UNIVERSITI TEKNIKAL MALAYSIA MELAKA

WIRELESS TEMPERATURE MONITORING SYSTEM USING WI-FI

This report submitted in accordance with the requirement of the Universiti Teknikal Malaysia Melaka (UTeM) for the Bachelor of Electronics Engineering Technology (Telecommunications) with Honours

by

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APPROVAL

This report is submitted to the Faculty of Engineering Technology of UTeM as a partial fulfillment of the requirements for the degree of Bachelor of Engineering Technology (Department of Electronics & Computer Engineering Technology) (Hons.). The member of the supervisory is as follow:

……

(Project Supervisor)

ABSTRACT

Nowadays, wireless communication devices and systems have a significant impact on everyone. This project describes a wireless temperature monitoring system using Wi-Fi that was developed using Arduino. This system can wirelessly transmit and receive electrical signals from a temperature sensor. Wi-Fi is used to transmit and receive the data from the Arduino Uno board, which is connected directly with Wi-Fi Shield and temperature sensor. The device gives many advantages to the user since they can monitor the temperature from anywhere in the world at anytime continuously. Cost burden can be minimized in terms of installation and maintenance of wiring in the factory, the laboratory, the house, the office and the classroom. Temperature monitoring of a particular place using wires can be difficult and sometimes impossible for example in places where humans are prohibited to enter. This problem can be solved by using wireless sensor network to ensure the temperature of the area can be remotely and continuously monitored by the user. This project also creates a system that can be monitored continuously via the internet.

ABSTRAK

Pada masa kini, system dan peranti komunikasi tanpa wayar mempunyai kesan yang besar kepada semua. Projek ini menggambarkan satu sistem pemantauan suhu wayarles menggunakan Wi-Fi yang dibangunkan menggunakan Arduino. Sistem ini secara wayarles boleh menghantar dan menerima isyarat elektrik daripada sensor suhu. Wi-Fi digunakan untuk menghantar dan menerima data dari papan Arduino Uno, yang secara langsung bersambung dengan Wi-Fi Shield dan sensor suhu. Peranti ini memberikan banyak kelebihan kepada pengguna kerana mereka boleh memantau suhu di mana-mana sahaja mereka berada di dunia ini dan pada bila-bila masa secara berterusan. Beban kos dapat dikurangkan dari segi pemasangan dan penyelenggaraan pendawaian di kilang, makmal, rumah, pejabat dan bilik darjah. Pemantauan suhu tempat tertentu menggunakan wayar boleh menjadi sukar dan kadangkala mustahil seperti di tempat-tempat di mana manusia dilarang untuk masuk. Masalah ini boleh diselesaikan dengan menggunakan rangkaian sensor tanpa wayar untuk memastikan suhu kawasan ini boleh dipantau dari jarak jauh dan secara berterusan oleh pengguna. Projek ini juga mewujudkan satu sistem yang boleh dipantau secara berterusan melalui internet.

DEDICATION

A deep appreciation

for the support, encouragement and understanding

of my beloved parents, ***Zulkipli bin Yacob*** *and* ***Wan Suriani binti Wan Mustapha****,*

This work is dedicated to them.

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CHAPTER 1

INTRODUCTION

1.1 Introduction

In the previous era, there were no wireless technology applications. On top of that, most people would not even be able to imagine how a wireless system works. In today's world, a wireless device has become common place. Wireless is defined as having no wires connection. In addition, the manual temperature monitoring is not portable and difficult to monitor at the distant remote location. Wireless Fidelity or also known as Wi-Fi is identified to replace the manual temperature monitoring system. The use of Wi-Fi application is to make the system easy to monitor from distant location. So, the high demand from users gave rise to the idea for "Wireless Temperature Monitoring System using Wi-Fi".

1.2 Project Background

"Temperature Monitoring System" is a system that is mostly used in factory, laboratory, office or school to monitor the temperature. This project is to improve the temperature monitoring systems and to indicate the status of the temperature in a certain area using Wi-Fi application. The use of Wi-Fi application is to make it easier to monitor the current temperature in certain areas such as factory, laboratory, office, classroom and house. Temperature monitoring of a particular place using wires can sometimes be impossible due to inaccessibility. So, there is a necessity for wireless monitoring system which enables the user to track the

temperature from a remote location. Nowadays, the users need a technology that suits their need for portable device. The temperature monitoring systems using Wi-Fi is a portable application and can be used in a wide area. By using The Arduino Wi-Fi Shield, it can be connected to the Wi-Fi system. From that, the user can monitor the status of the temperature from any remote location.

