ENERGY EFFICIENT CLUSTER-BASED PROTOCOL FOR WIRELESS SENSOR NETWORKS (WSN)

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To my beloved mother and brother

For their
Sacrifice, Encouragements and Blessing

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ABSTRACT

The development of genetic algorithm to improve the performance of Leach (Low Energy Adaptive Clustering Hierarchy) is presented in this thesis. Genetic algorithm (GA) used in Leach is known as Leach-GA. In the proposed work, Initialization, Population, crossover, mutation and fitness function are calculated based on 100 nodes. Two types of protocols namely, Leach and Leach-C are compared with Leach-GA. A routing protocol of LEACH and LEACH-C do not enable local computation to reduce the amount of the data that needs to be transmitted to the base station. A networking simulator known as NS-2 is used to validate the proposed algorithm. LEACH-GA was found to be more efficient than LEACH-C, which delivers about 20% more data per unit energy than LEACH-C. This is because the genetic algorithm has more effective calculations rather than simulated annealing which is found to be in LEACH-C and inherently produces less data for transmission.

ABSTRAK

Perkembangan Algoritma genetik untuk memperbaiki prestasi LEACH (Penggugusan Mudah Suai Hierarki Kuasa Rendah) dipersembahkan di dalam tesis ini. Algaritma genetik yang digunakan di dalam LEACH dikenali sebagai LEACH - GA. Di dalam cadangan kerja ini, Pengawalan, Populasi, Lelintas, Mutasi dan Fungsi Kecergasan dikira berdasarkan 100 nod. Dua jenis protokol dinamakan, LEACH dan LEACH -C dibandingkan dengan LEACH -GA. Protokol penghala oleh LEACH dan LEACH-C tidak membenarkan pengiraan tempatan untuk mengurangkan jumlah data yang perlu dihantar ke pangkalan. Jaringan penyelaku yang dikenali sebagai NS-2 digunakan untuk mengesahkan algoritma yang dicadangkan. LEACH-GA telah dikenalpasti lebih efektif dari LEACH-C, dimana memberikan 20 % data per unit kuasa dari LEACH-C. Ini kerana algoritma genetiknya mempunyai pengiraan yang lebih efektif berbanding dari simulasi penyepuhlindapan yang dijumpai di dalam LEACH-C dan penghasilkan data yang kurang untuk penghantaran.

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LIST OF ABBREVIATIONS

BS	-	Base Station
CBR	-	Class Basic Queuing
CDMA	-	Code Division Multiple Access
CEMS	-	Continuous emissions monitoring system
CSMA	-	Carrier Sense Multiple Access
FTP	-	File Transfer Protocol
GA	-	Genetic algorithm
LAN	-	Local Area Network
LEACH	-	Low Energy Adaptive Clustering Hierarchy
MAC	-	Mac Address
MEMS	-	micro-electro-mechanical systems
NS2	-	Network simulator
OTcl	-	An object oriented extension of Tcl
QoS	-	Quality of Service
TCP	-	Transmission Control Protocol
Tcl	-	Tool Command Language
TDMA	-	Time Division Multiple Access
TEEN	-	Threshold-Sensitive Energy Efficient Sensor
µAMPS	-	Micro-Adaptive Multi-domain Power-aware sensors
UDP	-	User Datagram Protocol
VBR	-	Variable Bit Rate
WSN	-	Wireless Sensor Networks

CHAPTER 1

INTRODUCTION

1.1 Overview

Low-cost, low power, multifunctional sensor nodes that are small in size and communicate unmetered in short distances have been developed due to the recent advances in micro-electro-mechanical systems (MEMS) and wireless communication [1]. These tiny sensors have the ability of sensing, data processing, and communicating with each other. Wireless Sensor Networks (WSN) which rely on collaborative work of large number of sensors are realized

Sensor nodes can be used within many deployment scenarios such as continuous sensing, event detection, event identification, location sensing, and local control of actuators for a wide range of applications such as military, environment, health, space exploration, and disaster relief [2]. Although a large volume of research has been performed and some algorithms are proposed, there is ongoing research on this subject in recent years.

