EMBEDDED BASED REMOTE MONITORING AND CONTROLLING SYSTEM

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This thesis is submitted as partial fulfillment of the requirements for the award of the Bachelor of Electrical Engineering (Electronics)

Faculty of Electrical & Electronics Engineering
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NOVEMBER, 2010
“I hereby acknowledge that the scope and quality of this thesis is qualified for the award of the Bachelor Degree of Electrical Engineering (Electronics)”

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Date : 30 NOVEMBER 2010
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<table>
<thead>
<tr>
<th>Signature</th>
<th align="left">: __________________________</th>
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</thead>
<tbody>
<tr>
<td>Author</td>
<td align="left">: ABDUL MUIZ BIN ROOMAI NOR</td>
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<tr>
<td>Date</td>
<td align="left">: 30 NOVEMBER 2010</td>
</tr>
</tbody>
</table>
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Remote monitoring and controlling system is a system that capable of measuring several ecological parameters in distance away room and capable setting the condition into desire environment through wireless communication system from central room. Depending on its application needs, various technologies as well as improvements have been designed, developed and implemented. In this case, a Zigbee based wireless communication approach is considered to monitor and control various parameters in remote location. This wireless technology offers an effective and noise-free communication between the central and remote room arrangement. Several sensors are equipped in each remote location to measure environmental parameters and these measurements are sent to the central office for storage and analysis purpose. In addition, the central office capable of instruct several command to remote location for output control execution. These features offer an efficient way to maintain condition in the room and allow user to obtain caution on occurrence of any abnormal conditions like parameters exceeding human comfort zone.
ABSTRAK

# TABLE OF CONTENTS

<table>
<thead>
<tr>
<th>TITLE</th>
<th>PAGE</th>
</tr>
</thead>
<tbody>
<tr>
<td>TITLE PAGE</td>
<td>i</td>
</tr>
<tr>
<td>DECLARATION</td>
<td>ii</td>
</tr>
<tr>
<td>DEDICATION</td>
<td>iii</td>
</tr>
<tr>
<td>ACKNOWLEDGEMENT</td>
<td>iv</td>
</tr>
<tr>
<td>ABSTRACT</td>
<td>v</td>
</tr>
<tr>
<td>ABSTRAK</td>
<td>vi</td>
</tr>
<tr>
<td>TABLE OF CONTENTS</td>
<td>vii</td>
</tr>
<tr>
<td>LIST OF FIGURES</td>
<td>x</td>
</tr>
<tr>
<td>LIST OF EQUATION</td>
<td>xii</td>
</tr>
<tr>
<td>LIST OF APPENDIXES</td>
<td>xii</td>
</tr>
</tbody>
</table>

## CHAPTER 1: INTRODUCTION

1.1: Introduction  
1.2: Project Objectives  
1.3: Project Scope  
1.4: Thesis Outline

## CHAPTER 2: LITERATURE REVIEW

2.1: Introduction  
2.2: Project Literature Review
2.3: Principle of Temperature 13
2.4: Principle of Humidity 14
2.5: Principle of Light Intensity 15

CHAPTER 3: SYSTEM ARCHITECTURE AND OPERATION 17

3.1: Introduction 17
3.2: Microcontroller System Board Module 18
3.3: Sensor Modules 19
3.4: Zigbee Transceiver Module 21
3.5: Serial Communication Module 22
3.6: Solid State Relay Circuit Module 23

CHAPTER 4: HARDWARE DESIGN 25

4.1: Introduction 25
4.2: Microcontroller Module 25
4.3: Sensors Module 28
4.4: Zigbee Transceiver Module 30
4.5: Solid State Relay Circuit 32

CHAPTER 5: SOFTWARE DEVELOPMENT 34

5.1: Introduction 34
5.2: Remote Room Network 35
5.3: Central Room Network 37

CHAPTER 6: TESTING AND EVALUATING RESULT 39

6.1: Introduction 39
6.2: Microcontroller System Board Module Testing 40
6.3: Serial Communication Module Testing 41
6.4: Sensors Module Testing 43
6.5: Xbee OEM RF module testing 45
6.6: AC Fan and Lamp Testing 46

