# HOME WEATHER MONITORING SYSTEM

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"I hereby acknowledge that the scope and quality of this thesis is qualified for the award of the Bachelor Degree of Electrical Engineering (Control and Instrumentation)"

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## ABSTRACT

Currently, weather is very unpredictable due to global warming. This unstable weather is harmful to some plants, patients in hospital, some research, and any process that need to be done under a certain condition. In order to prevent the risk of hazardous and reduce unfavorable condition in a room, we may need a system to control temperature in the room. For that reason, a home weather monitoring system is developed to monitor the temperature in a room. The system consists of two parts; they are remote location and control room. This system uses two pairs of transceivers, so that the remote location can be more flexible. Each pair of transmitter and receiver is placed in remote location and a control room. Remote location is equipped with a temperature sensor, fan and seven-segment display. Control room is equipped with seven-segment display and buzzer as siren. Control room's antenna receives signal data from remote location to display current temperature on seven-segment display and transmit the data back to control the fan if the temperature is exceeding 30 degree Celsius. If temperature is exceeding 40 degree Celsius, the siren in Control Room is activated to indicate high risk situation.

# ABSTRAK

Kebelakangan ini, cuaca semakin sukar diramalkan disebabkan oleh pemanasan global. Cuaca yang tidak stabil ini akan mendatangkan keburukan atau bahaya kepada tumbuhan, pesakit-pesakit di hospital, penyelidikan dan mana-mana proses yang dijalani di bawah keadaan yang tertentu. Untuk mengelakkan risiko yang merbahaya dan keadaan yang tidak selesa di dalam bilik, kita memerlukan satu sistem yang dapat mangawal suhu dalam bilik. Oleh itu, satu sistem pengawalan suhu bilik akan dikira dan diuji. Sistem ini dibahagikan kepada dua bahagian; iaitu bilik yang dikawal dan bilik kawalan. Sistem ini menggunakan dua pasang pemancar dan penerima, supaya bilik dikawal dapat diubah mengikut kehendak pengguna. Dua pasang pemancar dan penerima akan dipasang di bilik dikawal dan bilik kawalan masing-masing. Di bilik dikawal, ia juga dipasang dengan pengesan suhu, kipas, dan paparan. Manakala di bilik kawalan, ia dipasang dengan paparan dan siren sebagai isyarat bahaya. Bilik kawalan akan menerima data isyarat dari bilik dikawal untuk memaparkan suhu bilik tersebut. Jika suhu melebihi 30 darjah celsius, bilik kawalan akan menghantar data isyarat balik ke bilik dikawal untuk memasang kipas. Jika suhu terus naik dan melebihi 40 darjah celsius, loceng bilik kawalan akan berbunyi dan kipas di kawalan akan terus terpasang. Jika suhu diturunkan dan kurang daripada 40 darjah Celcius, siren akan ditutup.

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# CHAPTER 1

# INTRODUCTION

## 1.1 Introduction

Nowadays, technology has becoming more advance and most of the technologies are using embedded system. Millions of computing systems are built every year, destined for desktop computers like personal computers, laptops, workstations, mainframes, and server. What may be surprising that is that billions of computing systems are built every year for a very different purpose: They are also embedded within larger electronic devices, repeatedly carrying out a particular function, often going completely unrecognized by device's users. Embedded control system becomes quite common and can be found in a variety of electronic devices such as consumer electronics, home appliances, office automation, business equipment, and automobiles. Embedded system not only easy to use, but also can make machines function automatically without human's guidance.

At the same time wireless technology has played a major role in our daily life, wireless communication is the transfer of information over a distance without the use of electrical conductors or wires. The distances involved may be short such a few meters as in television remote control or very long  such thousands or even

millions of kilometers for radio communications. Such application adopting wireless communication includes cellular telephones, garage door openers, television remote control and security system.

This perfect combination of wireless and embedded system is used by engineers to design many wireless monitoring system either one way broadcasting or two way broadcasting. The wireless monitoring systems that are designed such as wireless health monitoring system, wireless structural monitoring system, wireless weather monitoring system, wireless modular monitoring system, wireless liquid monitoring system, and others.

