HARDWARE FOR OPTIMIZATION OF HARDWARE PLATFORM FOR WIRELESS SENSOR NETWORK

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" I hereby declare that I have read through this report entitle "Hardware For Optimization Of Hardware Platform For Wireless Sensor Network" and found that it has comply the partial fulfillment for awarding the degree of Bachelor of Mechatronics Engineering"

Signature : .....

Supervisor's Name : EN. ZULHANI B RASIN

Date : 12 MAY 2010

I declare that this report entitle "Hardware for Optimization of Hardware Platform for Wireless Sensor Network" is the result of my own research except as cited in the references. The report has not been accepted for any degree and is not concurrently submitted in candidature of any other degree.

Signature : .....

Name : KRITEEVASAN A/L ARAMUGAM

Date : 12 MAY 2010

To my beloved mother and father,

In appreciation of supported and understanding.

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ABSTRACT

Wireless Sensor Network (WSN) is a wireless network consisting of spatially distributed autonomous devices using sensors to cooperatively monitor physical or environmental conditions, such as temperature, sound, vibration, pressure or motion at different locations. It's basically consists of three main component, sensor, microcontroller and antenna or communication device. ZigBee is a wireless mesh networking standard being developed by an international consortium to provide open, reliable, low-power wireless communication. There are currently many wireless sensor networks in market such as ZMN 2405 from RF Monolithics, XBee from Maxstream, Easybee from Flexipanel and many more. The purpose of this project is to study on the currently available wireless sensor network device like ZigBee and XBee for the purpose of platform optimization such as hardware miniaturization, performance enhancement and getting results from it. Then doing selection, learning tools for programming and prototype fabrication. This project consists of software and hardware component. The finally optimized platform will then be evaluated through several experiments to confirm its performance and reliability.

ABSTRAK

Rangkaian Penderia Tanpa Wayar adalah peranti rangkaian tanpa wayar yang terdiri daripada bahagian penyebaran automatik yang menggunakan peranti pengesan untuk bekerjasama memantau keadaan fizikal atau keadaan persekitaran, seperti suhu, bunyi, getaran, tekanan dan pergerakan di lokasi-lokasi yang berlainan. Rangkaian Penderia Tanpa Wayar ini kebiasaannya merangkumi 3 bahagian utama iaitu mikropengawal, antenna dan senser. Kegunaan WSN adalah untuk membetuk rangkaian dan berkomunikasi dengan komputer untuk membolehkan data diambil daripada keadaan yang diletakkan peranti WSN. Terdapat pelbagai jenis rangkaian penderia tanpa wayar di pasaran seperti ZMN2405 daripada Rf Monolithics, XBee daripada Maxstream, EasyBee daripada Flexipanel dan sebagainya. Tujuan utama projek ini adalah mempelajari peranti-peranti penderia tanpa wayar yang terdapat di pasaran seperti Zigbee dan XBee untuk tujuan meringkaskan perkakasan perlantaran yang sedia ada. Projek ini mengandungi dua komponen, perisian dan perkakasan. Akhir sekali, ujian akan dilakukan terhadap perkakasan perlantaraan yang diringkaskan dan mendapatkan keputusan yang diperolehi daripada ujian terhadap perkakasan tersebut dan mengesahkan perlaksanaannya.

TABLE OF CONTENTS

LIST OF TABLES

LIST OF FIGURES

LIST OF ABBREVIATIONS

ADC	Analog to Digital Converter
FYP1	Final Year Project 1
FYP2	Final Year Project 2
GDI	The Great Duck Island
GPRS	General Packet Radio Service
MAC	Medium Access Mechanism
MCU	Microcontroller Unit
PC	Personal Computer
PHY	Physical Layer
PWM	Pulse Width Modulation
RF	Radio Frequency
UART	Universal Asynchronous Receiver/Transmitter
WAN	Wide Area Network
WISA	Wireless Interface to Sensors and Actuators
WSN	Wireless Sensor Network

FFD	Full Function Device
RFD	Reduced Function Device
GND/VSS	Ground
GPIO	General Purpose Input/Output
RST	Reset
NC	No Connection
GUI	Graphical User Interfaces
LQI	Link Quality Indicator
LSB	Least Significant Bit
MSB	Most Significant Bits

LIST OF APPENDICES

CHAPTER 1

INTRODUCTION

1.1 General Introduction

A wireless sensor network (WSN) is a collection of nodes organized into a cooperative network [1]. It will use sensors to cooperatively monitor physical or environmental conditions such as temperature, sound, vibration, pressure and other objects. If we use more sensors then we can create more networks using wireless. Each node consists of processing capability may contain multiple types of memory, have a RF transceiver, have a power source, and accommodate various sensors and actuators.

ZigBee or XBee is a wireless technology developed to address the unique needs with low-cost, low-power, that going to used as wireless sensor network. ZigBee or XBee is a standard or protocol used to define a communication between components. Zigbee is suitable for WSN with low data rate, low energy consumption, low memory capacity and small size requirement.

This project's hardware platform will be in optimized version with better performance than the platform currently available. All the hardware optimizing work will start with collecting data on available platform and make comparison about all specifications and characteristics. Then it will continued by hardware fabrication depends on the new optimized version data that collected. Performance evaluation on the new optimized version will be done in term of reliability, performance, efficiency and hardware size and the results will be compared with the already exist hardware platform.

1.2 Problem Statement

Below are some of the characteristic of the old hardware platform that is possible to be upgraded.

- Optimizing the platform in term of hardware size, performance, reliability, cost and efficiency.
- Select the specifications that can reduce high power consumption in term of transmit power, transmit mode, receive mode, sleep mode and distance (low range).
- Reduce high cost maintenance compare to old platform hardware and wiring system.

