DISTRIBUTED WIRELESS SENSOR NETWORK DEPLOYMENT

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Tajuk Projek : Distributed Wireless Sensor Network Deployment

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ABSTRAK

Wireless Senor Network (WSN) adalah sejenis peranti yang ditempatkan untuk memantau dan merekodkan data dalam bentuk wayerles. Ianya boleh ditempatkan dalam tempat kajian dalam dua jenis topologi berbeza yang dinamakan topologi tersentralisasi dan topologi terdistribusi dimana projek ini tertumpu pada topologi terdistribusi.

Pada amnya, projek ini tertumpu pada penempatan node di dalam satu tempat kajian terpilih yang akan membentuk topologi terdistribusi untuk memantau pemindahan data oleh node dari gateway. Dalam merancang tempat kajian, dua senario perlu dipertimbangkan dimana senario tersebut adalah saling berhadapan dan bukan saling berhadapan. Projek ini seterusnya akan mendapatkan kaedah mengoptimumkan node untuk mengurangkan pegunaan kuasa oleh node dimana kaedah yang telah ditemui adalah pengubahan pada kuasa RF dan kadar sampel.

Akhirnya, data sebelum dan selepas optimum dianalisasi untuk memastikan pengoptimum daro segi pengunaan kuasa dapat dikurangkan dengan jayanya.

ABSTRACT

Wireless Sensor Network is a spatially independent device that is placed to record and monitor the data wirelessly. In can be constructed into two different topologies which are centralized topology and distributed topology where in this proposed project, distributed topology WSN is concentrated.

The project concentrates on the deployment of the node in an appropriate test bed to form a distributed topology which will monitor the data transfer by the node from the gateway. On deploying a test bed, the scenario of line of sight (LOS) and non-line of sight (NLOS) must be taken into consideration. It will then explore on the method of optimizing the node to reduce the power consumption as well as the voltage drop by the node where the method that has been discovered are adjust the RF power as well as sampling rate.

As for the last phase of the project, the data before and after optimization is analyzed is order to ensure the optimization in terms of power consumption is successfully done.

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LIST OF ABBREVIATION

CL – Cross-Layer

CSMA – Carrier Sensing Multiple Access

EEPROM – Electrically Erasable Programmable Read-Only Memory

FYP – Final Year Project

GUI – Graphical User Interface

LEACH – Low-adaptive clustering hierarchy

LOS – Line of sight

MAC – Medium Access Control

MIMO – Multiple Input-Multiple Output

NLOS – Non-line of sight

OOAD – Object Oriented Analysis and Design

OODLC – Object-Oriented Development Life Cycle

PHY – Physical layer

PN2 – Programmer Notepad 2

RAM – Random Access Memory

RF – Radio Frequency

SDLC – System Development Life Cycle

SSADM – Structured System Analysis and Design

TX - Transmit

USB – Universal Serial Bus

WLAN – Wireless Local Area Network

WSN – Wireless Sensor Network

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CHAPTER I

INTRODUCTION

1.0 Project Background

Extreme success and tremendous achievement gained by our country Malaysia in recent years have prioritized us to be one of the leading nations in the world. The encouragement from the achievement has lead to a healthy race to be on trail with the out bursting technology development which occurs among a cluster of successful nations. On this case, a revolution from wired to wireless has been considered to be a part of the technology growth mentioned as Wireless Sensor Network (WSN) which can be used for various types of applications. Sensor has been a great tool in tracking and measuring purpose. Furthermore, improvement from wired sensor network to wireless sensor network would be a significant plus point.

WSN is known as a wireless network consists of spatially distributed independent devices or knows as mote; using sensors to cooperatively monitor several physical environment conditions such as temperature, sound, vibration, pressure, motion and pollutants at specific locations [1]. WSN can be used for many applications both indoor and outdoor scenarios such as habitat monitoring, machine health monitoring, traffic control, home automation and industrial

monitoring processes. WSN is divided into two different topologies which stand on its own beneficial reasons. Those two topologies are star and distributed where this project concentrates only on the distributed topology.

