

TEMPERATURE CONTROL SYSTEM USING ZIGBEE WIRELESS  
NETWORKING

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To my beloved family, for their genuine love, prayers and encouragement. To my supervisor and all lecturers who guide me, and to all my friends for your help and support.

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## ABSTRACT

Wireless technology has already become an important application which usually integrated to a wide range of device and other technologies. The enhancements provide by the wireless technology gives the ease of control to the users. Nowadays, almost all the electronic devices are equipped with wireless technology. This fact shows the necessity and benefits provide by this technology. This project is mainly concern about home power consumption observation system with wireless capabilities. It is use the Xbee as the wireless modules. This project uses two microcontrollers to handle the wireless communication protocol. The first microcontroller done the calculation needed and display it to the user with both hardware and software interface. The second microcontroller functions as the watch guard for the sensor circuit. The received data from sensor circuit is stored and send to the first microcontroller upon request. Moreover, the user interfaces gives ease of controls to the users. Furthermore, this system also has the interconnecting with Wireless Sensor Network (WSN) such as the IEEE802.15.4 Zigbee Protocol.

## ABSTRAK

Teknologi wayarles telah menjadi aplikasi penting yang biasanya terintegrasi untuk peranti dan teknologi lain. Alat tambahan mempunyai teknologi wayarles memberikan kemudahan kawalan kepada pengguna. Kini, hampir semua peranti elektronik dilengkapi dengan teknologi wayarles. Fakta ini menunjukkan betapa pentingnya teknologi ini. Projek ini berkaitan sistem pengawasan, penggunaan kuasa dirumah dengan kemampuan wayarles. Sistem ini menggunakan Xbee sebagai modul wayarles. Projek ini menggunakan dua mikropengawal untuk menangani protokol komunikasi wayarles. Mikropengawal pertama melakukan pengiraan yang diperlukan dan mempamerkannya kepada pengguna dengan antara muka peranti keras dan perisian. Fungsi mikropengawal kedua sebagai mengawasi litar pengesan. Data yang diterima daripada litar pengesan tersebut disimpan dan dihantar ke mikropengawal pertama atas permintaan. Dengan kemudahan antara muka, sistem ini memberikan kemudahan bagi pengguna untuk berkomunikasi dengan sistem ini. Selanjutnya, sistem ini juga mempunyai interaksi dengan teknologi pengesan wayarles seperti IEEE802.15.4 Zigbee Protokol.



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## LIST OF ABBREVIATIONS

WSN	-	Wireless Sensor Network
IEEE	-	Institute for Electrical and Electronics Engineers
LR- WPAN	-	Low rate Wireless Personal Area Network
LCD	-	Liquid Crystal Display
RF	-	Radio Frequency
MAC	-	Media Access Control
PCB	-	Printed Circuit Board
PIC	-	Programmable Integrated Circuit
DSP	-	Digital signal processors
LoWPANs	-	Low Power Wireless Personal Area Networks
FYP	-	Final year project
IC	-	Integrated Circuit
LED	-	Light Emitting Diode
PHY	-	Physical layer
ADC	-	Analog to digital converters
CPU	-	Central processing unit
CU	-	Control unit
DC	-	Direct current
RAM	-	Random access memory
ROM	-	Read only memory
EPROM	-	Erasable programmable read only memory
EEPROM	-	Electrically erasable programmable read only memory
ISM	-	Industrial, scientific and medical radio band
API	-	Application Programming Interface
APS &NWK	-	Application support and network layers
ARQ	-	Automatic request



FHSS	-	Frequency hopping spread spectrum
DSSS	-	Direct sequence spread spectrum
ISIS	-	ISIS schematic capture
VSM	-	Virtual system modeling
RSSI	-	Received signal strength indication
RISC	-	Reduces Instruction Set Computer
UART	-	Universal Asynchronous Receiver Transmitter
USART	-	Universal Synchronous Receiver Transmitter
CTS	-	Clear to send frame
RTS	-	Request to send frame
SPI	-	Serial Peripheral Interface
NRZ	-	Non return to zero
I/O	-	Input and output
R/W	-	Read and write
ICD	-	In circuit debugging function
PWM	-	Pulse width modulation

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# **CHAPTER I**

## **INTRODUCTION**

### **1.1 Overview**

This chapter will cover the introduction of the project where it involve of the project background, overview of project, problem statement, objective of project, scope of project, thesis outline and summary of work.

### **1.2 Project background**

Since a few years ago, wireless sensor network technology has been developed. Many research communities give their attention on developing wireless sensor network for many purposes. The introducing of the wireless sensor network has become a new paradigm in information-gathering method. This is because wireless sensor network consists of many self-organized sensing nodes that cooperate with each other to gather information. Each node is equipped with devices which are used to monitor and collect the data, process the collected data and then transmit the data to the adjacent nodes.

