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Efficient Data Transmission Clustering Method Using Compressive Sensing for Wireless Sensor Networks

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Abstract— **Compressive sensing (CS) reduces the number of data transmissions and also balances the traffic load throughout the networks. However, the total number of transmissions for data collection by using pure compressive sensing is still large. The hybrid method of using compressive sensing technique was proposed to decrease the number of transmissions in the sensor networks. The previous works also used the Compressive Sensing technique on the routing trees. Proposed a clustering method which uses hybrid compressive sensing for the wireless sensor networks. The sensor nodes are arranged into clusters which means the group of nodes. Inside the cluster, nodes transmit the data to cluster head (CH) without using compressive sensing technique. The two levels of transmission in clustering method using hybrid CS technique are: Intra cluster transmission that do not use CS technique and Inter cluster that uses CS technique. The data size is same in both the methods. Reducing the number of data transmission can decrease the energy consumption of the sensor nodes. The sensor nodes are independently and uniformly distributed in sensor field. The distance between sensor nodes in the sensor field is determined by Euclidian distance which is in communication range. Sensor nodes collect the data periodically and transmit to sink through multi-hop with less number of transmissions using clustering method. Sensor data in the sensor networks has temporal or spatial correlation. The correlated data is in the form of wavelet domain or Fourier transform domain. Proposed model explains the relationship among the size of clusters and number of data transmissions in the hybrid CS method which aims of calculating the optimal size of clusters that can lead to minimum number of data transmissions. Proposed a centralized clustering algorithm based on the results obtained from the analytical model. The proposed methodology aims at using information of the node distribution and node location to enhance a clustering method which uses hybrid CS for sensor network.**

I. Introduction

A wireless sensor networks spatially distributed autonomous sensors to monitor environmental or physical conditions, such as sound, temperature, pressure, vibrations, seismic events etc. and pass their data through the network to a main location. Most of the modern networks are bi-directional and also enables the control of sensor activity. The growth of wireless sensor networks was initially inspired by the military applications such as battlefield surveillance; today many such networks are used in many industrial and consumer applications, such as control machine health monitoring, industrial process monitoring, and so on. The WSN is built of many number of nodes from a few to several hundreds or even thousands, where every node is connected to every other (or sometimes several) sensors. Compressive sensing means that the sample and compression is based on the fact that signal can be recovered by relatively small number of random projection which contains most of its salient information. Compressive sensing improves the performance in wireless sensor networks by decreasing the number of re-transmission [1]. Signals are sampled according to the nyquist rate which is sampled at the rate of twice the highest frequency in order to be represented without error.

II. Existing System

In many sensor network applications, such as environment or physical monitoring systems, sensor nodes need to collect the data periodically from all the nodes and transmit them to the data sink through single hop or multi-hops. According to field experiments, the data communication contributes towards the energy consumption of the wireless sensor nodes [1]. It has become a necessary issue to decrease the amount of data transmissions in wireless sensor networks. The trending technology of compressive sensing (CS) [2], [3], [4] technique opens new frontiers for the aggregation of data in sensor networks [5], [6], [7], [8], [9], [10], [11], [12] and target localization in sensor networks. The compressive sensing (CS) method can substantially reduce the number of data transmissions and simultaneously balance the traffic load throughout the entire network.

III. Proposed SYSTEM

Proposed clustering method uses the hybrid CS for sensor networks. The sensor nodes are arranged into clusters comprising of many nodes. Within the cluster, nodes transmit the data to the cluster head (CH) without using CS. A data gathering tree spanning all the CHs is constructed to send data to the sink by using the CS technique. If the size of the cluster is too small, the number of clusters will be more and the data gathering tree for all CHs to send their collected data to the sink will be more, which would lead to a many number of transmissions by using the CS method but if the cluster size is