The system will be displayed in the form of a webpage. The 802.11 wireless specifications in an Arduino Wi-Fi shield allows an Arduino Uno Board to connect to the internet. The network specifications which are 802.11b and 802.11g help to connect Wi-Fi shield wirelessly. In addition, the data sent to the laptop will be translated into a radio signal using wireless adapter. The radio signal will be transmitted through an antenna to a decoder known as a wireless router. On top of that, the data received by the router will be passed to the internet. Then, the laptop wireless adapter will receive the coded data using radio signal from the internet. The Arduino will act as the brain of the system that monitor the input and output of the system. The program generated in Arduino Integrated Development will be transferred into Arduino UNO board. Arduino Wi-Fi Shield will control all the devices in the circuit to function. The temperature sensor is used in this project to detect the hotness or coldness of an object. There are two types of temperature sensor which were considered: contact and non-contact sensors.

1.3 Problem Statement

Temperature monitoring of a particular place using wires can be difficult and sometimes impossible for example in places where humans are prohibited to enter. This problem can be solved by using wireless sensor network to ensure the temperature of the area can be remotely and continuously monitored by the user. In fact, the system will be user-friendly and can be connected to a wide area. (Mendez, et al., 2011) in their article states that the costs of wireless sensor network are less compared to wiring and cabling installation. Temperature data will be processed and sent wirelessly to the monitoring system. In a usual situation of wired temperature system, it will cost more due to wastage of labour and material. Other than that, the

wired system is not portable because of rigid cabling installation. So, the wireless temperature monitoring system using Wi-Fi is the best solution.

1.4 Objectives

The main objectives of the wireless temperature monitoring using Wi-Fi project are listed below:

i. To study the temperature monitoring system using Wi-Fi on the laptop.
ii. To design the system of temperature monitoring using Arduino Wi-Fi shield.
iii. To develop a temperature monitoring that indicates the temperature status of the area whether the temperature is high or low.

1.5 Work Scope

The main work scope of this project is to design and develop a working wireless temperature monitoring system using Wi-Fi application. Wi-Fi application is preferred over all other wireless communication technologies because most of the users already have internet and Wi-Fi connection. The Arduino Uno Board and Wi-Fi Shield will be used to transfer the data of the current temperature reading to the system.

1.6 Report Organizations

This part explains all the process and the flow for completing this report and project. This report is divided into a few chapters and each is stated below:

Chapter 1: Introduction

This chapter will introduce the background of the project, the problem statement, the objectives, the work scope, and the report organizations.

Chapter 2: Literature Review

This chapter explains the literature research of related or previous projects. All literatures on previous projects are stated in this chapter. The summarization of the previous project will also be included here.

Chapter 3: Methodology

This chapter shows the project methodology. The methodology is based on System Development Life cycle (SDLC). The simulation, analysis and evaluation of the process of the project will be discussed in this chapter.

Chapter 4: Expected Results

This chapter will state the expected result that will be obtained using software and hardware development.

Chapter 5: Conclusion

This chapter will discuss the summary of the project.

1.7 Conclusion

In a nutshell, while learning the process of monitoring system, the wireless temperature monitoring system using Wi-Fi was developed. The main goal of this project is to develop a system that will be used to monitor the measurement of temperature using Wi-Fi applications. Furthermore, the main objective of this project is to monitor the temperature reading of a certain area and the temperature reading will be displayed via a webpage. The workscope of this project is to design and develop a working wireless temperature monitoring system using Wi-Fi application and the use of a suitable software for the project. The comparisons and improvements of this project will be described in the next chapter.

CHAPTER 2

LITERATURE REVIEW

2.1 Introduction

The idea of this project comes from the problem faced by any user in monitoring the temperature reading from a remote location. Temperature monitoring of a remote place could be difficult or sometimes impossible for example in places where humans are prohibited to enter. The problem can be solve by using wireless sensor network to ensure the temperature of the area can be monitored continuously by the user at any time and from anywhere. This chapter will explain about all the components that will be used and some related researches regarding this project.

2.2 Related Research

Regarding the temperature monitoring system, there are several related research that had been done. T. Fukatsu and M. Hirafuji (2005) conducted a project regarding field monitoring using sensor nodes with a web server. Data from the remote location of the monitoring system can be accessed from any place at any time. The project provides the high noise tolerance for data transmission using Ethernet LAN. According to L. Chai (2009), using the embedded web is more portable and manageable. The network utilised for the transmission data will be at high speed. Dlaverty (2009) published an article about recommended server room temperature. The article is about computer and networking equipment which has narrow temperature range between 10^0c to 28^0c. The article states that the equipment

temperature cannot go below 10^0c and cannot be above than 28^0c. If the temperature is not within the stated range, the equipment will be damaged.

M.Kassim, M.N. Ismail, C.K.H. Che Ku Yahya (2011) conducted a research to develop a web based temperature monitoring system that allows the user to continuously monitor the current temperature reading in a remote location. This research is about monitoring temperature reading in the server room which is set between 15^0c to 20^0c. If the temperature is lower or higher than the set temperature range, the server might crash. The web – based temperature monitoring system is developed to display the temperature reading in the server room. The web-based system was proven very cost effective.

