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CLUSTER METHOD USING HYBRID COMPRESSIVE SENSING FOR SENSOR NETWORK

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ABSTRACT-Compressive Sensing (CS) can reduce the number of data transmissions and balance the traffic load throughout networks. However, the total number of transmissions for data collection by using pure CS is still large. The hybrid method of using CS was proposed to reduce the number of transmissions in sensor networks. The previous works use the CS method on routing trees. In this paper, we propose a clustering method that uses hybrid CS for sensor networks. The sensor nodes are organized into clusters. Within a cluster, nodes transmit data to Cluster Head (CH) without using CS. CHs use CS to transmit data to sink. We first propose an analytical model that studies the relationship between the size of clusters and number of transmissions in the hybrid CS method, aiming at finding the optimal size of clusters that can lead to minimum number of transmissions. Then, we propose a centralized clustering algorithm based on the results obtained from the analytical model. Finally, we present a distributed implementation of the clustering method. Extensive simulations confirm that our method can reduce the number of transmissions significantly.

I. INTRODUCTION

A Wireless Sensor Network (WSN) consists of sensor nodes capable of collecting information from the environment and communicating with each other via wireless transceivers. The collected data will be delivered to one or more sinks, generally via multi-hop communication. The sensor nodes are typically expected to operate with batteries and are often deployed to not-easily-accessible or hostile environment, sometimes in large quantities. It can be difficult or impossible to replace the batteries of the sensor nodes. On the other hand, the sink is typically rich in energy [7]. Since the sensor energy is the most precious resource in the WSN, efficient utilization of the energy to prolong the network lifetime has been the focus of much of the research on the WSN. The communications in the WSN has the many-to-one property in that data from a large number of sensor nodes tend to be concentrated into a few sinks. Since multi-hop routing is generally needed for distant sensor nodes from the sinks to save energy, the nodes near a sink can be burdened with relaying a large amount of traffic from other nodes.

Sensor nodes are resource constrained in term of energy, processor and memory and low range communication and bandwidth. Limited battery power is used to operate the sensor nodes and is very difficult to replace or recharge it, when the nodes die. This will affect the network performance. Energy conservation and harvesting increase lifetime of the network. Optimize the communication range and minimize the energy usage, we need to conserve the energy of sensor nodes. Sensor nodes are deployed to gather information and desired that all the nodes works continuously and transmit information as long as possible. This address the lifetime problem in wireless sensor networks. Sensor nodes spend their energy during transmitting the data, receiving and relaying packets. Hence, designing routing algorithms that maximize the life time until the first battery expires is an important consideration. Designing energy aware algorithms increase the lifetime of sensor nodes.

In some applications the network size is larger required scalable architectures. Energy conservation in wireless sensor networks has been the primary objective, this constrain is not the only consideration for efficient working of wireless sensor networks. There are other objectives like scalable architecture, routing and latency [8]. In most of the applications of wireless sensor networks are envisioned to handled critical scenarios where data retrieval time is critical, i.e., delivering information of each individual node as fast as possible to the base station becomes an important issue. It is important to guarantee that information can be successfully received to the base station the first time instead of being retransmitted. In wireless sensor network data gathering and routing are challenging tasks due to their dynamic and unique properties. Many routing protocols are developed, but among those protocols cluster based routing protocols are energy efficient, scalable and prolong the network lifetime .In the event detection environment nodes are idle most of the time and active at the time when the event occur. Sensor nodes periodically send the gather information to the base station. Routing is an important issue in data gathering sensor network, while on the other hand sleep-wake synchronization is the key issues for event detection sensor networks.

Compressed sensing is a signal processing technique for efficiently acquiring and reconstructing a signal, by finding solutions to underdetermined linear systems [4]. This is based on the principle that, through optimization, the scarsity of a signal can be exploited to recover it from far fewer samples than required by the Shannon-Nyquist sampling theorem. There are two conditions under which recovery is possible. The first one is scarsity which requires the signal to be sparse in some domain. The second one is incoherence which is applied through the isometric property which is sufficient for sparse signals. MRI is a prominent application.