There are many types of motes using WSN where each mote has its own characteristic and purpose of sensing. Crossbow's IRIS mote is considered as one of its type where it is used to sense and measure many parameters such as temperature, humidity, pressure and light. It is also can be used to deploy both the star topology and distributed topology where distributed topology is the focus in this project.

1.1 Problem Statement

The change of technology has lead to the revolution from wired equipment to wireless environment in where it is found to be more users friendly to deal with. The usage of wired network is sometimes turning up to be impractical depending on the place where it is fixed. A recent terrorist and guerilla warfare countermeasure requires distributed networks of sensors that can deploy using aircraft and requires a self- organizing capability [2]. Referring to this case, deploying using a WSN would be a better option compared to wired sensor network where WSN is fast, easy to implement and easy to maintain.

Power consumption by the network differs by the influence of the topology used because it varies for the star topology and distributed topology. Star topology is the direct connection of a node to the base station where the power consumption by the node is not influenced by the distance the node is placed from the node. Instead, distributed topology is connected to another node before it is connected to the base station and since the transmit power and the receive power plays a major role, the distance of the node from other node plays an important role behavior of power consumption.

Propagation channel is an important aspect in this power consumption of WSN since it influences the power received to the node. The propagation

channel is considered at both free space and external blockage since the power consumption dues to these scenarios is different. The power consumption by the node will be much lower if it has external blockage in between compare to when it is only considered by free space.

1.2 Objectives

The objectives of this project are closely related to the problem stated above.

- To design a test-bed on deploying wireless sensor node with distributed topology.
- To evaluate and optimize the node parameters in order to reduce the total energy consumption per node.
- To analyze the energy consumption measured between before and after optimization processes.

1.3 Scopes of Work

This project emphasis on three different phases relates to the scopes of the project as well. Those phases as mentioned above are to deploy the distributed network (IRIS) mote in a test bed to ensure data transferring to the control center, collection performance parameters that affect the energy consumption and analyze the collected data in order to optimize the energy consumption.

1.3.1 WSN Test-bed Planning and Deployment

As the first part of the project, a deployment of the network in an appropriate test-bed is done using the IRIS motes (as shown in Figure 1.1). This deployment is truly necessary in order to verify that the constructed motes able to transfer data to the control center successfully. The data concentrated in this project refers to the sensing parameter of IRIS which is down to several sensors in single chip to run the sensing process individually. The sensors that mentioned above which later transferred as the data to the control center are humidity, temperature, photo-sensitive light and barometric pressure [3].

The test bed is selected by considering to scenario as necessary which are line of sight (LOS) and Non-line of sight (NLOS). Both this scenario is tremendously important as the effect in energy consume by the node will be influenced. Apart from that, the topology which is distributed has to give equal priority in this implementation prior to its objective. After both this consideration, the node is placed on a specific position in the test-bed and the data transfer to the gateway is monitored. The placement of the node is expected to form a distributed topology.

Figure 1.1 IRIS Mote

1.3.2 Data Collection and Network Optimization

As the placement of the node is successfully done on the test bed, the data is monitored from the gateway and the topology is observed to be on distributed along the way the data transfer is done. Since, IRIS is using battery as the source of power supply to activate its node, the lifespan of the node will be only dependent on the lifespan of the battery. Therefore, the optimization process on the power consumption is done by reducing the RF power as well as increasing the sampling rate. By doing so, the power consume by the node which reflect to the build of the network is expected to reduce.

1.3.3 Data Analysis

After the optimization process, the data obtain is then analyzed to the data before optimization in order to ensure the optimization process is successful. This process in other way reflect to emphasize the important of optimizing the node where the outcome from this phase of the project will determine the success of the second phase of the project which is optimizing the node in terms of power consumption.