CHAPTER 7: CONCLUSION AND RECOMMENDATION 49

7.1: Conclusion 49
7.2: Recommendation 50
7.3: Costing and Commercialization 51

REFERENCES 52

APPENDIX A
APPENDIX B
APPENDIX C
# LIST OF FIGURES

<table>
<thead>
<tr>
<th>FIGURE NO.</th>
<th>TITLE</th>
<th>PAGE</th>
</tr>
</thead>
<tbody>
<tr>
<td>2.1</td>
<td>Example of Zigbee Devices</td>
<td>8</td>
</tr>
<tr>
<td>2.2</td>
<td>Typical Zigbee Framework of Wireless Sensor Network</td>
<td>9</td>
</tr>
<tr>
<td>2.3</td>
<td>Block Diagram of the Command Control System</td>
<td>10</td>
</tr>
<tr>
<td>2.4</td>
<td>Block Diagram of Data Collection Process</td>
<td>11</td>
</tr>
<tr>
<td>2.5</td>
<td>Diagram of Simple Wireless Application Using Zigbee</td>
<td>12</td>
</tr>
<tr>
<td>3.1</td>
<td>Full System Block Diagram</td>
<td>18</td>
</tr>
<tr>
<td>3.2</td>
<td>Block Diagram of Microcontroller Board Module</td>
<td>19</td>
</tr>
<tr>
<td>3.3</td>
<td>Block Diagram of Sensors Module</td>
<td>20</td>
</tr>
<tr>
<td>3.4</td>
<td>Block Diagram of Xbee Module at Central Room Network</td>
<td>21</td>
</tr>
<tr>
<td>3.5</td>
<td>Block Diagram of Xbee Module at Remote Room Network</td>
<td>22</td>
</tr>
<tr>
<td>3.6</td>
<td>Block Diagram of Serial Communication at Central Room Node</td>
<td>23</td>
</tr>
<tr>
<td>3.7</td>
<td>Block Diagram of Serial Communication at Remote Room Node</td>
<td>23</td>
</tr>
<tr>
<td>3.8</td>
<td>Block Diagram of Solid State Relay Circuit Module</td>
<td>24</td>
</tr>
<tr>
<td>4.1</td>
<td>PIC16F876A Circuit Schematic Module</td>
<td>27</td>
</tr>
<tr>
<td>4.2</td>
<td>Circuit Schematic of Sensors Module</td>
<td>29</td>
</tr>
<tr>
<td>4.3</td>
<td>Circuit Schematic of Xbee at Central Room</td>
<td>30</td>
</tr>
<tr>
<td>4.4</td>
<td>Circuit Schematic of Xbee at Remote Room</td>
<td>31</td>
</tr>
<tr>
<td>4.5</td>
<td>Circuit Schematic Power Supply 3.3V</td>
<td>32</td>
</tr>
<tr>
<td>4.6</td>
<td>Solid State Relay Circuit</td>
<td>33</td>
</tr>
<tr>
<td>5.1</td>
<td>Flow Chart Program Receive at Remote Room</td>
<td>35</td>
</tr>
</tbody>
</table>
5.2 Flow Chart Program Transmit at Remote Room 36
5.3 Flow Chart Program Receive at Central Room 37
5.4 Flow Chart Program Transmit at Central Room 38
6.1 Circuit Schematic for Microcontroller Module Testing 40
6.2 Microcontroller Module Testing Program 41
6.3 Circuit Schematic for Serial Communication Testing 42
6.4 Serial Communication Testing Program 42
6.5 Serial Communication Testing Result 43
6.6 Sensors Module Testing Program 44
6.7 Sensors Module Testing Result 45
6.8 Xbee Module Testing Result 46
6.9 Remote Room 1 Circuit Board 47
6.10 Remote Room 2 Circuit Board 47
6.11 Central Room Circuit Board 48
## LIST OF FIGURES

<table>
<thead>
<tr>
<th>EQUATION NO.</th>
<th>TITLE</th>
<th>PAGE</th>
</tr>
</thead>
<tbody>
<tr>
<td>2.1</td>
<td>Kelvin</td>
<td>14</td>
</tr>
<tr>
<td>2.2</td>
<td>Centigrade</td>
<td>14</td>
</tr>
<tr>
<td>2.3</td>
<td>Fahrenheit</td>
<td>14</td>
</tr>
<tr>
<td>2.4</td>
<td>Rankin</td>
<td>14</td>
</tr>
<tr>
<td>2.5</td>
<td>Relative Humidity</td>
<td>15</td>
</tr>
<tr>
<td>2.6</td>
<td>R.H.</td>
<td>15</td>
</tr>
</tbody>
</table>
## LIST OF APPENDICES

<table>
<thead>
<tr>
<th>APPENDIX NO.</th>
<th>TITLE</th>
<th>PAGE</th>
</tr>
</thead>
<tbody>
<tr>
<td>A</td>
<td>Program</td>
<td>55</td>
</tr>
<tr>
<td>B</td>
<td>Hardware</td>
<td>62</td>
</tr>
<tr>
<td>C</td>
<td>Data Sheets</td>
<td>65</td>
</tr>
</tbody>
</table>
CHAPTER 1