One of the challenging subjects and design constraints in WSNs is efficient energy consumption. Since a sensor node is a microelectronic device, it can only be equipped with a limited power source (<0.5 Ah, 1.2 V). In most application scenarios, replenishment of power resources might be impossible or infeasible [2]. Moreover, each node plays the dual role of data originator and data router, in multi-hop sensor networks, therefore dysfunction of nodes can cause serious problems in the sensor network [2]. Furthermore, most of the application based on long time monitoring directly affects the network efficacy and usefulness

Another factor that affects the channel is the speed of motion which impacts how rapidly the signal level fades as the mobile terminals moves in space. The impairments include attenuation and attenuation distortion, free space loss, noise, atmospheric absorption, multipath, speed of the mobile, the speed of surrounding objects and also the transmission bandwidth of the signal.

The lifespan of an energy-constrained sensor is determined by how fast the sensor consumes energy. A node in the network is no longer useful when its battery dies. Researchers are now developing new routing mechanisms for sensor networks to save energy and pro-long the sensor lifespan. The dynamic clustering protocol allows us to space out the lifespan of the nodes, allowing it to do only the minimum work it needs to transmit data.

LEACH protocol is a kind of dynamic clustering method based routing protocol presented by Wendi Rabiner Heinemann. The simulation results of LEACH protocol show that LEACH achieves between 7x and 8x reduction in energy compared with direct communication and flat protocol, and it takes approximately 8 times longer for the first node to die than the other two kinds of protocols, which means that the lifetime of WSN is 8 times longer.

An under designed system will not be able to achieve and maintain the QoS requirements. Alternatively, an overdesigned system will be unnecessarily complex and

costly. This maybe especially true in the case of LMS systems, given the need for small, low-cost terminals and practical limitations on processing power. In this work, we present a novel routing protocol scheme, based on the hierarchical routing protocol by using genetic algorithm (GA)

1.2 Problem Background

Genetic algorithm is used at base station, which provides energy efficient solutions to the optimizer to determine the best cluster formation that will give minimum energy consumption during run time. Clustering techniques in WSN can expand the lifetime of the whole network through data aggregation at the cluster head. Clustering is one of the methods used to manage network energy consumption efficiently for (100s and 1000s of micro sensors). All nodes (micro sensors) need to convey sensed data to base-station. Some data loss must be acceptable

1.3 Objectives

In this project following objectives shall be achieve to efficient the delivering data from source to destination.

1. To extend the lifetime of network as much as possible.
2. To propose an algorithm that can improve the delivery of data.

To use GA to select cluster head

1.4 Problem Statement

There are a few cases of higher energy consumption; this is due to the poor average fitness of the final population. LEACH does not require all the nodes to become cluster heads, but the selection cluster head mechanism uses more energy for calculation. Energy consumption during communication is a major factor; therefore, number of transmissions must be reduced to achieve extended battery life. LEACH does not guarantee that the desired number of cluster heads is selected. LEACH assumes all nodes can transmit with enough power to reach BS if it is necessary. By using GA's fitness function, LEACH could select the nodes that have a higher energy level and are relatively closer to the BS.

1.5 Project Scope

The scopes of this project are: Propose intelligent energy-efficient hierarchical clustering protocol that performs better than the traditional cluster-based protocols.

1. Energy optimization should be considered as the key objective when studying the overall network design problem.

2. Proposed method is the selection of a cluster head that can minimize the maximum intra-cluster distance between itself and the cluster member, and the optimization of energy management of the network

Within the scope of this study, first a literature survey has been performed to review the current work on WSN duty cycle control algorithms, then simulation based

performance evaluation of such algorithms has been exercised, with special focus on a selected study, repeating the results reported in the literature, and finally a novel duty cycle control algorithm has been proposed and its performance has been evaluated, comparing the achievement with that selected study

1.6 **Project outline**

This thesis is organized into six chapters. Their contents are outlined as follows:

Chapter 2 provides an extensive review of Architecture of WSN

Chapter 3 discusses about recherché methodology

Chapter 4 presents the design procedure and implementation of Leach and Leach-C in NS2

Chapter 5 describe the analysis and result of LEACH, LEACH-C, and LEACH-C

Chapter 6 concludes the work undertaken by summarizing the system and providing several suggestions for future work.

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