REMOTE MEASUREMENT OF WEARABLE SENSOR USING ZIGBEE

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DEDICATION

To my beloved parents *for the love that arose for me until today*

My supporting brothers *that never stopped praying for me*

And

My entire friends and lecturers *for the encouragement and ideas*

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Alhamdulillah, praise to Allah S.W.T for the guidance and blessing best owed upon me, for without it I would not have been able to come this far.

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ABSTRACT

Substation is one of the most important parts of power system. The manual inspection is still used in many substations in Malaysia. Obviously, it is significant to establish an aid inspection monitoring and positioning system in substations, which is useful to the inspectors and manager. Thus, this project focused on Remote Measurement of Wearable Sensor using ZigBee to help user in monitoring temperature. This project aims to detect the temperature using heat sensor where is connected to microcontroller to send the data using ZegBee and store in excel. The main objective of this project is to design a circuit for transmitter and receiver of ZigBee module. The ZigBee module transmits and receives the data (temperature) measured by the heat sensor at two condition; normal temperature condition and at exceeded temperature point. In this project, the smart wireless temperature data using ZigBee module is introduced for mankind in the future and the performance of the system was analysed.

ABSTRAK

Pencawang elektrik adalah salah satu bahagian yang paling penting dalam system penjanaan kuasa. Pemeriksaan manual masih digunakan dalam banyak pencawang di seluruh Malaysia. Jelas sekali, ia adalah penting untuk mewujudkan pemantauan bantuan pemeriksaan dan sistem kedudukan dalam pencawang yang berguna kepada pemeriksa dan pengurus. Oleh itu, projek ini mengenai "Remote Measurement of Wearable Sensor using ZigBee" ini dicadangkan untuk membantu pengguna memantau suhu darirangkaian ZigBee. Projek ini bertujuan untuk mengukur suhu dengan menggunakan sensor haba dengan menghubungkanalat elektronik yang kecil seperti litar mikro-pengawal dan menghantar data kepada Visual Basic dan seterusnya dimasukkan ke dalam Microsoft Excel. Objektif utama projek ini adalah untuk merekabentuk dan membina litar pemancar dan penerima yang akan dilaksanakan dengan rangkaian ZigBee. Rangkaian ZigBee digunakan untuk menghantar dan menerima data (suhu) yang diukur oleh sensor suhu pada dua keadaan seperti suhu dalam keadaan suhu bilik dan pada ketika suhu telah melebihi suhu yang ditetapkan. Dalam projek ini, kawalan tanpa wayar bagi menyukat keadaan suhu menggunakan rangkaian ZigBee diperkenalkan untuk kegunaan manusia pada masa hadapan dan prestasi sistem ini dianalisis.

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LIST OF ABBREVIATION

POR	-	Power-on Reset
BOR	-	Brown-out Reset
ASM	-	Assembly Language
PCB	-	Printed Circuit Board
LED	-	Light Emitting Diode
EN	-	Enable
RS	-	Register Select
R/W	-	Read/Write
EEPROM	-	Electrical Erasable Programmable Random Access Memory
ICD	-	In Circuit Debugging
A/D	-	Analog-to-Digital
PWM	-	Pulse Width Modulation
UART	-	Universal Asynchronous Receiver Transmitter
WSN	-	Wireless Sensor Node
LCD	-	Liquid Crystal Display
PIC	-	Programmable Integrated Circuit
ISM	-	Industrial, Scientific and Medical
RAM	-	Random Access Memory
PAN	-	People Area Network
CLH	-	Cluster Head
CID	-	Cluster Identifier
PC	-	Personal Computer
RISC	-	Reduced Instruction Set Computer
LP	-	Low Power Crystal
XT	-	Crystal/Resonator

LIST OF ABBREVIATION

HS	-	High Speed Crystal
RC	-	Resistor/Capacitor
Rx	-	Receiver
Tx	-	Transmitter

CHAPTER I

INTRODUCTION

1.1 Background

Substation is one of the most important parts of power system. The manual inspection is still used in many substations in Malaysia. Obviously, the manual inspection is significant to establish an aid inspection monitoring and positioning system in substations, which is useful to the inspectors and manager [1].

The functions of the system are exactly positioning of staff that entered monitoring area and real-time monitoring the high-risk work area and non-work area and timely warning to abnormal behaviour. The system also can record and replay the inspected track, and avoid careless inspecting occurs as shown in Figure 1.1. The figure shows that the architecture of the presented system, which mainly includes three parts this are monitoring centre, WSN communication network and terminal. The terminal includes three parts this are sensor, sound and light alarm module and WSN node. Monitoring centre can display data real-timely. In case of emergency, monitoring centre can control terminal. By combining with the real environment of the substation, nodes are deployed reasonably in accordance with the principle of cost optimization [2].

