four Head nodes detected by procedures of detection Head and leaf nodes. The number of head nodes and leaf nodes may vary depending upon the formation of graph while applying tree map. Here node P (dark blue) is the root node because it has highest score among all Head nodes. If user requests any information in the sensor field sink can communicate through node P. The node P can collect the results of all Head nodes. The root node can send the information to the sink with help of same radio. Finally user gets information through satellite or internet.

5. Results and analysis

The proposed techniques were implemented by network simulator version 2.28. The performance of the proposed data gathering algorithm and evaluation of the performance of the algorithm is compared with PEGASIS, LEACH and Direct Transmission. The following metrics are measured and compared with Network lifetime, Energy consumption, Delay, Energy×delay, Height of the DG-tree, Leaf nodes.

This work attempts an investigation into the existing efficient data gathering algorithms proposed for WSNs. And also focused on reliable and energy efficient data gathering algorithm in wireless sensor Networks using score based data gathering algorithms where nodes have different transmission ranges and different sink node locations.

Theoretical analysis was carried out to evaluate its performance of the proposed algorithm. Figure 4 shows the round of first node failure. The SBDG and EE-SBDG protocols have good performance during the first node failure compared to other protocols such as PEGASIS, LEACH and Direct transmission. First node failure has increased while increasing the transmission range. The X- axis represents the transmission range in meter and the Y- axis represents the round of first node failure.

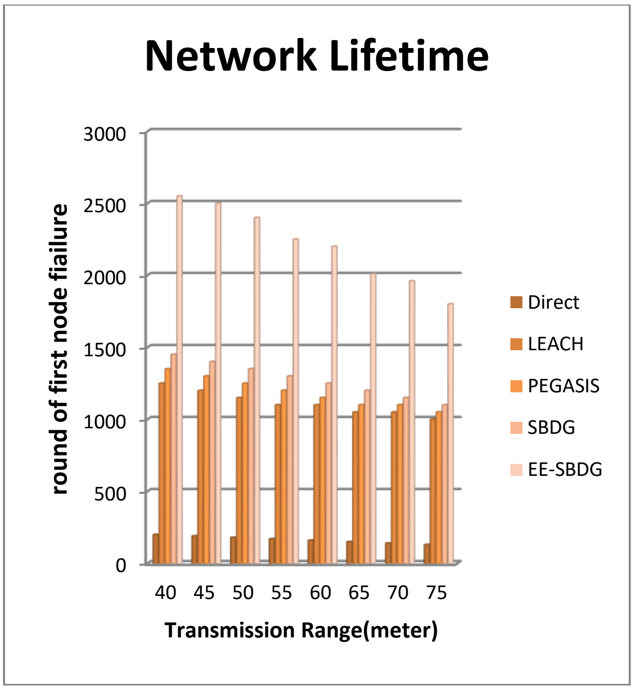

Figure 4: Transmission range Vs round of first node failure

Energy consumption is increasing when transmission range is increasing. Energy consumption of data gathering is less than energy consumption of sending data to the upstream node. Energy consumption per round is shown in figure 5.

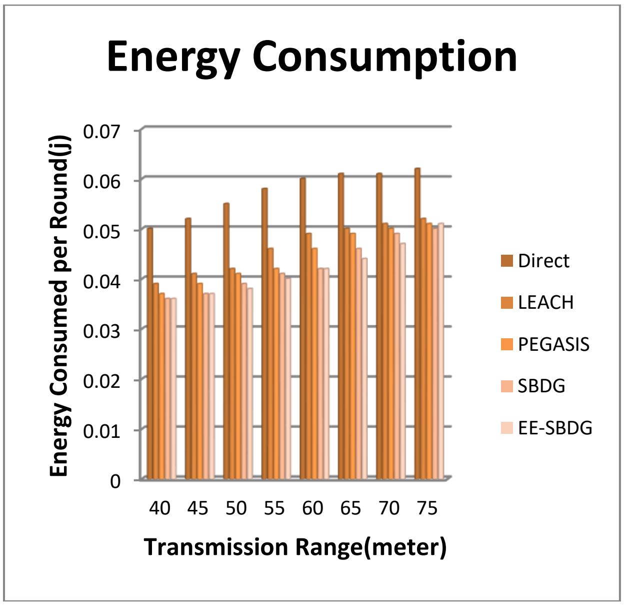

Figure 5: Transmission range Vs energy consumed per round

6. Conclusion

The developed algorithms are benefited to increase the lifetime of a network by spending minimum amount of energy. Algorithms are also developed to decrease delay during the gathering of data without substantially increasing energy consumption.

Unlike PEGASIS and LEACH, the delay per round of data gathering is considerably lower when SBDG is employed. Compared with other existing protocols, SBDG and EE-SBDG are fair with node usage because of the scoring system and residual energy respectively. Overall, the score-based data gathering algorithm gives a significant solution for gathering data effectively with maximize the network lifetime.

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