II. RELATED WORKS

Numerous secure data aggregation schemes have been proposed. These schemes are designed for different security requirements. A number of schemes [1] have been proposed based on the commit-and-attest principle. In these schemes, the base station broadcasts aggregation results to all sensors. Then, every sensor verifies that its sensing data were indeed counted. Another work [3] can actually count and sum even if a few compromised sensors inject false values. Yu [2] introduces a random sampling technique that enables aggregation queries to not only detect malicious sensors, but also to tolerate them.

On the other hand, several studies attempt to provide confidentiality. That is, an aggregator can directly execute addition operations on encrypted numeric data. CDA places more emphasis on passive attacks. More specifically, it considers if adversaries can eavesdrop the communications on the air. After CDA, succeeding research has been proposed to achieve higher security levels. They consider the following scenario. If sensors within the same cluster encrypt their sensing data with a common secret key, an adversary may decrypt or fake the aggregated ciphertext by compromising only one sensor. Later, Mykletun et al. proposed a data aggregation scheme based on addition homomorphic public-key encryption. It seems more secure since every sensor stores only public key. The adversary cannot launch the same attack through compromising only one sensor. Nevertheless, the adversary can still impersonate other legal sensors to send the forged cipertexts to the cluster head with the same public key. Authenticity of data is not supported.

III. PROBLEM STATEMENT

By using CS in data gathering, every node needs to transmit M packets for a set of N data items. That is, the number of transmissions for collecting data from N nodes is MN, which is still a large number. In the hybrid method, the nodes close to the leaf nodes transmit the original data without using the CS method, but the nodes close to the sink transmit data to sink by the CS technique. Applied hybrid CS in the data collection and proposed an aggregation tree with minimum energy consumption.

Clustering is a standard approach for achieving efficient and scalable performance in wireless sensor networks. Overlapping clusters are useful in many sensor network applications, including inter-cluster routing, node localization, and time synchronization protocols. A randomized, distributed multi-hop clustering algorithm (KOCA) for solving the overlapping clustering problem is also proposed. KOCA aims at generating connected overlapping clusters that cover the entire sensor network with a specific average overlapping degree [6]. Through analysis and simulation experiments we show how to select the different values of the parameters to achieve the clustering process objectives. Moreover, the results show that KOCA produces approximately equal-sized clusters, which allows distributing the load evenly over different clusters. In addition, KOCA is scalable; the clustering formation terminates in a constant time regardless of the network size. The following problems are identified from the existing system

- Geographic locations and node distribution of the sensor nodes are ignored
- The nodes close to the sink transmit data to sink.

IV. ROUTING AND DATA COLLECTION SCHEMES

Routing topologies play an important role in the performance of sensor networks in data collection and data dissemination. The Collection Tree Protocol (CTP) is the defector routing protocol standard for data collection. Since remote monitoring is one of the key drivers in sensor networks, data from individual nodes must be sent to a sink, often located far from the network, through the use of specific routing paths [9]. Typically, these routing paths comprise a spanning tree rooted at the sink node. During data collection, a node can send its data to its unique parent node, which in turn can send it to its parent and so on, until the data reaches the sink. The structure of the routing tree plays an important role in data collection. While one hand budgeting and technological constraints may require the placement of nodes at specific locations, thus sometimes limiting network performance in terms of throughput and delay, one might, on the other hand, construct specific routing topologies to optimize performance metrics.

A routing topology can either be static or dynamic. A static routing topology has the advantage of having fixed routing paths that are a priori known to the network designer and can be leveraged for easy maintenance and optimizing certain performance metrics, such as energy consumption, throughput, delay, etc. Since sensor nodes are subject to failure due to battery power depletion or environmental causes, static routing paths can at times be fatal in disconnecting the network. This might hamper network operations and requires additional resources for network maintenance. In addition, when new nodes join the network, re-computing some of the routing paths might be expensive.

On the other hand, dynamic routing topologies, such as those used in Dynamic Source Routing (DSR), routing paths are discovered only when a packet needs to be sent to a given destination. Computing such on the fly routing paths requires control messages to flow from the source to the destination, that could possibly include link quality estimation, congestion indicators, etc, which could help in establishing robust routing paths. Clearly, dynamic routing thus incurs overhead as compared to static routing.

