A COMPARATIVE STUDY OF TOPOLOGY CONTROL ALGORITHM IN WIRELESS SENSOR NETWORK

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For my beloved father and mother

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ABSTRACT

Wireless Sensor Network (WSN) is an emerging technology which offers facilities of data acquisition to various applications especially for harsh environment and unreachable area implementations. A WSN consists of a number of sensor nodes that collect the information of the environment phenomenon changes in the required field and disseminate the data until it reaches the base station. This project focuses on determining the best combination of Topology Construction (TC) and Topology Maintenance (TM) for a WSN. Each of TC and TM algorithms were studied to understand their working principle and mechanism. The performance of TCs, TMs and their combinations are investigated through simulation works by using a WSN simulator called Atarraya. The performance comparison of several TC-TM combinations are analyzed based on the number of messages sent, energy spent ratio and network lifetime. The simulation results show that the combination of A3 and Energy Local Patching DSR outperforms other TC-TM combinations when implemented in a 100 node dense network.

ABSTRAK

Rangkaian penderia wayarles (WSN) merupakan teknologi baru yang menawarkan kemudahan pemerolehan data untuk pelbagai aplikasi terutamanya untuk persekitaran yang merbahaya dan kawasan sukar diterokai. WSN terdiri daripada beberapa nod sensor yang mengumpul maklumat daripada perubahan fenomena alam sekitar dalam kawasan tertentu dan menghantar data tersebut kestesen pangkalan. Projek ini memberi tumpuan kepada penentuan kombinasi terbaik Topologi Pembinaan (TC) dan Topologi Penyelenggaraan (TM) untuk WSN. Setiap algoritma TC dan TM dikaji untuk memahami prinsip kerja dan mekanisma masing-masing. Prestasi kombinasi TC dan TM dinilai dan dikaji melalui simulasi menggunakan simulator WSN dipanggil Atarraya. Perbandingan prestasi beberapa kombinasi TC-TM dianalisa berdasarkan bilangan mesej dihantar, nisbah tenaga yang digunakan dan jangka hayat rangkaian. Keputusan simulasi menunjukkan bahawa gabungan *A3* dan *Energy Local Patching DSR* mengatasi prestasi gabungan TC-TM yang lain apabila dilaksanakan dalam rangkaian padat (100 nod).

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CHAPTER 1

INTRODUCTION

1.1 Project Background

Technological advancements have brought a lot change in the modern day life and give new ideas in making life more conveniently to live. The advancement in technology also figures out a new solution to environmental monitoring applications such as in obtaining data from a volcano area which is extremely dangerous to be executed by human being. The deployment of a WSN in the target area can help us study the varying physical quantities under different environmental circumstances over a specified period [1].

WSN are being widely studied and a lot of research is being made in the last few years due to high potential of this technology to be implemented into enormous type of applications. A WSN is a group of specialized transducers with a communications infrastructure for monitoring and recording conditions at diverse locations. In WSNs (WSNs), each node consists of a battery, memory to store the sensed data and uses wireless communications to send and collect data. The added advantages of flexibility and low make sensor nodes best suitable for sensor data collection. WSNs are being implemented in wide range of applications, which poses many new challenges for the researches to be reached.

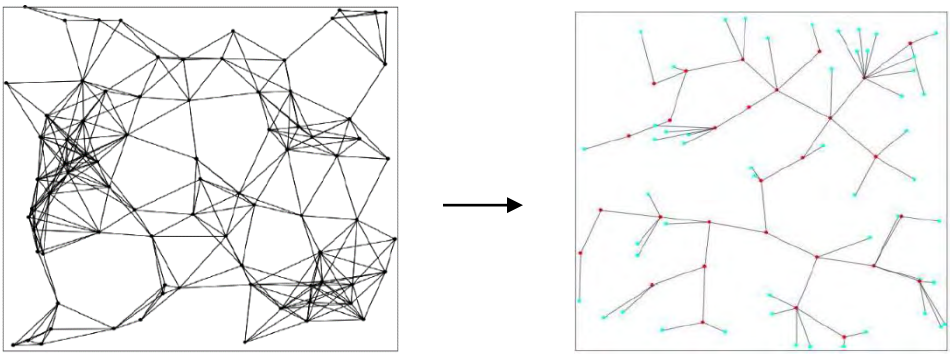
The sensor node is connected to a battery and efficient consumption of battery resource can increase the network lifetime, this is considered as a challenge while designing WSN algorithm. Improving network lifetime, connectivity, coverage, mobility, security are some of the challenges which are considered when choosing or designing a WSN.

