Indian Journal of Science and Technology, *Vol 7(S4), 76–79, April 2014*

ISSN (Print) : 0974-6846
ISSN (Online) : 0974-5645

Attribute based Spanning Tree Construction for Data Aggregation in Heterogeneous Wireless Sensor Networks

R. Jayalakshmi[1*], B. Baranidharan[2] and B. Santhi[3]

[1]School of Computing, SASTRA University, Thanjavur, Tamil Nadu- 613401, India;
ammu.jaya13@gmail.com , baranidharan@it.sastra.edu, shanthi@cse.sastra.edu

Abstract

Wireless sensor network consists of densely deployed sensor nodes which have limited resources like energy, node lifetime. Data aggregation is an effective scheme to reduce redundancy of sampled data generated by sensor nodes. Homogeneous sensor networks easily adapt the data aggregation scheme because of easy synchronization of data samples; but heterogeneous sensor network have difficulty to handle data aggregation due to synchronization of different data packets produced by different sensor nodes. In order to perform efficient data aggregation in heterogeneous sensor networks our proposed method Attribute based Spanning Tree (AST) introduced the method of attribute based spanning tree construction over heterogeneous networks. Based on the characteristics of sensor nodes, logical separation of nodes formed then each group constructs Minimum Spanning Tree (MST), aggregation follows this MST to reach sink node. By adapting Kruskal's algorithm into our proposed method MST is constructed in sensor nodes. Our simulation results shows that AST is more spatially convergent and it uses shortest path cost for aggregation leads to increase node lifetime and saves energy.

Keywords: Data Aggregation, Heterogeneous Sensor Networks, Spanning Tree

1. Introduction

Wireless Sensor Networks (WSNs) are the collection of sensor nodes which doing the functions of sensing, processing and transferring environmental information to the base station. It increasingly used in different applications such as habitat monitoring and environment[1-3], are used for data gathering application areas. Data aggregation is the effective mechanism to increase the lifetime of the sensor nodes, eliminating unnecessary redundant data transferring, and reducing traffic overhead. To achieve energy efficient sensor node network, it is essential to include data aggregation and to deploy variety of applications in WSN, it uses different sensors such as humidity, pressure, sound, motion, vibration, acoustic, temperature. They are used at habitat monitoring[4], fire detection systems[5], target tracking[6] applications.

2. Related Works

In network aggregation[7], which is aggregating values of sensor nodes inside the network and avoiding individual communication of sensor node to base station. This method is well known that avoids redundant data packets, but not fit for heterogeneous sensor networks.

Select Cast method[8] is the combination of Multiple Hop Length (MHL) and Single Hop Length (SHL) method where SHL is non-hierarchical routing scheme where links have similar length, based on lower bound threshold value of gathering efficiency particular sensors

**Author for correspondence*

are selected in local regions. MHL is hierarchical routing scheme where different length links has been connected and fixed number of sensors is selected by using block coding technique, aggregation done at network.

EADAT[9] provides aggregation by using broadcast scheduling among neighbors of sink node; It deals with the residual energy of individual nodes in sensor network. EADAT introduced heuristic for constructing aggregation tree; the sensor node which have high residual energy do the process of broadcasting. Residual energy comparison is made at each aggregation step; if one sensor node has high residual energy than other, broadcasting operation turns to next node, finally the node which have high residual energy among all sensor nodes get the channel to transmit data and send packets. Even though this approach may efficient for tree based network, broadcasting needs more energy.

TAG[10] introduced the concept of merging in network aggregation with querying language. To aggregate sensor information this approach uses SQL queries with aggregation scheme; Queries do the job of aggregator functions such as MIN, AVG, and MAX. TAG provides interface for sensor node aggregation later executes aggregation operator using SQL queries.

GIST[11] provides a way to construct tree over sensor nodes; Based on group independent spanning tree construction, aggregation done at those nodes. GIST uses shortest path tree (SPT) and Minimum Spanning Tree (MST) schemes; It decreases tree formation overhead in network. Once GIST tree is constructed, sink broadcast request queries and get corresponding sensory information from sensors through that constructed tree.