1.3 Objective

Objectives of the proposed project to be studied: -

- Identify the available platform in market and do critical study on its performance to select the best platform with better specifications.
- Come out with the optimized version of platform in term of performance and reliability for hardware and software.
- Performance evaluation on platform specifications like range, memory capacity, transmit mode, receive mode, transmit power, cost and sleep mode.

1.4 Scope

The scope of the project is to:-

- Study on the wireless sensor network (WSN).
- Doing selection, learning tools for programming and prototype fabrication.
- Optimize and improve the platform after doing critical studies on the currently available wireless sensor network.
- The finally optimized platform will then be evaluated through several experiments to confirm its performance and reliability.

1.5 Report Outline

Chapter 1 is explained about the general introduction, objective of the project, problem statement and also the scope of the project.

Chapter 2 will included the literature reviews on previous researches on wireless sensor network, Zigbee overview which is the main parameters in WSN, characteristics of ZigBee and the theories behind the work.

Chapter 3 described the details of methodology included the components that used to design the WSN, the hardware and software being used in the project are described as well.

Chapter 4 described the results of the project, including the components of the hardware and software of the project. The performance analysis of the implemented project also is discussed.

Chapter 5 is discussed about the recommendation for the future work and also the conclusion of the project.

CHAPTER 2

LITERATURE REVIEW

2.1 Literature Review of Past Works

Wireless sensor network is a kind of network that is made up of a large number of sensor nodes. These nodes are spread to carry out different kinds of operations to find the values of different kinds of attributes like temperature, acceleration, pressure, sound and humidity in certain environments. So there is no need to have a big computer setup to evaluate all these things, instead cheap small sensor devices.

The advantage of these wireless sensor network we no need to measure manually. It is because less maintenance comparing the system which uses ZigBee technology with traditional wired network system. ZigBee is a wireless technology developed to address the unique needs will be used as WSN in this project and by adopting wireless way wiring is convenient and economical. So it has advantage of low cost, low power and wider coverage. Additionally it complies with IEEE802.15.4 protocol, which makes it convenient to communicate with other products that comply with the protocol too like wireless personal area networks (WPAN). WSN also easy to install, configure, and easy to carry out.

There are some important features which are important to know concerning the understanding of the wireless sensor networks are [2] like the important of small battery requirements. It is important using small battery for a sensor node to conserve energy to stay alive for a longer period of time. That's why it goes to sleeping mode some times during operation to conserve energy.

Apart from that, communicating nodes are attached to each other by some wireless medium in the multi-hop sensor networks, so the medium which will be used should be available worldwide. Encryption methods can be used to carry out the security operations in these networks.

2.1.1 Case Study 1 on WSN Application: The Design of Wireless Sensor Network System Based on ZigBee Technology for Greenhouse [3].

2.1.1.1 Wireless Sensor Network System for Greenhouse

Y W Zhu, X X Zhong and J F Shi from The Engineering of Optical and Electronic College, ChongQing University China, provide an in-depth study of applying wireless sensor networks system based on ZigBee Technology for Greenhouse. Every greenhouse in this system comprises a gateway and some wireless nodes. Gateways and nodes are all embedded with a CC2420 RF transceiver (ZigBee compliant) produced by Chipcon company. Data can be transmitted by transceiver between gateways and nodes, and finally the data from all greenhouses are collected to be transmitted to a server. The sketch of the system is shown in Figure 2.1.

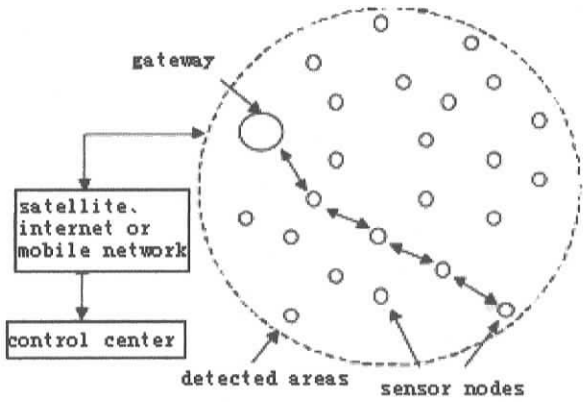

Figure 2.1: Typical Framework of Wireless Sensor Network.

The framework and functions of the system lies in the following:

(1) Communicating with the server via Ethernet;

(2) Communicating with nodes by RF transceiver;

(3) Atmega128L MCU and TinyOS operating system;

(4) Temperature, humidity and light intensity collection periodically;

(5) Transmitting collected data to gateway by using CC2420.

The Framework of Wireless Sensor Network is shown in Figure 2.1. Each node will sense, compute and communicate each other. Each sensor can either receive message or transmits message, and can transmit messages to a gateway via self-configuration and multi-hop routing. Then, the gateway can use many ways such as Internet, satellite and mobile communication network (in this system we use Ethernet) to communicate with remote network. More than one gateway may be used for large-scale application. Because of its limited communication areas the node must use multi-hop routing to access the nodes out of communication areas.

The wireless sensor network nodes use battery power and their power capabilities are limited due to its small size of node. The transmission rate of the network is low and it needs enough power to work steadily for a long time. Therefore low-power design is significant. The system adopts MICAz mote module produced by Crossbow Technology and its sketch of hardware is shown in Figure 2.2. MICAz embedded with a ZigBee compliant RF transceiver and it works between 2.4 and 2.4835 GHz, a globally compatible ISM band. Its DDSS radio offers both high speed (250 kbps) and hardware security (AES-128). The MICAz 51-pin expansion connector supports Analog Inputs, Digital I/O, I2C, SPI and UART interfaces. These interfaces make it easy to connect to a wide variety of external peripherals, including a variety of sensor, data acquisition boards and gateway.