1.4 Project Significant

WSN has been used as a good sensing and tracking device in this modern era where it is implemented for many applications. Even though, there are some of the user still does not really understand on the energy consumption by the node which lead to the drop of voltage in the battery. This project studies about the propagation scenario which influences the implementation of the node where it is highlighted to be the major contribution by this project. It is a necessary to

understand on the propagation scenario involve where different propagation scenario lead to different power consumption by the node.

This project is also significant where the methods to reduce the power consume by the node as well as the battery voltage drop is discussed. By understanding this method, it can be applied by the user of WSN in the future to increase the lifespan of the battery which lead to increase the lifespan of the network.

1.5 Project Contribution

This project leads to many achievements that majorly on the award winning and paper published. This project entered the INOTEC 2010 competition that was held on the 1st and 2nd April 2010 at Universiti Teknikal Malaysia Melaka (UTeM) and won the silver medal. It also achieve to won the 2nd Runner's Up position for the Wireless Broadband and Multimedia category where it was selected to be the second best project for the mentioned category.

A publication is also published compiling the result and analysis where the title of the publication is "A Study of Topology Characteristic on the Real Deployment of Wireless Sensor Networks" which was submitted to the 4th International Symposium on Broadband Communications (ISBC 2010) [4].

1.6 Thesis Organizations

This thesis starts with the introduction on the Wireless Sensor Network (WSN) and Iris mote in chapter 1. Chapter 1 also elaborates on the problem statement leading to the objective of conducting this project, the complete scope of the project, project significant and also the contribution by this project. This is followed by chapter 2 which explains on the literature review of the project where it illustrate the important characteristic and parameter that involve widely in this

project. The process flow of the project with the use of hardware and software in the project is briefly explained in chapter 3. Chapter 4 then explains on the result that is obtained for this project as well as the analysis that can be made from this project. The thesis is finally concluded with chapter 5 which derive the conclusion prior to the objective of the project and future recommendation that can be made from this project.

CHAPTER II

LITERATURE REVIEW

2.0 Introduction

In developing a project, one should be aware of the previous research and related sources to their project as they can identify information, ideas, and method are very much relevant. Previous research has been found to be useful sources as they appear to be a good guideline to develop a new project and execute it successfully. Apart from that, the characteristic review of the product used in the project is also equally important as this could produce a brief understanding of the project.

This chapter will start the phase with the explanation on the keywords of the project which then further proceeds to discuss and study on Literature Review of the Distributed Wireless Sensor Network which explores the characteristic of Crossbow's IRIS sensor network as well as the study of the previous research on this project as the final phase. For this project, the research will be done using the reference on books, articles, online journals about the existing systems that are available in market nowadays.

This chapter starts on the explanation of the keywords and continues with the study of the characteristic of the Crossbow's IRIS sensor node before

concluding with the review of the previous research that has been done together with some comparison.

2.1 Keywords

Keyword is defined as the terms that are being used in the project. This keyword can be classified as the hardware tools and software tools needed for the project and also the techniques used in conducting this project.

On this project, there are several terms that have been found important and this has been classified to be the keyword in my project. There are a total of two keywords that has been highlighted as important point that is IRIS and Distributed Node deployment.

2.1.1 IRIS

IRIS mote is one of the leading product create by the Crossbow to the use of data measurement. IRIS is a 2.4GHz Mote module used for enabling low-power, wireless sensor network which features several new capabilities that enhance the overall functionality of Crossbow's wireless sensor networking products.[5] Those features are:

- Outdoor line-of-sights tests have yielded ranges as far as 500 meters between nodes without amplification.
- IEEE 802.15.4 compliant RF transceiver.
- 2.4 to 2.48 GHz, a globally compatible ISM band.
- Direct sequence spread spectrum radio which is resistant to RF interference and provides inherent data security.
- Expansion connector for light, temperature, RH, barometric pressure, acceleration/seismic, acoustic, magnetic and other Crossbow sensor boards.