Chapter 2
Clustering and Compressive Data Gathering for Transmission Efficient Wireless Sensor Networks

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ABSTRACT

The chapter focuses on minimizing the amount of wireless transmission in sensory data gathering for correlated data field monitoring in wireless sensor networks (WSN), which is a major source of power consumption. Compressive sensing (CS) is a new in-node compression technique that is economically used for data gathering in an energy-constrained WSN. Among existing CS-based routing, cluster-based methods offer the most transmission-efficient architecture. Most CS-based clustering methods randomly choose nodes to form clusters, neglecting the topology structure. A novel base station (BS)-assisted cluster, spatially correlated cluster using compressive sensing (SCC_CS), is proposed to reduce number of transmissions in and form the cluster by exploiting spatial correlation based on geographical proximity. The proposed BS-assisted clustering scheme follows hexagonal deployment strategy. In SCC_CS, cluster heads are solely involved in data gathering and transmitting CS measurements to BS, saving intra-cluster communication cost, and thus, network life increases as proved by simulation.

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INTRODUCTION

Wireless Sensor Network (WSN) is an agglomeration of randomly scattered tiny sensor nodes, whose primary objective is to gather data for the specific application they have been deployed in an Adhoc fashion. This gathered data is wirelessly transmitted to the Base Station (BS)/Sink. Wireless Communication is the main contributor to a sensor's energy consumption. Hence, even though sensory data gathering is the fundamental task in WSN, it is a major source of power consumption. To reduce the number of data packet transmission required for data gathering usually compression techniques are employed. However, conventional compression techniques introduce excessive in-node computations and control overheads. Compressive Sensing (CS) is a new in-node compression technique that compresses sensory data and accurately recovers it at the BS. It can be very economically used for data gathering in energy constrained WSN. A brief overview of CS is as follows:

Compressive sensing is a new framework developed for single-signal sensing and compression. It exploits the fact that many natural occurring signals are sparse or compressible if represented on a proper basis and represented concisely, then recovery from a small number of projections is guaranteed or traceable (Donoho David L.,2006). Compressive sensing data compression is accomplished in the following three steps.

1. Sparse representation of the signal
2. Sampling the signal
3. Recovery of the original signal.

- **Sparse representation of the signal**
  Consider a signal f^d to be a real-valued discrete-time signal with finite length N. Vectorally represented as

$$f^d = \left[f_1, f_2, \ldots\ldots\ldots\ldots f_N \right] \in \mathbb{R}^N \tag{1.1}$$

It is defined as k-sparse if it has a sparse representation in a proper basis

$$\psi = \left[\psi_{ij} \right] \in \mathbb{R}^{NXN} \tag{1.2}$$

Where $f^d = \psi x$ and x has only k non-zero elements