PERFORMANCE EVALUATION OF K-NEIGH TREE TOPOLOGY CONTROL PROTOCOL IN WIRELESS SENSOR NETWORKS

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This report is submitted in fulfilment of the requirements for the award of the Bachelor of Electronic Engineering (Telecommunication Electronics)

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“I hereby declare that this project is the result of my own effort except for quotes as cited in the references”

Signature : …..…………………………………...
Student : LEONARD ETIENNE BOUDVILLE
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Signature : ....

Student : LEONARD ETIENNE BOUDVILLE

Date : ....8/6/2015.......................

APPROVAL

"I hereby declare that I have read through this project report and in my opinion this project report is sufficient in terms of scope and quality for the award of Bachelor of Electronic Engineering (Telecommunication Electronics)."

Signature	: ....
Supervisor	: ZAHARIAH BT MANAP
Date	: ……………………………….………

APPROVAL

"I hereby declare that I have read through this project report and in my opinion this project report is sufficient in terms of scope and quality for the award of Bachelor of Electronic Engineering (Telecommunication Electronics)."

Signature : ....

Supervisor : ZAHARIAH BT MANAP

Date : 8/6/2015

DEDICATION

For my beloved mother and brothers

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ABSTRACT

Wireless sensor networks (WSNs) are widely used in various industries such as in healthcare, military, disaster relief and environment monitoring applications. WSNs have an advantage over wired systems as they are easy to deploy at a low cost. Despite this, WSNs possess several setbacks such as high energy consumption which in turn shortens the lifetime of the networks. One of the methods that have been studied to overcome this problem is by implementing a Topology Control (TC) in a WSN. TC is the reorganization and management of node parameters and modes of operation to modify the topology of the network with the goal of extending its lifetime while preserving the connectivity and sensing coverage. In this project, the performance of the K-Neigh tree TC protocol is evaluated by combining it with selected Topology Maintenance (TM) algorithm to determine the best combination for a network with reduced energy consumption and longer network lifetime. The simulation is carried out by deploying a 100 node network in the WSN simulator called Atarraya. The outcome of this project shows that the most optimum configuration is the combination of the K-Neigh tree TC protocol with HGTTRecRot TM algorithm.

ABSTRAK

Rangkaian sensor tanpa wayar (WSN) digunakan secara meluas dalam pelbagai industri seperti dalam penjagaan kesihatan, ketenteraan, bantuan bencana alam sekitar dan aplikasi pemantauan. Rangkaian sensor tanpa wayar mempunyai kelebihan berbanding sistem berwayar kerana ia adalah mudah untuk dipasang pada kos yang rendah. Walaubagaimanapun, rangkaian sensor tanpa wayar mempunyai beberapa halangan seperti penggunaan tenaga yang tinggi yang akan memendekkan hayat rangkaian. Salah satu kaedah yang telah dikaji untuk mengatasi masalah ini ialah dengan melaksanakan Kawalan Topologi (TC) di dalam rangkaian sensor tanpa wayar. Kawalan Topologi adalah penyusunan semula dan pengurusan parameter nod dan mod operasi untuk mengubah suai topologi rangkaian dengan matlamat untuk melanjutkan hayatnya di samping memelihara hubungan dan penderiaan liputan. Dalam projek ini, pelaksanaan protokol kawalan topologi *K-Neigh Tree* dinilai dengan menggabungkan ia dengan beberapa algoritma Topologi Penyelenggaraan (TM) yang terpilih untuk menentukan kombinasi yang terbaik untuk rangkaian bagi mengurangkan penggunaan tenaga dan rangkaian seumur hidup lebih lama. Simulasi ini dijalankan dengan pelancaran satu rangkaian yang bersaiz 100 nod dalam perisian computer rangkaian sensor tanpa wayar yang dipanggil Atarraya. Hasil projek ini menunjukkan bahawa konfigurasi yang paling optimum adalah gabungan protokol TC *K-Neigh Tree* dengan algoritma TM HGTTRecRot.