1.2 Problem Statement

Wireless sensors are in general a battery-powered stand-alone devices with limited processing power and communication capabilities. Wireless sensors have limited sources of energy to power their functions. Green technologies are those designed to be more efficient in energy consumption and conservation and/or to utilize greener energy sources than used previously. Sensor network energy utilization and more efficient energy conservation are major areas of concern to ensure proper long term operation of a wireless sensor.

Due to limits on each of the sensor's communication ranges, sensor network nodes will need to communicate with other nodes to relay information to the user. Different sensor network topologies will exhibit different coverage and energy utilizations. The topology control needs to maintain WSN node connectivity and sensing coverage. Topology Control is an ongoing process that updates the connectivity in a WSN that can be utilized to save energy thereby extending the operational life of the WSN nodes.

Therefore, in this project, a topology control will be done by combining several cases of Topology Construction (TC) and Topology Maintenance (TM). Those combinations will emits different energy consumption and network lifetime, therefore the best combination of both protocols with efficient energy consumption can be determined.



(a) (b)

Figure 1.1: (a) Original topology, (b) Reduced A3 Topology

1.3 Work Scopes

There are 2 types of WSN applications which are event driven and time driven. In an event driven WSN, the nodes will be triggered to send data when there are changes on the deployment area for example if there is an increasing in temperature or humidity and if there are traces of movement. Other than that, in a time driven WSN, the nodes will be triggered to send data according to a predetermined period of time. However, this project will focus on time-driven WSN application.

Table 1.1: TC and TM cases combination

Cases	Topology Construction	Topology Maintenance
Case 1	Simple Tree	HGETRecRot
		Energy Local Patching DSR
Case 2	A3	HGETRecRot
		Energy Local Patching DSR
Case 3	CDS Rule K	HGETRecRot
		Energy Local Patching DSR
Case 4	KNEIGH Tree	HGETRecRot
		Energy Local Patching DSR
Case 5	Energy Efficient CDS	HGETRecRot
		Energy Local Patching DSR

Table 1.1 shows the cases of various combination of TC and TM used in this project. Two TM protocol which are HGETRecRot and Energy Local Patching DSR will be applied to each of TC chosen. Therefore, in one case, there will be two result to be compared to determine the best TM while TC will be analyzed by comparing their performance with other TC.

1.4 Project Objectives

This project aims to make a performance evaluation of TC protocol in WSN and suggest the most suitable TC-TM combination for a dense WSN. To achieve the aim, three objectives have been listed as follows:

1. To simulate several combinations of TC/TM protocols for WSN by using Atarraya.
2. To investigate the performance of the TC and TM protocols in terms of energy consumption.
3. To determine the most suitable combination of TC/TM for time-driven WSN applications.

1 .5 Report Structure

The first chapter of this thesis is an introduction that briefly explains the project background, problem statement, objectives and scope of works. In the following chapter, the literature review on the background of WSN and working mechanisms of TC protocols are described. Chapter 3 describes the project methodology, while Chapter 4 discusses and analyses the simulation results. Lastly, the conclusion is stated in Chapter 5.

CHAPTER 2

LITERATURE REVIEW

2.1 Wireless Sensor Network

(WSN) is a group of specialized transducers with a communications infrastructure for monitoring and recording conditions at diverse locations [1]. In early 1970, the evolution of the technology started with the invention of wired sensors. Later, a lot of changes have been introduced and because of the development of various technologies over the years has result in high efficient, robust, and low cost devices with the capability to store, and process data with good effectiveness and reduced power intake. A Wireless sensor node consists of the following components; sensor, processor, memory unit, power source a radio unit and any additional circuitry for additional features. The following figure shows the block diagram of a basic sensor node with its main components.