### **1.3 Overview of project**

This project covers the implementation of temperature control wireless networking by using Zigbee. The IEEE802.15.4 Zigbee protocol is a wireless technology developed as an open global standard to address the unique needs of low cost, low power, wireless sensors network. Zigbee is generally used for home care, digital home control, industrial and security control. This project developed a suite of room care sensor network system by Zigbee's characteristic which is embedded sensors that is temperature sensor. The sensed temperature is converted to the digital form by the means of analog to digital converter and transmitted through Zigbee module and displayed on a local LCD display. On receiving end temperature is received through another Zigbee module and each acquisition of temperature is compared with a user defined set point. If this value exceeds the set point a control signal goes to a final control element or a buzzer.

### **1.4 Problem statement**

Temperature controllers are needed in any situation requiring a given temperature be kept stable. This can be in a situation where an object is required to be heated, cooled or both and to remain at the target temperature (set point), regardless of the changing environment around it. This project involved close loop control. A temperature controller is a device used to hold a desired temperature at a specified value. For this project, the temperature sensor was implementing by using Zigbee technology in transmitting and receiving data wirelessly. Indirectly, flexible implementation and monitoring of data acquisition can be implementing without wired connection that is more complex to be implement. Zigbee wireless protocol offers low complexity and it also offers three frequency bands of operation. Besides that, the distance between A Zigbee trans-receiver to another Zigbee trans-receiver located within a 10 m radius with minimum noise. It is not convenient for long distance transmission of signal.

## 1.5 Objectives of project

The aim of the project is to interface the smart wireless temperature data logger using IEEE802.15.4 Zigbee protocol. Hence, the sensed temperature can be measured throughout the LCD display. The temperature then compared with the set point. If it exceeds the set point, a control signal goes to a final control element or a buzzer. The specific objectives of these projects are:

- a) To design and construct the transmitter and receiver circuit that will implement with Zigbee module
- b) To interface the smart wireless temperature data logger using IEEE802.15.4 Zigbee protocol
- c) To measure the performance of the signal range

## 1.6 Scope of project

The scope of this project focused into two stages, which are hardware and software development. In this project, it involves two parts in order to accomplish one complete system in wireless networking. It has two boards collectively from a Zigbee network, one of which is transmitter and receiver circuit. This project uses the LM35DZ room temperature sensor to detect room temperature. These sensors can measure temperatures from 0°C to 100°C. The sensed temperature is converted to the digital form by the means of analog to digital converter and transmitted through Zigbee module. Next, the final module is the microcontroller at the receiving end interfaced with an LCD and a buzzer. Overall, the scope of this project include designing the whole system, build the hardware for the system, successfully establish a point-to-point connection between Zigbee modules, using proper software to program the microcontroller PIC 16F877A and LCD interfaces for user purposes.

## 1.7 Thesis outline

As a requirement in thesis format, it include by five chapters. In chapter I, it focuses on brief introduction of the project carried. The important things in this chapter are the problem statement, project objectives and project scopes are well emphasized in this part.

Chapter II normally is focused for literature review that covers related theory and previous works regarding this project are explained in this chapter. It discuss on the Wireless Sensor Network (WSN), Sensor node, Xbee/Xbee-PRO OEM RF modules, microcontroller and LM35DZ temperature sensor.

Chapter III consists of project methodology. It also includes information on research and experiment carried during the project development. It will explain on the concepts, theories and principles used in order to complete the project. In this chapter, the functional of each component which used has been explained clearly.

Chapter IV consists of result and analysis. It explains and focused for component description from the project. This chapter described the hardware and software system development.

Chapter V consists of discussion and conclusion for this project. It will explain for this chapter it includes the discussion, conclusion, the witness and also the further improvement that can be made in future.

## 1.8 Summary of work

Implementation and general works done are summarized in Table 1.1. It also includes the future works until this project is complete. The plan may change during the FYP 2 course.

Table 1.1: Project plan

<b>Month</b>	<b>Expected achievements</b>
August 2010	Initial research of the title, project proposal and module design
September 2010	Research on the components needed, pricing and purchasing
October 2010	Further research and design prototype of the circuit design and proposal presentation
November 2010	Establishing/Assembling the system circuitry
December 2010	Working on hardware circuitry, wireless system and programming
January 2011	Programming, troubleshooting and implementation the system.
February 2011	Completion of the hardware, testing and optimization
March 2011	Final adjustments for demonstration and presentation

## **CHAPTER II**

### **LITERATURE REVIEW**

#### **2.1 Overview**

This chapter will introduce the term of Wireless Sensor Network (WSN), Sensor node, Zigbee protocol, Xbee/Xbee-PRO OEM RF modules, microcontroller, and Zigbee versus Bluetooth. The main objective of this chapter is to describe in details the above term and the role its play in this project.

#### **2.2 Wireless Sensor Network (WSN)**

Wireless Sensor Network consists of large numbers of sensor nodes. The nodes are equipped with sensor devices that are used for a certain applications. For example, the sensor device is camera and it is used to retrieve the environment data visually, microphone is used to detect the sound, thermometer and thermocouple are used to detect the changes in temperature.

Every sensor nodes are also equipped with wireless module in order to communicate with each other. The communication between the nodes are performed by establishing the routing topology in the system before the data can be transmit from the certain sensor node to the collection point or host.[1]