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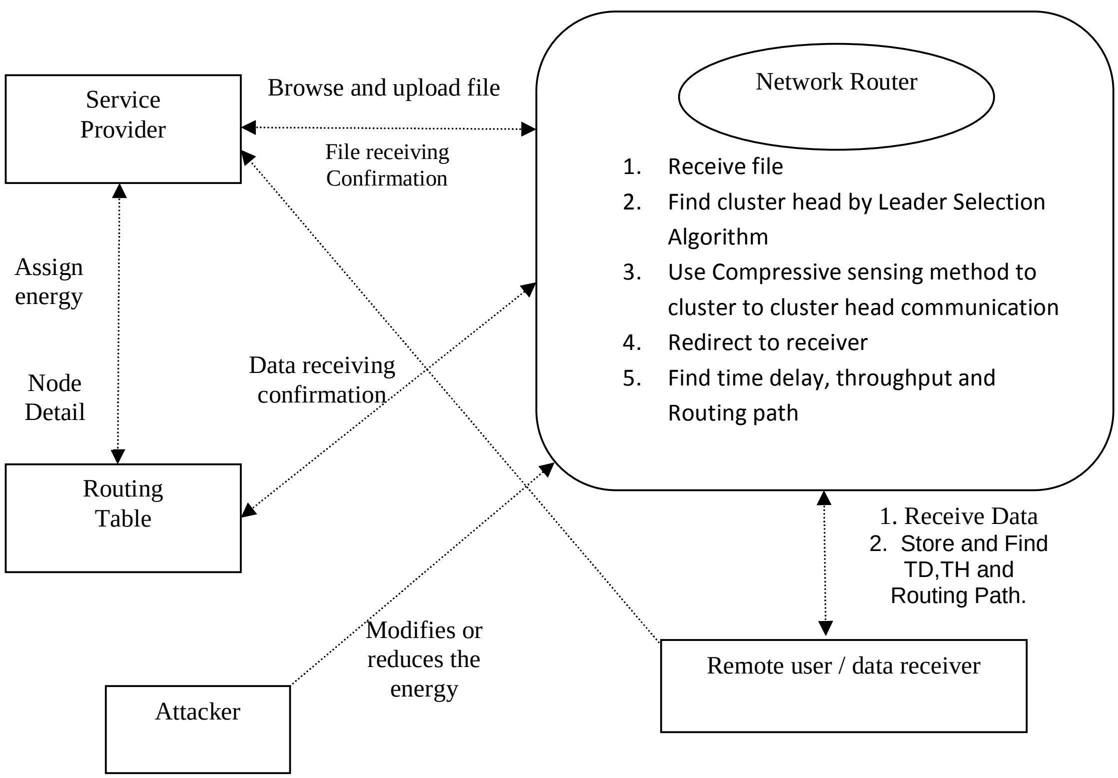
too small, the number of data transmissions required to collect the data from sensor nodes inside a cluster to the CH will be very high.

There are two levels of transmissions in our clustering method using the hybrid CS: inter cluster transmissions that use the CS technique and intra cluster transmissions that do not use the Compressive sensing technique. The data size in inter cluster transmissions is the same as the data in intra cluster transmissions. Thus, reducing the number of transmissions can effectively reduce the energy consumption of sensor nodes. For intra cluster transmissions, we simply let sensor nodes to send their data to the CH following the shortest path routing (in terms of number of hops). In inter cluster transmissions, we construct a minimal cost (in terms of number of hops) backbone tree which links all CHs to the sink and then transmit the data projections through this backbone tree.

Block Diagram



The system architecture for the proposed system is shown above. The service provider will browse the data file and then upload the browsed file to the router and router will send to particular receivers.

The Router manages a multiple clusters (cluster1, cluster2, cluster3, and cluster4) to provide data storage service. In cluster there are n-number of nodes named as (n1, n2, n3, n4…). Similarly, the cluster head will select different node based on highest energy. The time delay will be calculated according to the concept of routing delay.

In cluster n-number nodes are present and the clusters are communicates with every clusters (cluster1, cluster2, cluster3 and cluster4). The receiver receives the data file from the service provider through router. The receivers receive the file by without changing the File Contents.

Attacker is one who is injecting the fake energy to the corresponding sensor nodes. The Attributes are Network Model, Wireless sensor networks, attackers, clustering, data aggregation, compressive sensing, File Management, Congestion.

VI. Overview of Centralized Clustering Algorithm

The sensor network is designed by a graph G = (V, E) [15], [16],[17] where V represents the sink node and N is the number of sensor nodes present. If two nodes in V are within the communication range of each other, then there is a link between the two nodes.

As the centralized algorithm, it is assumed that the sink node has the full knowledge of the network topology. It already knows the network graph G = (V, E). The sink will divide the sensor nodes into many number of clusters, then chooses a Cluster Head for each cluster consisting of many nodes, and then construct a backbone tree that connects all Cluster Heads to the sink [18]. After computing the clustering, the sink broadcasts all the clustering information to sensor nodes and start collecting all the data respectively.

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Centralized Clustering Algorithm

In this section, we present the centralized clustering algorithm [22], [23], [24] . Given the network G = (V, E) our algorithm has two major steps:

1) Select C CHs from the set V of N sensor nodes and divide the sensor nodes into C clusters.

2) Construct a backbone routing tree that connects all CHs to the sink.

At each iteration, the algorithm proceeds following steps:

1. Connect sensor nodes to their closest CHs.

2. For each cluster, choose a new CH, such that the sum of the distances from all nodes in this cluster to the new CH is minimized.

3. Repeat the above two steps until there is no more change of the CHs.

This algorithm converges quickly. The simulations show that it takes nearly about four or five iterations on an average for computing the algorithm for CHs of clusters. We use a minimum spanning tree (MST)-based method which computes the backbone tree that connects all CHs comprising of all nodes and the sink.

Distributed Implementation

This section presents a distributed implementation of the clustering method.

1) Every sensor node knows its geographic location. This location information can be obtained via attached GPS or some other sensor localization techniques [20], [21].

