Energy-Efficient Data Gathering and Aggregation for Wireless Sensor Networks

by

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Yuexian Wang

To my parents

Contents

Abstract

Wireless sensor networks, when compared with other traditional wireless communication systems, possess two unique characteristics: (i) the limited battery power supply of sensor nodes, and (ii) the redundant data which are correlated among different nodes. These two are associated with energy consumption and data traffic control. The research in this thesis aims at designing an energy efficient routing scheme with data aggregation in wireless sensor networks.

In this thesis, we developed an energy-efficient routing scheme consisting of the setup phase, the routing tree optimisation phase and the data gathering phase. The setup phase is to build initial routing trees by the ant colony optimisation algorithm which is executed between the base station and all sensor nodes. A key to our routing scheme is the routing tree optimisation phase. The routing tree optimisation is performed by the base station using the particle swarm optimisation algorithm. We propose a modified particle swarm optimisation algorithm that is capable of jointly exploring the data traffic and communication structure to provide the optimal strategy for data gathering. Once the routing tree optimisation has been accomplished, it comes to the data gathering phase. Data flows to the aggregator node, the aggregator node then transmits the gathering data to the base station via multi-hop in this phase of operation.

The performance of our routing scheme is evaluated by comparing with three existing routing schemes using simulations. Our scheme performs as well as the shortest path tree algorithm and saves more than 45% energy over the other two algorithms in the non-aggregation scenario. If perfect aggregation occurs, our scheme obtains about 5% energy reduction at least. When varying from non to perfect aggregation, the simulation results show that our scheme can adapt to the change of data correlation condition and achieve at least 25% energy saving on average. Since our scheme can save energy and enhance transmission efficiency, it is well suited for applications where energy and data traffic are the primary considerations.

Statement of Originality

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Signed

Date

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Yuexian Wang (August 2011)

Conventions

Typesetting

This thesis is typeset using the LaTeX2e software.

The fonts used in this thesis are Times New Roman and Sans Serif.

Referencing

Referencing and citation style in this thesis are based on the Institute of Electrical and Electronics Engineers (IEEE) Transaction style [1].

For electronic references, the last accessed date is shown at the end of a reference.

Units

The units used in this thesis are based on the International System of Units (SI units) [2].

Spelling

The Australian English spelling is adopted in this thesis.

Abbreviations

ACA Ant Clustering Algorithm

ACO Ant Colony Optimisation

BS Base Station

CDMA Code Division Multiple Access

CH Cluster Head

DD Directed Diffusion

GAF Geographic Adaptive Fidelity

GA Genetic Algorithms

GEAR Geographic and Energy Aware Routing

LEACH Low Energy Adaptive Clustering Hierarchy

MAC Media Access Control

MAST Minimum Aggregation Spanning Tree

MEMS Micro Electro Mechanical System

MST Minimum Spanning Tree

OSI Open System Interconnection

PEGASIS Power-Efficient Gathering in Sensor Information Systems

PSO Particle Swarm Optimisation

QoS Quality of Service

RF Radio Frequency

SI Swarm Intelligence

SLT Shallow Light Tree

SPIN Sensor Protocols for Information via Negotiation

SPT Shortest Path Tree

TDMA Time Division Multiple Access

TSP Traveling Salesman Problem

WSNs Wireless Sensor Networks

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