INTRODUCTION

1.1 Introduction

Wireless sensor networks have come to the forefront of the scientific community recently. Depending on its application needs, various technologies have been applied in design and development of wireless sensor network for remote monitoring. The technology is typically being used in various fields including meteorological system to solve unpredictable climate condition. In this case, several factors are involved including ambient temperature, relative humidity, and light brightness intensity. For this reason, a simple but an efficient professional meteorological system is required to monitor and control the environmental condition remotely. Lately, remote monitoring and controlling system has become a promising field of future technology which is entering a new era with the development of wireless sensing devices. In the beginning it is limited to supervisory control and data acquisition only, but these days remote monitoring and controlling refers to the measurement from a network operation centre and the ability to change any operation of certain devices from the room.
In similar manner, embedded system have gain enormous amount of processing power and functionality over recent years. Many of the formerly external components can now be integrated into a single system-on-chip. Embedded system is a combination of a microchip and software to perform a specific task, embedded into a manufactured product. This tendency has resulted in a dramatic reduction in the size and cost of embedded systems. Embedded system is an essential element of many innovations where it is designed to increase the reliability and performance of the product. The perfect combination of wireless and embedded system has been used by designer engineers to design various type of wireless monitoring and controlling system. This technology allows the remote location to report information of measurement to the system designer or operator. One of the advantages of this technology is it allows automatic monitoring, alerting and necessary record-keeping parameter for safe and efficient operations.

A distributed control strategy is the most desirable and reliable setup for monitoring environmental measurement. In addition, supervisory in real-time would preserve the quality for the process because of existence wireless link between the remote interface computer and the measurement sensor network. Furthermore, output control device provide eminence feature along the system. Thus, the aim of this project is to develop an embedded based monitoring and controlling system based on Zigbee technology. The system capable monitoring environment parameter at remote location and provide a communication link between the device and user for controlling purpose. The environment parameter specifically temperature, light intensity and humidity are displayed through computer using GUI application. The system provides mutual interoperability between various electronic and power devices as well as interactive interface for people to control the system operation.
1.2 Project Objectives

The main objective of this project is to develop a system that capable of monitoring and controlling various parameters in remote location and place the location into desire environment by using Zigbee-based wireless communication line. The environmental parameter specifically temperature, light intensity and humidity are displayed through personal computer at central operation network.
1.3 Project Scope

In order to achieve the objectives of the project, the scope of the project are summarized as follow:

- Develop microcontroller sub-system at remote location in star topology network

- Design and construct temperature, humidity and light intensity sensors circuit to measure environment parameter.

- Develop output module circuit to activate AC appliance and set environment into desire condition.

- Develop a serial asynchronous communication system between master module and personal computer for user-friendly environment.

- Develop and configure wireless communication link between two operational arrangement using Zigbee devices.

- Develop the firmware for graphical user interface for acquiring input data process and command control execution output device.
1.4 Thesis Outline

The thesis consists of six chapters. Each chapter discusses the development and operation of Embedded Based Remote Monitoring and Controlling System (ERING). Below are the elaborations of every chapter in the thesis.

Chapter 1 describes an overall review of the project. Aspect that included is objectives, project background and scopes as well as thesis organization.

Chapter 2 discusses the literature review of the project. The development of monitoring system, controlling system and wireless communication will be discussed in this chapter.

Chapter 3 presents the architecture and operation of the system. Block diagram for each module involved are discussed.

Chapter 4 discusses the details of hardware design of each module. The connections of hardware are shown in circuit schematic diagram.

Chapter 5 indicates the software development for each module network. The discussion is based on modular approach where a flow chart diagram is used for simple approach explanation.

Chapter 6 present various testing and result of each module operation aspect. The entire integrated modules operation is also discussed in this session.

Chapter 7 concludes the outcome of the project. The recommendation on this project is included in this chapter for future works to enhance system performance.
CHAPTER 2

LITERATURE REVIEW

2.1 Introduction

This chapter discusses the research and finding that have been made regarding this project field. The discussion starts from the development of monitoring system, controlling system and wireless communication as well as its function to acquiring data input and sending output command. All the related research papers and journals that provide thought and concept concerning this project ground also is explained into a simple means.

2.2 Project Literature Review

Transceiver is a device that has both the transmitter and receiver circuits are integrated and share common or single housing. Technically, transceivers must combine a large number of transmitter and receiver circuit operations. Similar devices include transponders, transverses, and repeater. In this project, an Xbee RF module as shown in
Figure 2.1 is used as a transceiver. XBee OEM RF modules are IEEE 802.15.4 compliant solution that meets the unique needs of low cost and low power wireless sensor networks. Features of this module are easy to use, require 3.3 volt power, and provide reliable delivery of critical data between devices [1].