In the context of data collection, which is the primary focus of this thesis, we consider routing topologies that are given a priori, as well as construct specific topologies that are optimized for enhancing the throughput-delay trade-off. In particular, given a deployment of nodes, our scheduling algorithms run on routing topologies that are optimized for maximizing aggregated converge cast throughput and minimizing data collection delay [5]. We propose algorithms to construct routing topologies that have low node degree as well as low depths. Having a low degree helps in reducing bottlenecks in the presence of multiple frequencies, and low depth helps in reducing delays.

V. CLUSTER BASED DATA COLLECTION SCHEME FOR WSN

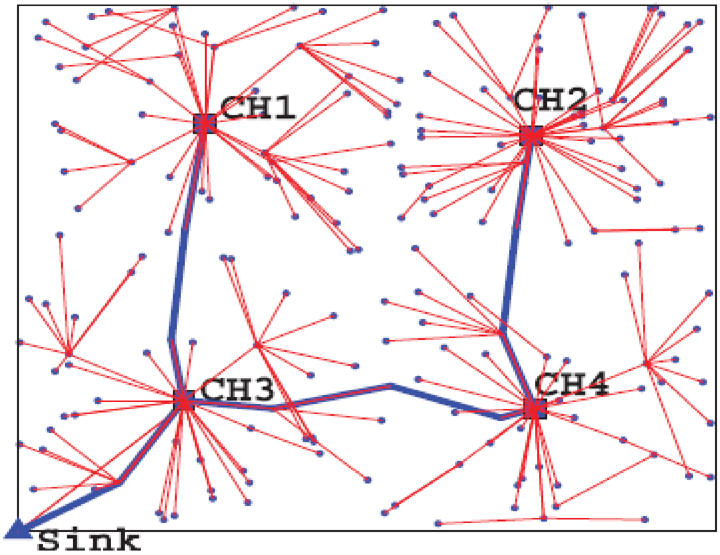

Figure 5.1. System Architecture

The above figure shows the system architecture of cluster method using hybrid compressive sensors. In this architecture each sensor nodes are gathered to form a cluster .Each cluster will be have a cluster head. Rather than the sensor nodes the cluster head consist of a compressive sensor. The compressive sensor may help to balance the traffic load, also it reduce number of packet transmissions. The sensor nodes are transmit in formations to their corresponding cluster head. The cluster head will manage the packets and make it a compresses form, which means each packet will be having a size of 1024 bytes. The cluster head may transmit the data or packets from cluster head to destination.

5.1. Cluster Formation

Cluster formation is the process of grouping sensor devices by collecting the grid location information and gathering energy information. In this project we are using grid sensor deployment so we are defining cluster formation will be done within the grid. So initially we are calculating the each and every node location information and energy of the node. We are initializing the network with same energy level. So initial cluster head selection is done randomly and remaining node in that grid is joining with that cluster head.

5.2. Cluster Head Election

The geographic location of the central point of a cluster area, the sensor node that is closer 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 there is a sensor node falling in to 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, where r is the transmission range of sensors. The value of H is determined such that there is at least one node within H hopes from the central point of a cluster. To elect the CH each candidate broadcast a CH election message that contains its identifier its location and the identifier of its cluster. The CH election message is propagated not more than 2H hopes. After a time out the candidate that has the smallest distance to the center of the cluster among the other candidates becomes the CH of the cluster.

5.3. Sensor Mode Clustering

After a CH is elected, the CH broadcast 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 identifier and location of the CH, and the number of hop that the message has travelled. The hope count is initialized to be 0.All nodes can receive the advertisement messages from at least one CH. After the advertisement of CH is complete, each non CH nodes decides which cluster its joins. The decision is based on the number of hops to each CH. The routing from a sensor node to its CH follows the reverse path in forwarding the advertisement message. The data of sensor nodes within its cluster is collected by this routing tree.

5.4. Backbone Tree Construction and 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. 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 points information to all sensor nodes, all sensor nodes know the location of the sink and the hop distance to it. This module provides the following advantages: Better traffic load balancing in data gathering method. Geographic locations and node distribution of the sensor nodes are considered Nodes distributed design help to improve data transmission. Number of transmissions in a network is reduced and improved the energy efficiency of the network

VI. TREE BASED DATA GATHERING MECHANISM FOR WSN

In this project, the tree base data collection scheme is taken into account. To make our project as efficient we divided our project into small modules. There are given as below.