Nowadays, one of wireless technology application that is widely used is monitoring the status of a room remotely. This is due to the fact that there are some high risk areas or rooms especially in a laboratory or industrials plant that need to be monitored remotely in order to reduce the risk of hazardous or unfavourable environmental conditions. Therefore, a monitoring system is designed to provide early warning of various hazards in room remotely.

In order to monitor the status of the environment, this system may consist of sensory systems, transducer, transceiver, output display such as seven-segment display, liquid crystal display (LCD), speaker, light, fan or air-conditioner. The sensor can be temperature sensor, humidity sensor, or light sensor. A transducer is an electronic device that converts energy from one form to another. Common examples include microphones, loudspeakers, thermometers, position and pressure sensors, and antenna. Although not generally thought of as transducers, photocells, LEDs (light-emitting diodes), and even common light bulbs are transducers. Transceiver, on the other hand, is used to send and receive data remotely. The core of the design is microcontroller to control the operation of system. Some of the I/O device such as LCD or Seven-segment display may be required to display the status of the sensors.

Currently, weather is very unpredictable due to global warming. This unstable weather is harmful to some plants, patients in hospital, some research, and any process that need to be operated under a certain condition. In order to prevent the risk of hazardous and reduce unfavourable condition in a room, embedded control and wireless network connection are used to design a home weather monitoring system to control room's temperature. A home weather monitoring system is a system that is used to monitor and control the environmental condition in remote room.

## 1.2 Project Objective

The objective of this project is to design a home weather monitoring system. Home weather monitoring system consists of a control room and one or more remote locations. In the control room, user can set the desired temperature. When temperature in remote location changes from the desired value, control room will receive the signal and control the temperature in remote location by switching on heater or air-conditioner. Since this project uses wireless technology to connect between the control room and the remote location, the latter can be placed anywhere as long as the distance from control room to remote location is within the range of transmitting level. Thus, the scopes of the project are:

- Users can control and achieve the desired environmental condition in remote location.
- Temperature room will be displayed at both locations by using LCD and gives information to residents all the time.
- Temperature can be controlled automatically without human observation. It is convenient and no need human's guidance.

The system design is based on microcontroller MC68HC11. In order to achieve the objective, the project is divided into two parts:

- Hardware design that consists of microcontroller, encoder, decoder, transmitter, receiver, sensor, seven-segment display, motor, and buzzer modules.
- Software development by using Assembly Language MC68HC11.

## 1.3 Organization of the Thesis

The thesis is orderly organized into 6 chapters.

Chapter 1 presents the introduction, objective and the scope of the project. The chapter also summarizes the content of the thesis.

Chapter 2 discusses the architecture of the project. It also explains each module on this project.

Chapter 3 gives a detailed discussion on the design of the hardware of each module in the systems. The module consists of microcontroller board, sensor, encoder and decoder, transmitter, receiver, seven-segment display, motor and buzzer.

Chapter 4 discusses the development of the software of each module and system operation. This chapter also includes the flowchart of each module.

Chapter 5 presents various testing and results that are conducted to each module. Some recommendation and system upgrades are also discussed.

Lastly, Chapter 6 presents the overall conclusion for this thesis and a few suggestion and recommendation are proposed for future development.

# CHAPTER 2

# SYSTEM ARCHITECTURE

## 2.1 Introduction

The system is designed using modular technique to simplify the process of testing and troubleshooting. As the system requires the use of microcontroller, the design consists of two parts, hardware and software.

In this home weather monitoring system, a simple concept is used where a room's temperature can be monitored and controlled by a user in monitoring in different room. The room which is needed to be maintained at a certain degree of temperature considers as remote location; and other room is considered as control room. Thus, hardware design consists of two boards that represent remote location and control room. Each location requires a microcontroller to control the system operation used. Two different programs are written in assembly language for two locations and are assembled to obtain the object code by using AS11 assembler. The codes then are uploaded to each microcontroller for system operation.