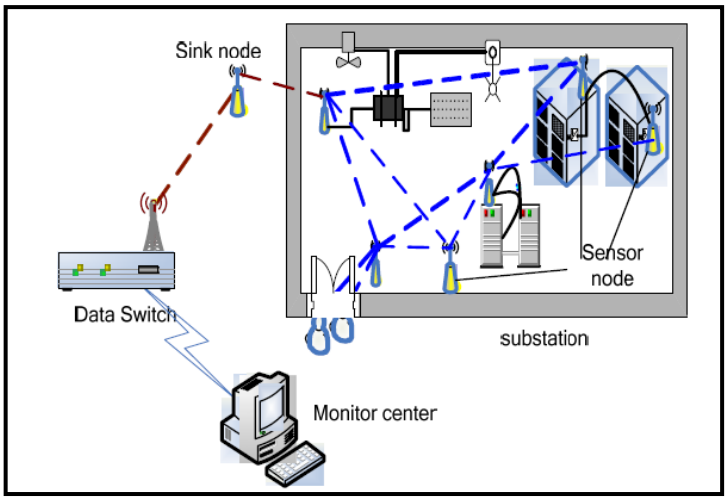

Figure 1.1 :The Architecture of Monitoring System.

The terminal is installed in high-risk work area of substation. As it receives "start "command from monitoring centre, the microwave sensor will start to work. In this case, if anyone enters the monitoring area, the terminal will start light and sound alarm. At the same time, abnormal event will be uploaded to the monitoring centre and real-time displayed in monitoring system.

1.2 Objectives

- To design circuit for transmitter and receiver of ZigBee module.
- To measure the smart wireless temperature data using ZigBee.
- To analyze the performances of the signal range.

1.3 Problem Statement

- Dangerous for inspector since substation is high-risk work area.
- Carelessness of inspectors.
- Time-consuming since the wide distribution of substations.
- No accurate time of failure discovery.

1.4 Scope of Work

This project focused on measuring of temperature through the Transmiert-Receiver of Zigbee module and display the result on the user computer. This project primarily covered the following parts:

- The connection between the programmable integrated circuit (PIC) circuits with Zigbee module.
- The construction of programmable integrated circuit embedded circuit and LCD circuit.
- The construction of programmable integrated circuit embedded circuit and temperature sensor.
- The design of command or coding for programmable integrated circuit 16F877A that connected to the Zigbee module.

All the parts above will function in one system that transmitting system will send the data through the Zigbee module and the receiving system will display the data on user computer.

1.5 Project Significant

- This system can bring awareness to the authorities to the importance of health condition of power transformer.
- To help user monitor the temperature using ZigBee network.
- To measure the performance of the signal range that can help technician in maintenance.

CHAPTER II

LITERATURE REVIEW

2.1 Introduction to ZigBee

ZigBee is a wireless network protocol specifically designed for low data rate sensors and control networks as shown in Figure 2.1. ZigBee is a consortium of software, hardware and services companies that have developed a common standard for wireless, networking of sensors and controllers. While other wireless standards are concerned with exchanging large amounts of data, ZigBee is for devices that have smaller throughout needs. The other driving factors are low cost, high reliability, high security, low battery usage, simplicity and interoperability with other ZigBee devices [3].

Compared to other wireless protocol that ZigBee wireless protocol offers low complexity. ZigBee wireless protocol also offers three frequency bands of operation along with a number of network configurations and optional security capability. In health care, ZigBee can be used for patient monitoring process control, assuring compliance with environmental standards and energy management. Used correctly, ZigBee enabled devices can give a warning before a breakdown occurs so that repairs can be made in the most cost effective manner. They will be used for controlling our home entertainment systems, lights, garage door openers, alarms, panic buttons and many other uses.