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LIST OF ABBREVIATIONS

WSN	–	Wireless Sensor Networks
TC	–	Topology Control
TM	–	Topology Maintenance
DGTTRec	–	Dynamic Global Time-based Topology Recreation
DGETRec	–	Dynamic Global Energy-based Topology Recreation
SGTTRot	–	Static Global Time-based Topology Rotation
SGETRot	–	Static Global Energy-based Topology Rotation
HGTTRecRot	–	Hybrid Global Time-based Topology Recreation and Rotation
HGETRecRot	–	Hybrid Global Energy-based Topology Recreation and Rotation

CHAPTER I

INTRODUCTION

1.1 Introduction

The title of this project is the Performance Evaluation of K-Neigh Tree Protocol in Wireless Sensor Networks (WSNs). This project evaluates the performance and efficiency of the K-Neigh tree topology control protocol compared with the Just Tree topology control protocol.

1.2 Project Background

Today's technology has been seen to improve drastically throughout the years. There are many innovations in various fields which could change the course of history and bring forth a new age of technological discovery. Among the new innovations is the constant improvement towards the technology of the Mars rover [1] which is used to robotically survey and study the environment of Mars to determine if it could be inhabited by human beings in the future. Besides that, the wireless technology has been used in almost every possible method to improve and ease the access of communication. Among the fields of wireless communication is the field of WSNs. This particular field is a continuous growing field in both practical and research domains. This technology functions to gather information in real life applications. Several common applications of WSNs are applied in military operations, transportation-related applications and security mechanisms. The technology is also being used to access areas or regions which are difficult to be done manually by human beings due to critical conditions such as high temperatures, extremely low temperatures and in the wilderness. WSNs deployed into such areas aids us to study the conditions of the environment with ease of access.

WSNs is currently a major study whereby many research had been conducted within the past few years as this technology has a high potential in gaining credibility of its usage and applications [2] [3] [4]. WSNs are self-configured and infrastructure-less wireless networks made of small devices equipped with specialized sensors and wireless transceivers. The main goal of a WSN is to collect data from the environment and send it to a reporting site [1] where the data can be observed and analyzed. Among the features of WSNs is that it is a homogeneous device. WSN is typically composed of nodes with the same features. Besides that, WSN are typically composed of stationary nodes, or at most slowly moving. For example, a WSN is used to track animal movements. WSN also has a large network size whereby the number of nodes in a network could range from ten to thousands of nodes. The general architecture of a WSN is shown in Figure 1.1 [1].

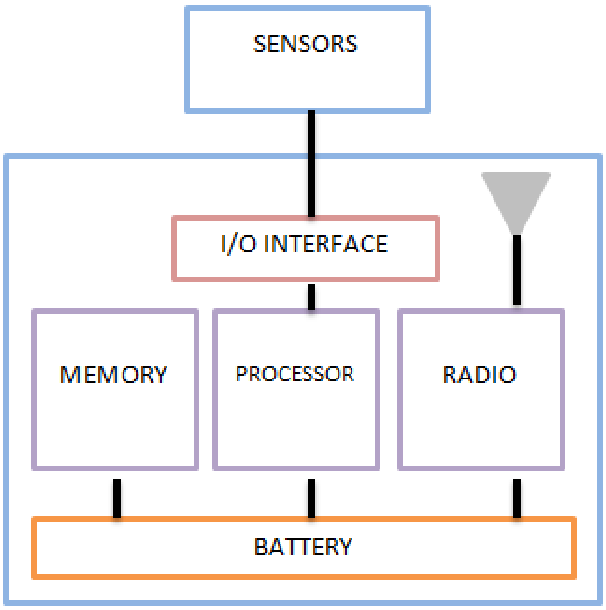

Figure 1.1 General architecture of a wireless sensor device [1].

However, WSNs also presents a series of serious challenges that still need considerable research and efforts. Among the main challenges related to WSN implementation is energy conservation. WSNs are battery powered, therefore the network lifetime depends how wisely energy is used. In a large scale WSN, it is important to minimize the number of times battery needs to be changed. It is desirable to have network lifetimes in the order of one or more years. To achieve long network lifetimes, topology control is implemented to the nodes of the WSNs. Besides that, scalability, interconnectivity, reliability, heterogeneity, privacy and security are also among the challenges faces in WSN technology.