## 2.2 System Architecture

A simple block diagram of wireless home weather monitoring system is shown in figure 2.1. It is divided into 5 main modules. They are:

- Microcontroller Board Module
- Wireless Communication Module
  - Data Encoder and Decoder Circuit
  - Transmitter and Receiver Circuit
- Sensory Module Circuit
- Data Temperature Transmission
- Control Fan from Control Room

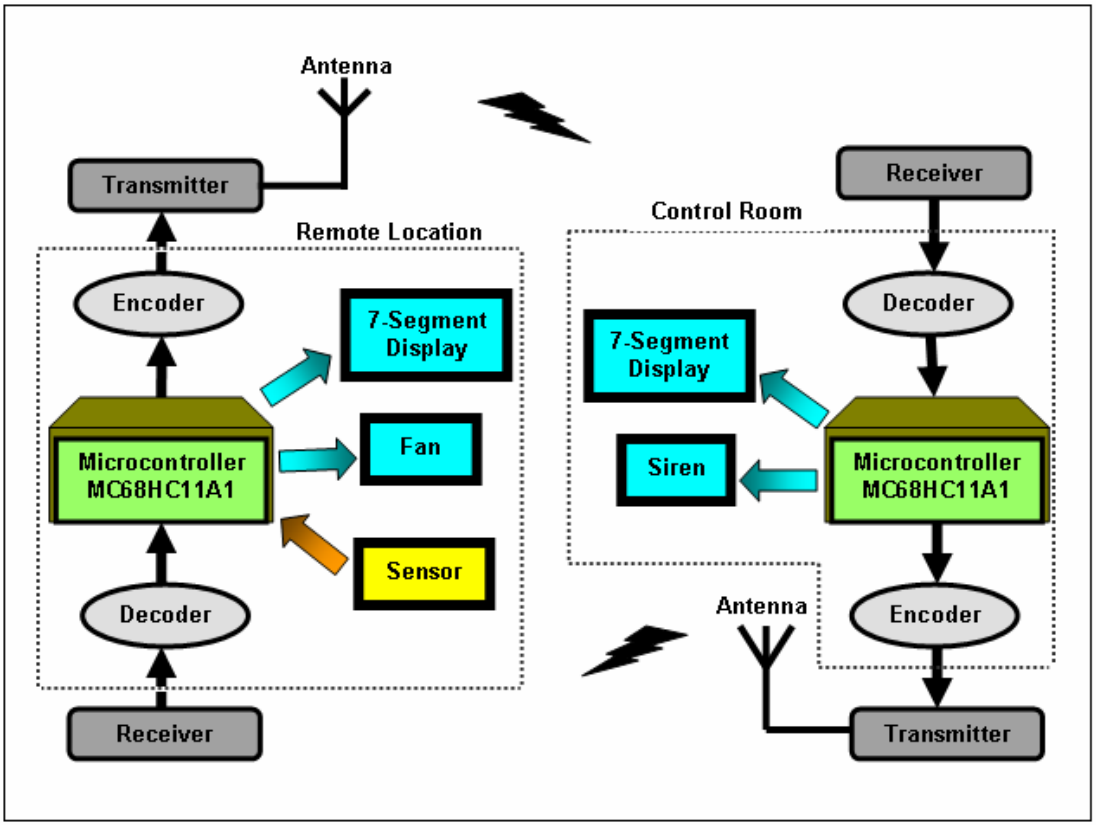


Figure 2.1: Block Diagram for Wireless Monitoring System

### 2.2.1 Microcontroller Board Module - Bootstrap Mode Connection

The microcontroller implemented in this project is from 8-bit family from Motorola. However, the MC68HC11A1 is chosen since it offers various functions and applicable for the project.

MC68HC11A1 can operate with four modes. They are bootstrap mode, special test mode, single-chip mode and expanded mode. This project uses bootstrap mode because this project does not require extra I/O ports. Microcontroller module consists of MC68HC11A1, power circuit, reset circuit, clock circuit and EIA232 module as shown in Figure 2.2.