PEDAP[12] provides near optimal shortest path spanning tree method in routing scheme; It assumes only tree based sensor node architecture. Using prim's algorithm, spanning tree is constructed among sensor nodes; It first start with node includes minimum weighted edge node for each iteration until all the sensor nodes are covered without creating cyclic. According to tree construction, sensory data packets are routed to reach sink node, in order to achieve less power consumption of network. This approach uses number of election rounds; some nodes are die due to less energy, in next iteration sink node eliminates those nodes and to continue next round.

All those existing schemes[7-12] may produce efficient aggregation in homogeneous sensor network, but does not appropriate for heterogeneous sensor network.

3. Proposed Method

Data aggregation in homogeneous sensor network is quite easy. But it is challenging to perform data aggregation in heterogeneous sensor network. A two or more different applications grouped to form heterogeneous sensor networks where different types of nodes are involved. In such cases, data aggregation is difficult because of synchronizing different sensor packets. To avoid such inconsistencies, we proposed our algorithm AST that implies logical separation of sensor network i.e. same type of sensors forms a virtual path to group together. After sorting out sensor groups examine MST among sensor nodes of each group. MST connects all sensors by choosing shortest distance to travel from one node to another. It generates graph to include all nodes without forming cyclic group among nodes. Data aggregation is done at MST graph nodes to avoid reaching same node again.

3.1 Phases Involved in Algorithm

- Construction of MST
- Sequential aggregation

3.1.1 Phase 1: Construction of MST

Initially, the heterogeneous networks are collaboration of various types of sensor nodes, later those sensor nodes to be arranged by its characteristics i.e. same type of sensors grouped to form virtual link based on sensor characteristics like its measuring units, communication range logical arrangement is made.

Now the MST is constructed by using Kruskal's algorithm for group of sensors. Kruskal's algorithm is a greedy algorithm to form MST by finding shortest distance between two nodes in tree; here sensors are nodes of a tree it consider nodes in ascending order of its weight. The minimum weight node is get preference to form MST, similarly start from initiator node MST is constructed by selecting minimum weight path to reach sink node. For each type of sensors separate MST is constructed by using Kruskal's algorithm likewise MST is constructed in all the groups in heterogeneous networks.

3.1.2 Phase 2: Sequential Aggregation

After figure out MST construction of all groups, step by step sequential aggregation is conducted at every sensor group. A node which is at most far away from sink node is initializing data aggregation; initiator node start aggregation from its position, then the process gradually goes to next sensor nodes there by achieving aggregation. MST of one sensor group does not interfere another sensor group path; for each group initiator will be different.

3.2 Motivation

Assume three different application sensors used in heterogeneous network. Figure 1 depicts that small sample portion of WSN network. In Figure 1 solid circle represents pressure sensor node; empty circle represents temperature sensor node. To apply existing aggregation schemes[7,10,12] are not work efficiently in this sensor network because of using two different application sensors such as pressure and temperature. If in case pressure sensor node sent its data packet to temperature sensor node, it is impossible to cumulate those two values due to different measuring unit of sensors. But our proposed algorithm solves the problem of data aggregation at heterogeneous network. In this sensor network pressure sensor nodes are identified to form one logical group, similarly temperature sensor nodes also arranged. In each logical group MST is constructed separately then follows sequential aggregation made at every group by using Kruskal's algorithm.

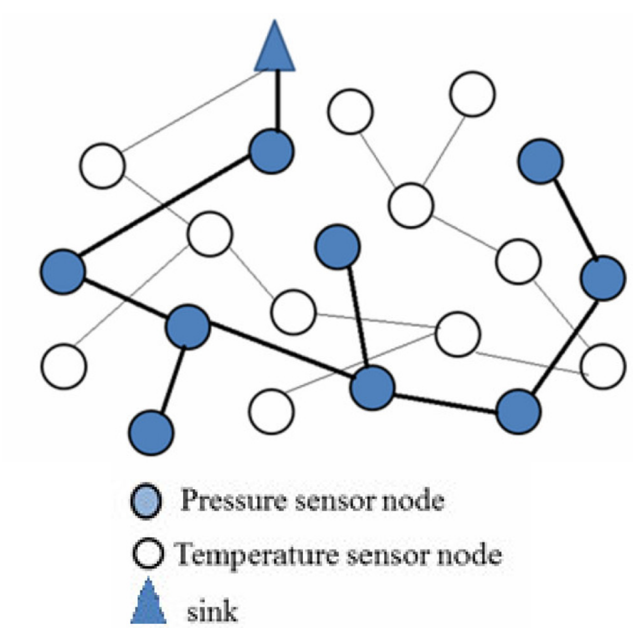

Figure 1. MST construction at Heterogeneous Network.