1.3 Problem Statement

WSNs are generally battery-powered devices with limited signal processing and communication capabilities. For that reason, the networks have limited energy to operate throughout a long period of time.

As it is known, a WSN has the capability to contain a large number of wireless sensor nodes. Due to these large network sizes of a WSN, it is known that it requires a large amount of energy for information transfer and communication. The requirement of a high energy for communication in the network would in turn cause the lifetime of the network to be reduced, which in turn would cause the wireless sensor nodes in the network to be drained of its battery power which eventually causes the node to "die off". Besides that, it is also known and encouraged that a network to be built up of a smaller amount of sensor nodes as a smaller network size would indeed reduce the energy consumption and at the same time prolong the lifetime of the network

In this project, the performance of K-Neigh tree topology control protocol will be evaluated by comparison with several Topology Construction and Topology Maintenance protocols and algorithms.

1.4 Scope of Project

There are two types of WSNs which are categorized to event driven and time driven networks. In an event driven network, the nodes will be triggered to send data when there are changes within the deployment area. Examples of an event driven network are temperature increment, low humidity and movement tracking. On the other hand, a time driven network operates whereby the nodes will be triggered to send data according to a specified time that has been programmed, without taking into account the same set of transmitted reading.

This project will focus on time-driven application WSN. Among the combinations of the topology construction protocols and topology maintenance are shown in Chapter 3 of this report. A detailed explanation on Topology Construction and Topology Maintenance will be reviewed in Chapter 2. The project will be simulated using Atarraya: A Topology Control Simulator for WSNs. This simulator is an open source software simulator and is explained in detail in Chapter 3 of this report.

1.5 Project Objectives

The aim of this project is to evaluate the performance of K-Neigh Tree topology control protocol in WSN. To achieve the aim, three objectives have been listed as follows:

1. To simulate the K-Neigh tree topology control protocol based on selected parameters.
2. To evaluate the performance of K-Neigh tree protocol with the combination of several TM algorithms.
3. To compare the performance of K-Neigh tree protocol over Just Tree Topology Control Protocol.

1.6 Result

The results of this project was evaluated based on the total energy spent ratio and the number of nodes alive at the end of every simulation for each parameter combinations. The results of this project which is explained in detailed in Chapter 4 of this project has shown that the optimum combination of TC and TM for K-Neigh tree TC protocol is with HGTTRecRot TM at 100 nodes.

1.7 Report Structure

This content of this report begins with the introduction in Chapter 1. In this chapter, there will be explanation several sub-topics which include project background, problem statement, objectives, and the scope of the project. Chapter 2 covers the literature review of the project. In this chapter, the topology control, topology construction and the topology maintenance is explained in detailed.

The methodology of the project is described in Chapter 3 and the results are analysed in Chapter 4.

The final chapter of this project states the conclusion and gives several suggestions for future works.

1.8 Conclusion

A brief overview introduction of the project was provided in this chapter. The following chapter will provide detailed information on the literature review of this project.

CHAPTER II

LITERATURE REVIEW

2.1 Introduction

This chapter covers all researched sources and related work based on topology control in wireless sensor network. This includes a detailed explanation on every method, concept, TCs and TMs used in this project as stated in the scope of this project in Chapter 1.

2.2 Background Study

WSN is a particular type of ad hoc network, in which the nodes are 'smart sensors', that is small devices equipped with advanced sensing functionalities. In WSNs, the sensors exchange information on the environment in order to build a global view of the monitored region. WSNs are expected to bring a breakthrough in the way natural phenomenon is observed as the accuracy of the observation will be considerably improved. A wireless sensor node consists of sensors, processor, memory, a radio transceiver and an input/output interface. The input/output interface allows the integration of external sensors into the wireless device. Wireless sensor devices are equipped with low-power and computationally constrained microcontrollers. Microcontrollers consume less energy than more advanced CPUs, which is an important consideration in WSNs since it is powered by batteries.