Mendez, et al. (2011) conducted a project on Wi-Fi based smart wireless sensor network for an agricultural environment. The project is to investigate the relationship between Ethernet connection and wireless communication. The wireless sensor network is more cost effective compared to cabled network. Besides that, the server can also be connected to the network either with wireless or Ethernet connection. K.S. Joshi and A.D. More (2014), in their article mentioned that Wireless Sensor Network (WSN) is used to monitor remote physical environment where human are prohibited to enter. The Wi-Fi acts as wireless transmitter and receiver. The Wi-Fi is used as a module of WSN because of its low power, low budget and suitability for distant location. According to M. Singson and Rajesh (2010) in surveys on the awareness and the use of Wi-Fi infrastructure in student community, the WLAN is the best mobile technology available. The data transmitted can be accessed from distant location. Furthermore, the system will be compatible and reliable. The WLAN enables the students to avoid the trouble of gaining access through LAN cable. The default access technology is Wi-Fi. In addition, the WLAN has growth and expanded in healthcare facilities, educational institution, office spaces, laboratory and factory. C.H Chavan and P.V. Karande (2014) developed a smart wireless sensor network (WSN) for an agricultural environment. This paper states that wireless remote monitoring from certain places is an effective method which improves efficiency. Furthermore, wireless monitoring allows the user to reduce human power, save time and reduce cost. In addition, the WSN are created using Wi-Fi (IEEE 802.11).

According to Malche et al. in their previous research of Harnessing the Internet of Things (IoT): A Review stated that the Internet of Things (IoT) technology is the latest technology which is gaining popularity. The IoT incorporates extensive variety of machines from sensors fuelled by microcontrollers to different gadgets and sensors controlled by processors which has comparative ability as found in the smart phones. In addition, Hina ruqsar et al (2014) in their previous project titled "Internet of Things Based Real Time Gas Leakage Monitoring and Controlling" stated that IoT speaks to the following advancement of the web, taking a tremendous jump in its capacity to accumulate, investigate and disseminate information. On top of that, their project used Xively as a service platform built for the IoT. In addition, normal cloud stage named Xively is the cloud administrations expects to give a shared view through which any gadget associated with the web cloud that really corresponds with some other gadgets.

2.3 Wireless Temperature Monitoring Using Wi-Fi

This project is to improve the temperature monitoring systems and to indicate the status of the temperature in a certain area to a remote user using Wi-Fi application. The Wi-Fi is categorized as Wireless Local Area Network (WLAN).The use of Wi-Fi application is to make it easier to monitor the latest temperature in certain areas such as factory, laboratory, office, classroom, library and house. Monitoring temperature of a particular place directly sometime is difficult or can even be impossible. One example is places where humans are prohibited to enter. So, there is a necessity for wireless monitoring system which enables the user to track the temperature from a remote location.

2.4 Wi-Fi/ IEEE 802.11

The IEEE 802.11 WLAN is the most popular of the internet access network technologies and is also known as Wi-Fi. Institute of Electrical and Electronics Engineers (IEEE) quoted that "IEEE 820.11 is set as the standard of wireless LAN (WLAN)". The Wi-Fi acts as a wireless transmitter and receiver of the

networks. The range of WLAN connection is up to 1 km. The specification for Wi-Fi is low power, low budget and, cost less than cable installation and suitable for distant locations. The Wireless Local Area Network (WLAN) IEEE 802.11 provides high speed transmission network with high power consumption. The IEEE 802.11 is widely used in public places, public transportation, homes, shops and offices. The Wi-Fi application focuses on web, email and video. The WLAN 802.11 is flexible and compatible with all mobile devices such as laptop, tablet, and hand phone.

There are several types of 802.11 standards which are 802.11a, 802.11b, 802.11g and 802.11n. The table 2.4.1 below shows the information on IEEE 802.11 standards.

Table 2.4.1 IEEE 802.11 standards

Protocol	Release Date	Op. Frequency	Data Rate (Typ)	Data Rate (Max)	Range (Indoor)	Range (Outdoor)
Legacy	1997	2.4-2.5 GHz	1 Mb/s	2 Mb/s		
802.11a	1999	5.15-5.35/5.47-5.725/5.725-5.875 GHz	25 Mb/s	54 Mb/s	~25 meters	~75 meters
802.11b	1999	2.4-2.5 GHz	5.5 Mb/s	11 Mb/s	~35 meters	~100 meters
802.11g	2003	2.4-2.5 GHz	25 Mb/s	54 Mb/s	~25 meters	~75 meters
802.11n	2007 (unapproved draft)	2.4 GHz or 5 GHz bands	200 Mb/s	540 Mb/s	~50 meters	~126 meters

The specified data rate of the IEEE 802.11 is 1 Mbps, 2 Mbps, 5.5/11 Mbps and 54 Mbps. The maximum data for 1 Mbps is Basic Rate (BR), 2 Mbps is Extended Rate (ER) while for 5.5/11 Mbps is High Rate (HR). The specification of 54 Mbps is Extended Rate Physical (ERP).