4. Experimental Setup

We implement our AST scheme in matlab; To simulate our proposed method AST, Figure 2 depicts that we deployed 100 sensors nodes in 100 X 100 m rectangular area which are heterogeneous sensors such as 34 temperature sensor nodes, 33 pressure sensor nodes, 33 humidity sensor nodes are randomly placed in application area.

Each group of sensor nodes are identified, MST constructed separately on the groups by using our AST scheme Figure 3, 4, 5 shows the MST construction of temperature, pressure, humidity sensor groups respectively.

To analyses the performance of AST scheme, two existing method such as In network aggregation[7] and TAG[10] are compared. The total energy consumption by all those methods is calculated by assuming same transmission energy, reception energy, path loss value and distance between two nodes.

Figure 6 illustrates that our proposed AST have consume less energy after aggregated data sent to base station.

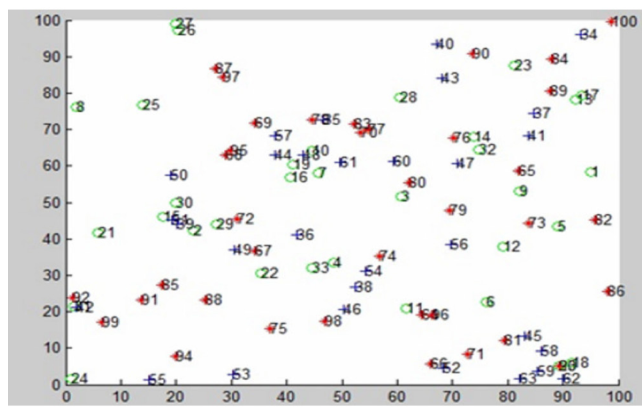

Figure 2. 100 sensor node deployment.

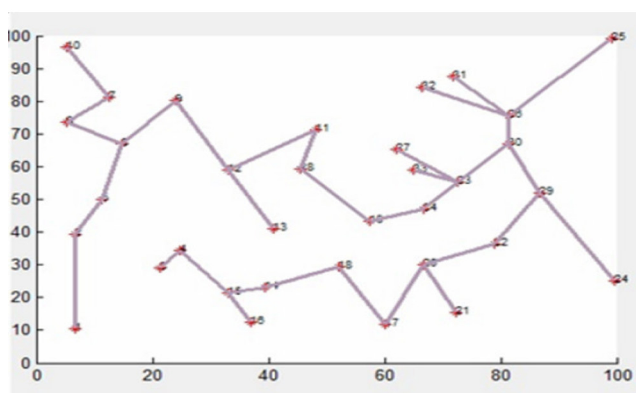

Figure 3. MST of temperature nodes.

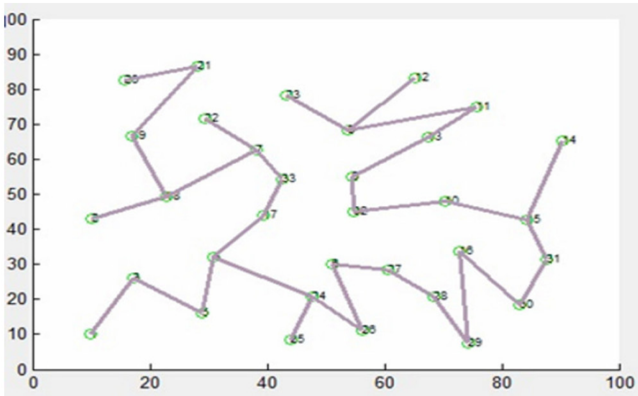

Figure 4. MST of pressure nodes.