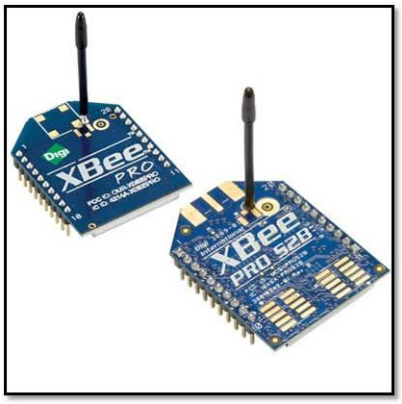

Figure 2.1: ZigBee Module

2.1.1 Principal Operation of ZigBee

ZigBee hardware typically consists of an eight bit microcontroller combined with a miniature transceiver a small amount (example 32 KB) of flash memory and RAM. Most of the ZigBee stack is provided in ASIC. ZigBee operates with ISM 2.4 GHz frequency band and is pin for pin compatible with maxstream's ZigBee product. There are three radio frequencies used for ZigBee radio frequency communications 2.4 GHz with 16 channels and a data rate of 250 kbps for worldwide coverage, 868 MHz with a single channel and a data rate of 20 kbps in Europe and 915MHz with 10 channels and a data rate of 40 kbps in America.

For comparison, even at 250 kbps the data throughput is only about one tenth that of blue tooth. Another wireless networking solution but more than sufficient for monitoring and controlling usage. Broadcast range for ZigBee is approximately 70 meters. Theoretically ZigBee networks can contain up to 64 k (65,536) network nodes. Current testing has not reached anywhere near that level. The name ZigBee is said to come from the domestic honeybee, which uses a zigzag type of dance to communicate important information to other hive members [4].

2.1.2 Different Types of Topologies

The three types of topologies that ZigBee supports are shown below which is [5]:

a) Star Topology

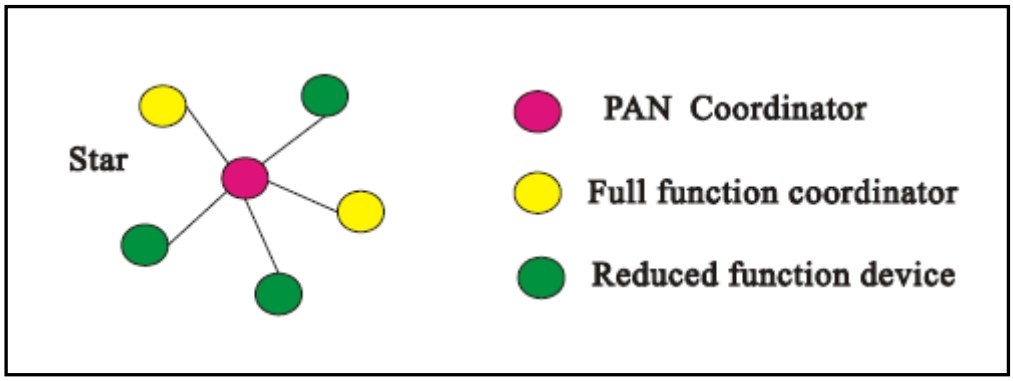

Figure 2.2: Star Topology

In the star topology, the communication is established between the devices and a single central controller called PAN coordinator. The PAN coordinator may be mains powered while the devices will most likely be battery powered. Applications that benefit from this topology include home automation, personal computer (PC) peripherals, toys and games. After an FFD is activated for the first time, the FFD may establish the network and become the PAN coordinator. Each star network chooses a PAN identifier, which is not currently used by any other network within the radio spear of influence. This allows each star network to operate independently.

b) Mesh Topology

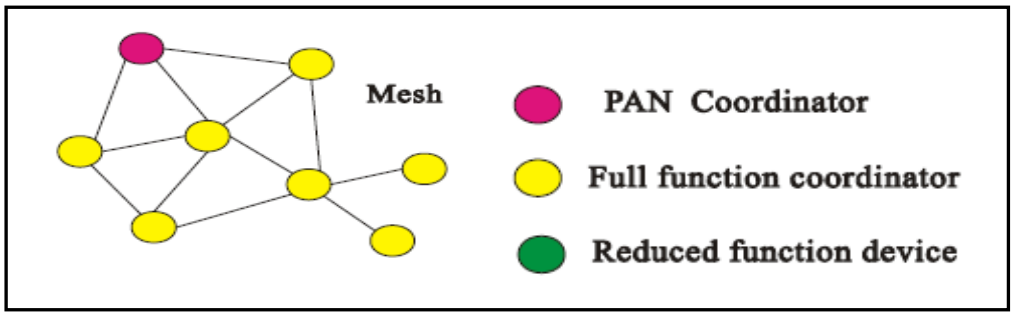

Figure 2.3: Mesh Topology

In the Mesh topology, there is also one PAN coordinator. In contrast to star topology, any device can communicate with any other device as long as they are in range of one another. A Mesh network can be ad-hoc, self-organizing and self-healing. Applications such as industrial control and monitoring, wireless sensor networks assert and inventory tracking wood benefit from such a topology. Mesh topology also allows multiple hopes to root massages from any device to any other device in the network and can provide reliability by multipath rooting.