2) The sink knows the area of the whole sensor field

This is a reasonable assumption, since in most applications of the sensor networks, usually the sink knows the area which has sensors surrounded for surveillance or environmental monitoring.

In our distributed algorithm, the sink divides the field into C cluster-areas, determines the geographic central point of each cluster-area having many nodes, and then later broadcasts the information to all sensor nodes to elect CHs. The sensor node which is the closest to the middle of a cluster-area is selected and said as CH. The CHs then broadcast advertisement messages to sensor nodes to invite sensor nodes to join their respective clusters.

Calculating Central Points of Cluster-Areas

Given a sensor field and the number of cluster C to be divided to, the sink needs to find out the central points of C cluster-areas. First divide the whole sensor field into small grids. Then, placed a virtual node at the center of each grid to represent the grid. Nodes in the grids will be selected as the approximate central points of the cluster-areas. Then use an auxiliary graph G = (V, E) to help finding the central points, where VA is the set of nodes in the grids, and each node in VA has a connection to every other nodes in its adjacent grids. Each grid, except that lies on the border of the sensor field, has eight adjacent nodes.

The sink then broadcasts the locations information of central points to all sensor nodes for CHs election.

The size of the grids that the sink divides the sensor field to depends on the accuracy of locating the central points. The smaller the size is, the more accurate the locations information will be, but it incurs more computation cost in this case.

Cluster Head Election

Given the geographic location of the central point of a cluster-area, the sensor node that is the closest to the central point will become the CH. Since the sensor nodes do not know who is the closest to the central point of a cluster area, and we do not know if at all if there is a sensor node which is falling into the close range of the central point, we let all nodes within the range of Hr from the center be the CH candidates of the cluster. The value of H is determined such that there is at least one node within H hops from the central point of a cluster. To elect the CH, each candidate node broadcasts a Cluster Head election message which contains nodes location, nodes identifier and the identifier of its own cluster. In the extreme case that no sensor node falls within H hops from the central point so that there is no CH for this cluster-area, the nodes in this cluster-area accept the request from adjacent CHs and then become members of other clusters. Thus, no node will be ignored out of the network.

Sensor Node Clustering

After a CH is elected, the CH broadcasts an advertisement message to other sensor nodes in the sensor field, to invite the sensor nodes to join its cluster. An advertisement message carries the information: the location and identifier of the CH, and the number of hops the message has traveled. Initially the hop count is limited to 0. When a sensor node receives an advertisement message, if the hop count of message is lesser than that observed from the same CH, it updates the information in its record including the node of previous hop and the number of hop to the CH, and further broadcasts the message to its corresponding neighbor nodes; else, the message is rejected. After the completion of advertisement of CH, each non-Cluster Head node chooses the cluster to which it should attach. The decision is based on how many number of hops to each CH is required. The routing from a sensor node to its CH follows the reverse path in forwarding the advertisement message. The data of the sensor nodes within a cluster is collected through this routing tree

Backbone Tree Construction and Sensor Network Maintenance

A backbone tree is constructed in a distributed fashion to connect all CHs and the sink. Through the broadcasting of the advertisement messages from CHs, each CH receives the advertisement messages from the other CHs that are close to it [25], [26]. Thus, it has the knowledge about the locations of its nearby CHs and the number of hops to them. Since the sink needs to broadcast the central point's information to all sensor nodes, all sensor nodes know the location of the sink and the hop distance to it. When a CH fails or runs out of energy, the

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neighboring nodes of the CH will detect the failure of the CH. These nodes will broadcast a message to all the nodes in this cluster to start the new CH election.

IV. CONCLUSION

In this paper hybrid CS was used to design a clustering-based data collection method, which reduces the data transmissions in wireless sensor networks. The information on locations and distribution of sensor nodes is used to design the data collection method in cluster structure. The Sensor nodes are organized into many number of clusters. Within a cluster, data are collected from all nodes to the respective cluster heads by shortest path routing; at the cluster head, data are then compressed to the projections using the Compressive Sensing technique. The projections are forwarded to the sink following a backbone tree.

First proposed an analytical model that studies the relationship between the size of clusters and number of transmissions in the hybrid CS method, to check the optimal size of clusters that can lead to small number of transmissions. Then, proposed a centralized clustering algorithm based on the results obtained from the analytical model on spanning tress. At last, presented a distributed implementation of the clustering method of wireless sensor networks. Extensive simulations confirm that our method can decrease the number of transmissions.

When the number of measurements is 10th of the number of nodes in the network, the simulation results show that our method can reduce the number of transmissions by about 60 percent compared with clustering method without using CS. Meanwhile, our method can reduce the number of transmissions up to 30 percent compared with the data collection method using SPT with the hybrid CS. Even for the non homogenous networks in the irregular sensor field, our method can effectively reduce the number of data transmissions compared with these data collection methods.

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