In addition, the IEEE 802.11 frame has four address fields which are able to hold 6 byte MAC address. The figure 2.4.2 below shows the breakdown of the 802.11 frame.

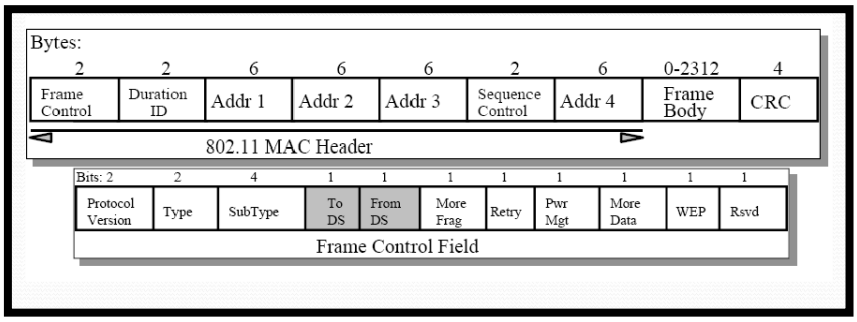

Figure 2.4.2 802.11 frame

Figure 2.4.3 below shows the 802.11b/g channel transmits in the 2.4 GHz band with a total of fourteen available channels. Only eleven channels are available in United States (US). While in Europe, 13 channels are available. Malaysian Communications and Multimedia Commission quoted that "there are those who move the Wireless Area Network (WLAN) technology to local condition using the 2400 MHz to 2500 MHz, 5150 MHz to 5350 MHz, 5470 MHz to 5650 MHz and 5725 MHz to 5875 MHz frequency bands to provide access to the internet service". According to D. Yoharaaj, Alyani Ismail and Raja Syamsul Azmir Raja Abdullah (2009) in their paper stated that "the wireless application that is selected to be studied is the Wireless Local Area Network (WLAN) based on the IEEE 802.11b standard. In Malaysia, this WLAN band spans from 2.4 GHz to 2.48 GHz."

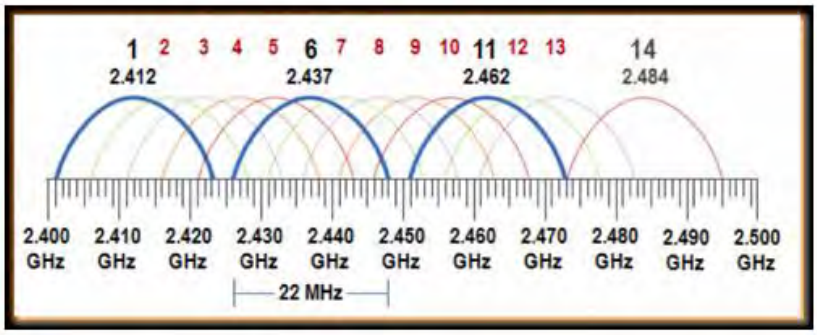

Figure 2.4.3 802.11b/g channel transmits in between 2.4 GHz

2.5 Temperature Sensor

In the market, there are many types of temperature sensors. The use of the temperature sensor is to detect the hotness or coolness of an object. In addition, the

temperature sensor is designed to measure a property which changes in responses to the temperature. There are two types of temperature sensors which are contact and non-contact. The contact sensor requires physical contact and can be used in solid, liquid or gases. These types of contact sensors are Resistance temperature detectors (RTD), thermistor, thermocouples and I.C sensor. The thermocouple sensor is best suited to high temperature use while RTD is the most stable sensor. The thermistor is the best for the low-cost application over a limited temperature range. On the other hand, non-contact sensor is usually used when the process or the object to be monitored involved movement. The advantages of the contact sensor are its economical cost, the application range and simplicity to apply. In contrast, the advantages of non-contact sensors are faster response time and can sense the temperature of the irregular shaped objects. The disadvantages of the contact sensors are the sensor is slow to respond and easy to damage. For the non-contact sensor, the disadvantages are it cannot measure gas temperature and any temperature affected by the environmental conditions such as dust, and smoke.

2.6 Arduino Uno Board

Arduino Uno Board is a microcontroller board that is based on an ATMEGA328 processor. The board consists of fourteen digital inputs and outputs which are Pulse Width Modulation (PWM) outputs, analogue inputs, ceramic resonator, USB connection, power jack, In-Circuit Serial Programming (ICSP) header and reset button. The table 2.6.1 shows the summary of an Arduino Uno Board specification.