c) Tree Topology

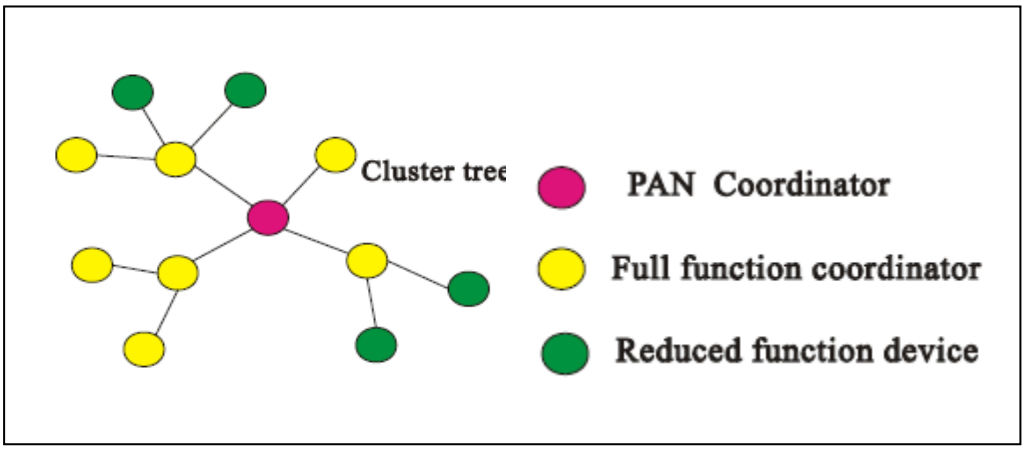

Figure 2.4: Tree Topology

Cluster tree network is special case of Mesh network in which most devices are FFD's and an RFD may connect to a cluster tree network as a leave node at the end of a branch. Any of the FFD can act as a coordinator and provide synchronization services to other devices and coordinators. Only one of this coordinator however is the PAN coordinator. The PAN coordinator forms the first cluster by establishing itself as the cluster head (CLH) with a cluster identifier (CID) of zero, choosing an unused PAN identifier, and broadcasting beacon frames to neighboring devices. A candidate device receiving a beacon frame may request to join the network at the CLH.

If the PAN coordinator permits the device to join, PAN coordinator will add this new device as a child device in neighbor list. The newly joined device will add the CLH as parent in neighbor list and begin transmitting periodic beacons such that

other candidate devices may then join the network at that device. The advantage of this clustered structure is the increased coverage area at the cost of increased message latency.

2.1.3 Difference between Bluetooth and ZigBee

ZigBee looks rather like Bluetooth but is simpler, has a lower data rate and spends most of the time in snoozing. This characteristic means that a node on a ZigBee network should be able to run for six months to two years on just two AA batteries. The operational range for ZigBee is 10 to 75 meters compared to 10 meters for Bluetooth (without a power amplifier). ZigBee sits below Bluetooth in terms of data rate. The data rate of ZigBee is 250 kbps at 2.4 GHz 40 kbps at 915MHz and 20 kbps at 868 MHz where as that of Bluetooth is 1Mbps.

ZigBee uses a basic master slave configuration suited to static star networks of many infrequently used devices that talk via small data packets. ZigBee allows up to 254 nodes. Bluetooth protocol is more complex since Bluetooth is geared towards handling voice, images and file transfers in ad hoc networks, Bluetooth devices can support scatter nets of multiple smaller non synchronized networks. Bluetooth only allows up to 8 slave nodes in a basic master slave Pico net setup. When ZigBee node is powered down, Bluetooth can wake up and get a packet in around 15 milliseconds where as a Bluetooth device would take around 3 seconds to wake up and respond [5].

2.2 Liquid Crystal Display (LCD)

This component is specifically manufactured to be used with microcontrollers, which means that LCD cannot be activated by standard IC circuits. LCD is used for displaying different messages on a miniature liquid crystal display. The model described here is for low price and great capabilities most frequently used in practice. LCD is based on the HD44780 microcontroller (*Hitachi*) and can display messages in two lines with 16 characters each. LCD also can display all the letters of alphabet, Greek letters, punctuation marks, mathematical symbols. Moreover, LCD may also possible to display symbols made up by the user.