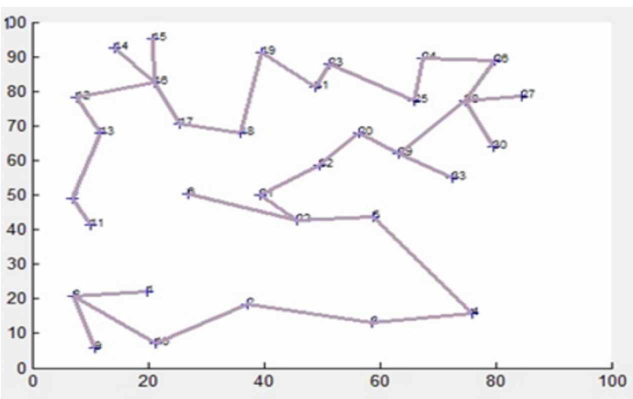

Figure 5. MST of humidity nodes.

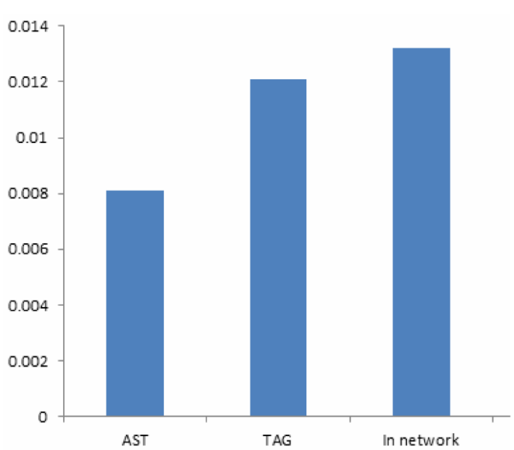

Figure 6. Energy consumption graph.

This occurs because AST uses shortest way to transmit the data which infers only less energy is needed. But at existing methods[7,10] each node uses individual transmission to base station leads more energy consumption; so AST works well at heterogeneous sensor network.

5. Conclusion

The data aggregation plays a vital part to create energy efficient WSN. In this paper we suggested AST to handle heterogeneity in sensor node network; AST gives a way to organize sensors into groups by its features, then construct shortest distance tree path to conduct data aggregation at each group. Thus the simulation results show AST uses minimum energy for total transmission and prolongs the node lifetime.

6. References

1. Mo L, He Y, Liu Y, Zhao J, Tang S, Li X, Dai G. Canopy closure estimates with greenorbs: sustainable sensing in the forest. Proc Seventh ACM Conf Embedded Networked Sensor Systems (SenSys '09); 2009.
2. Labraoui N, Guerroui M, Aliouat M, Zia T. Data aggregation security challenge in wireless sensor networks: a survey. Adhoc & Sensor Wireless Networks. 2011; 12(3/4):295–324.
3. Liu C, Cao G. Minimizing the cost of mine selection via sensor networks. Proc IEEE INFOCOM '09; 2009.
4. Cerpa A, Elson J, Estrin D, Girod L, Hamilton M, Zhao J. Habitat monitoring: application driver for wireless communications technology. SIGCOMM Comput Commun Rev. 2001; 31(2):20–41.
5. Cleary TG, Notarianni KA. Distributed sensor fire detection. Proc Int Conf Autom Fire Detection (AUBE); 2001. p. 139–50.
6. Zhang W, Cao G. DCTC: Dynamic Convoy Tree-based collaboration for target tracking in sensor networks. Ad Hoc and Sensor Wireless Networks. 2004 Sept; 3:1689–701.
7. Yao Y, Gehrke J. The cougar approach to in-network query processing in sensor networks. SIGMOD Rec. 2002; 31(3):9–18.
8. Cheng W, Shaojie T, Mo L, Changjun J. SelectCast: scalable data aggregation scheme in wireless sensor networks. IEEE Proceedings. 2011; 3(4).
9. Ding M, Cheng X, Xue G. Aggregation tree construction in sensor networks. IEEE. 2003; 2168–72
10. Madden SR, Franklin MJ, Hellerstein JM, Hong W. TAG: A Tiny Aggregation service for ad-hoc sensor networks. Proc Symp Operating Systems Design and Implementation (OSDI). 2002 Dec. p. 131–46.
11. Jia L, Noubir G, Rajaraman R, Sundaram R. GIST: Group Independent Spanning Tree for data aggregation in dense sensor networks. 2006. p. 282–304
12. Tan HO, Korpeoglu I. Power efficient data gathering and aggregation in wireless sensor networks. SIGMOD Record. 2003 Dec; 32(4):66–71.