- Network Design
- Beacon Sharing and Update the Level
- Energy Monitor
- Tree Formation

6.1. Network Design

In the first module, we created the network with no. of sensor node and base node. Each and every sensor placed in specific interval. And each and every sensor capable receiving data from sensors and it can forward to another. That meaning is each sensor can act as parent node as well as child node. In our project, we constructed the network with 21nodes. In that, nodes 0 to 19 are sensor node and 20th node is root node.

6.2. Beacon Sharing and Update the Level

In this module, node can forward the data to selected parent node. Parent node selection is depends on the beacon update and then energy update. Each node maintains energy level of parent nodes as discussed in section of Energy monitor. The need of this previous current level is to make trust on parent node.

6.3. Energy Monitor

By using this energy compression of each node each node can conclude that node is correct node or malicious node. Basic idea behind the energy compression of parent node is every node loss the energy when node receives the packet or transfers the packet and even in ideal mode also node will loss small amount of energy. Malicious node always provides the beacon information with some unmatched sequence number or high energy level information, to make sensor as foolish.

6.4. Tree Formation

In this trust aware routing scheme node always store the energy level in allocated array. So node can check previous result before current value update. According to the level of trust, child node creates the parent node list. To make energy efficient data collection and increase life time of network, node will choose best path with high energy level of parent node.

VII. EXPERIMENTAL EVALUATION

The two metrics to evaluate the performance of the clustering with hybrid CS proposed in this paper: the number of transmissions which is required to collect data from sensors to the sink, and the reduction ratio of transmissions (reduction ratio for short) of our method compared with other methods. Four other data collection methods are considered. In the clustering without CS method, the same cluster structure to our method is used, but CS is not used. In the Shortest Path Tree (SPT) without CS, the shortest path tree is used to collect data from sensors to the sink. In the SPT with hybrid CS, the shortest path tree is used to collect data from sensors to the sink, and CS is used in the nodes it has more than M descendant nodes. In the optimal tree with hybrid CS, a tree having minimum transmissions is used.

In this paper, we propose a clustering method that uses the hybrid CS for sensor networks. The sensor nodes are organized into clusters. Within a cluster, nodes transmit data to the cluster head (CH) without using CS. A data gathering tree spanning all CHs is constructed to transmit data to the sink by using the CS method. One important issue for the hybrid method is to determine how big a cluster should be. If the cluster size is too big, the number of transmissions required to collect data from sensor nodes within a cluster to the CH will be very high. But if the cluster size is too small, the number of clusters will be large and the data gathering tree for all CHs to transmit their collected data to the sink will be large, which would lead to a large number of transmissions by using the CS method.

In this regard, we first propose an analytical model to find the optimal size of clusters that can lead to minimum number of transmissions. Then, we propose a centralized clustering algorithm based on the results obtained from the analytical model. The project may include three parts, first we propose an analytical model then Develop a centralized clustering algorithm and finally we go for the distributed implementation of the model developed in the previous stage. One important issue for the hybrid method is to determine how big a cluster should be. If the cluster size is too big, the number of transmissions required to collect data from sensor nodes within a cluster to the CH will be very high. But if the cluster size is too small, the number of clusters will be large and the data gathering tree for all CHs to transmit their collected data to the sink will be large, which would lead to a large number of transmissions by using the CS method

VIII. CONCLUSION

This approach is used hybrid CS to design a clustering–based data collection method, to reduce the data transmission in wireless sensor networks. The information on locations and distribution on sensor nodes is used to design the data collection method in cluster structure. Sensor nodes are organized into clusters. Within a cluster, data are collected to the cluster heads by shortest path routing; at the cluster head, data are compressed to the projections using the CS technique. The projections are forwarded to the sink following a backbone tree. We first propose an analytical model that studies the relationship between size of the cluster and number of transmissions in the hybrid CS method, to find the optimal size of clusters that can lead to minimum number of transmissions. Then, proposed a centralized clustering algorithm based on the result obtained from the analytical model. Finally present a distributed implementation of the clustering method. Extensive simulations conform that our method can reduce the number of transmission significantly. When the number of measurements is 10^{th} 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. Mean while, this method can reduce the number of transmission up to 30 percent with the data collection method using SPT with the hybrid CS. Even for the non homogenous network in the irregular sensor field, this method can significantly reduce data transmission compared with these data collection methods.

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