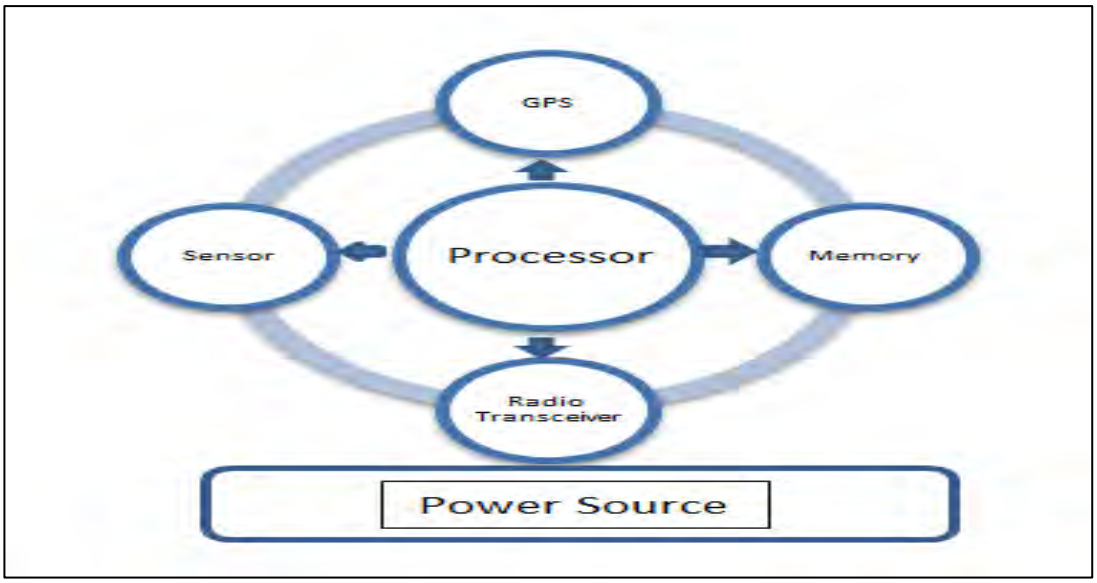


Figure 2.1: Basic block diagram of a wireless sensor node

The core processor generally functions to process the information and control alternate parts in the sensor node. Fundamentally, processor goes about as a brain to the sensor network because of its imperative part. Processor is the primary segment in the sensor network as it relegates the assignments to the sensor nodes and when the sensor node is broke down or harmed, another sensor needs to take its position so that the scope or system integration still in ideal level.

For the memory part, microcontroller contains embedded memory which will be sufficient to store the projects. Yet, when the sensor measures the information, dependent on the application necessities and outside elements number of information gathered by the sensor varies. Presently the information gathered ought to be put away and figured such that just clean information must be sent to the cluster head or to the base station. Likewise when a base station sends protocols or project for the sensor nodes, the got substance ought to be put away so an outer additional memory is needed.

The fuctionality of both the receiver and transmitter are incorporated together into a solitary gadget called Transceiver. The node has this functionality fabricated in so that the sensor can send information to the sink node and consequently assembles the control signal from the sink node or from a base station.

Technology advancement in semiconductor industry have come about into reconciliation of effective innovations in a little chip. There are right now a great many sensors which are being made for distinctive applications. Sensors to record temperature, weight and so forth., inside of a transient sensors grew way past the creative ability from detecting quakes, underground marine life, detecting the level of diabetes in the blood inside a human body. All the sensor is picked by sort of utilization to be actualized.

Target area of the sensor is vital while conveying. At the point when the zone of target is known and straightforward, the deployment can be effortlessly done. Yet, when an intricate territory is focused on, the data of the whole field ought to be known in addition to the sensors area in the field. One conceivable intends to get the data of the sensors area is by utilizing GPS empowered sensors. Incorporation of GPS is an extremely costly fit it in every sensor node, so other conceivable intends to discover the position of sensor is by nearby correspondences.

2.2 Topology Control

Topology of the network is determined by those nodes and links that allows direct communication. When WSN is deployed, each of the nodes communicates with a subset of nodes according to the distance between them (communication radius). Then,