Zigbee is a new wireless technology that now can be seeing widely used to deploy a sensor network. This technology has put such a compromising enhancement into the sensor network in various fields. The infrastructure comprised of sensing, computing and communications elements allows the administrator to observe and react in the direction of events and phenomena shifting in a specified environment [2]. Typical applications include, but are not limited to, data collection, monitoring, surveillance and medical telemetry. The major applications of Zigbee focus on sensor and automatic control, such as military application, industrial control, smart buildings and environment monitoring. Agriculture automation is also an applicable field recommended by Zigbee alliance.

ZigBee is a specification for a suite of high level communication protocols using small, low-power digital radios based on the IEEE 802.15.4 standard for wireless personal area networks (WPANs). ZigBee builds upon the 802.15.4 standard to define application profiles that can be shared among different manufacturers. IEEE 802.15.4 is a standard defined by the IEEE [3]. It allows the technology to be widely deployed in wireless control and monitoring applications. The low power-usage allows longer life with smaller batteries and the mesh networking provides high reliability and larger range. ZigBee operates in the industrial, scientific and medical (ISM) radio bands. The technology is intended to be simpler and less expensive than other WPAN such as Bluetooth [3].
A wireless network is an infrastructure for communication “through the air” in which no cables are needed to connect from one point to another. Wireless communication is generally considered to be a branch of telecommunications. Wireless operations permits services, such as long range communications, that are impossible or impractical to implement with the use of wires and it can be implement via radio frequency communication, microwave communication or infrared (IR) short-range communication. Applications may involve point-to-point communication, point-to-multipoint communication, broadcasting, cellular networks and other wireless networks [4].

According of [2], the frameworks of Zigbee operating arrangement can be classified as high-tech network. As shown in Figure 2.2, each node can sense, compute and communicate each other. They can either receive message or transmits message (full-duplex), and can transmit messages to a gateway via self-configuration and multi-hop routing. The gateway can use many ways to communicate with remote network, such as Internet, satellite, mobile communication network and in this system we use pc interfacing. 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 and in this case, it will
compromise two nodes. One of them will act as the central server where the Zigbee will directly connect to the personal computer.

![Figure 2.2: Typical Zigbee Framework of Wireless Sensor Network](image)

Furthermore, [2] describes that in 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 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.

In this modern age, communication had becomes an essential element in various arrangement and coordination system. In order to form a communication lines, humans currently using diverse way to join and connect each gateway. Referring [5], one of the examples is by using mobile phone and PC. Mobile phone can serve as powerful tool for world-wide wireless communication. A system is developed to remotely monitor process through spoken commands using mobile. Sound spectrum features are extracted from spoken words. For recognition of various words used in the command learning Vector Quantization Neural Network is
required. The accuracy of spoken commands is about 98%. A text message is generated and sent to control system mobile in form of SMS. On receipt of SMS, control system mobile informs micro-controller based card, which performs specified task. The system alerts user in case of occurrence of any abnormal conditions like power failure, loss of control, etc [5].

It is observed that many mobile users especially older generation find it inconvenient to use mobile keypad for text entry as it involves continuous pressing of many keys for alphabets and is time consuming. In order to relieve the users from this burden, spoken words are used to send commands for control. The Block Diagram of the scheme is shown in figure 2.3. The microphone is connected to MIC interface of sound section on motherboard of Pentium IV based PC. User mobile is connected through cable using USB port. In this approach, predetermined phrases of words are selected for various commands. The Mel cepstrum features are extracted from the spoken words for recognition. Mel cepstrum exploits auditory principles as well as discriminating property of the cepstrum and is proven to be one of the most successful feature representations in speech related recognition tasks [5].

![Figure 2.3: Block Diagram of The Command Control System](image)

In addition, communication lines also can be formed using personal computer (PC) interfacing. In [6] described the application of the wireless devices for the purpose of temperature data collection and storage using digital computer. PC interfacing offer several attractive features like acknowledgement about execution of
command from system, ease of implementation and cost-effective approach. In Figure 2.4, block diagram of the data collection process in the system is shown. The PC system connected to Zigbee based coordinator board through serial communication using RS-232 cable. Meanwhile, the sensor network connected to microprocessor before it sends data to Zigbee before it transmit to another one. This system will help to minimize the need for wire connections, cost, power consumption and manpower to promote stable environment in order to produce good quality products [6].

Figure 2.4: Block Diagram of Data Collection Process

In telecommunication and computer science, serial communication is the process of sending data one bit at one time, sequentially, over a communication channel or computer bus. There are two basic types of serial communications, synchronous and asynchronous. With synchronous communications, the two devices initially synchronize themselves to each other, and then continually send characters to stay in synchronous. Asynchronous means "no synchronization", and thus does not require sending and receiving idle characters [7]. In [8] describe about the Universal Serial Bus (USB) that has been developed to overcome disadvantages of previously available communication interfaces; it is a fast, bi-directional,