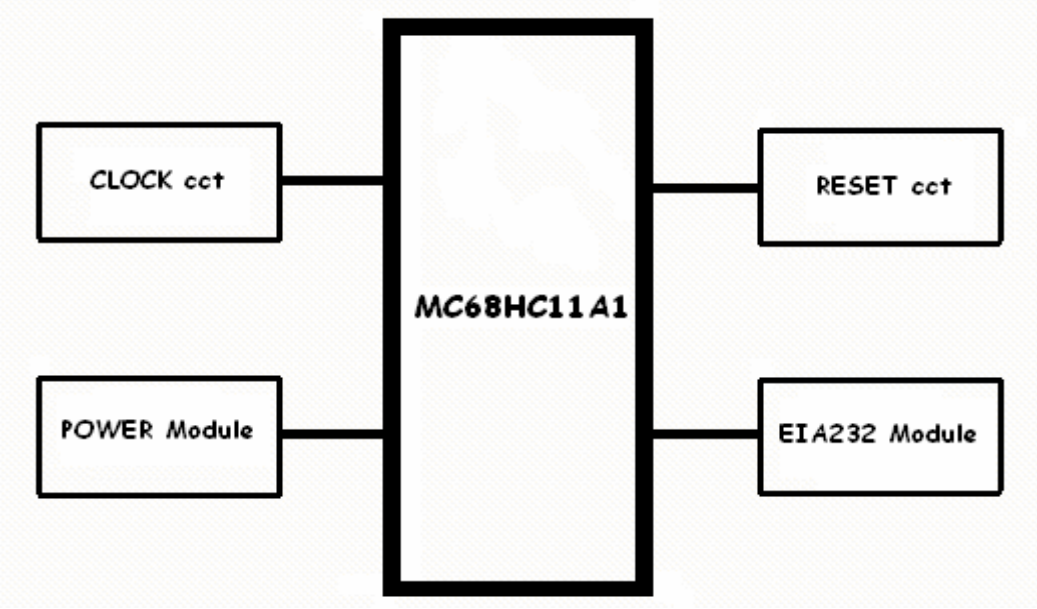


Figure 2.2: Microcontroller Board Module

### 2.2.2 Wireless Communication Module

This module consists of four parts. They are the encoder, decoder, transmitter and receiver as shown in Figure 2.3. In addition, an antenna module is also included in transmitter and receiver module.

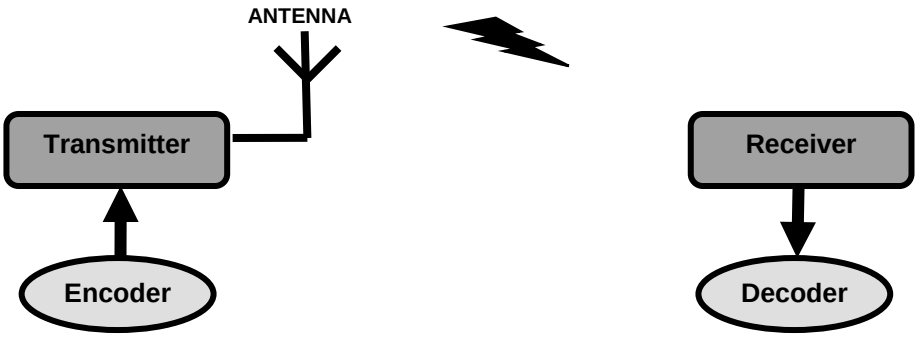


Figure 2.3: Wireless Communication Network

#### 2.2.2.1 Data Encoder and Decoder Circuit

Data encoder is a device used to change a signal or data into a code. The code may serve any of a number of purposes such as compressing information for transmission or storage, encrypting or adding redundancies to the input code, or translating from one code to another. This is usually done by means of a programmed algorithm, especially if any part is digital, while most analog encoding is done with analog circuitry. The data consist of 8 bits address and 4 bits data.

The data encoder implemented in this project is the HT12E from HOLTEK. This is $2^{12}$ encoder's series of CMOS LSIs for remote control system applications. They are capable of encoding information which consists of N address bits and 12-N

data bits. Each address/data input can be set to one of the two logic states. The programmed addresses/data are transmitted together with the header bits via an RF or an infrared transmission medium upon receipt of a trigger signal (TE). Application using this encoder is in burglar alarm system, smoke and fire alarm system, garage door controllers and door controllers.

On the contrary, data decoder is a device which does the reverse of an encoder, undoing the encoding so that the original information can be retrieved. Normally the process of the data decoder is the reverse process of data decoder.

The data decoder implemented in this project is the HT12D from HOLTEK. This is $2^{12}$ decoders are a series of CMOS LSIs for remote control system applications. They are paired with Holtek's $2^{12}$ series of encoders. For proper operation, a pair of encoder/decoder with the same number of addresses and data format should be chosen.

The $2^{12}$ series of decoders are capable of decoding information's that consist of N bits of address and 12-N bits of data. Of this series, the HT12D is arranged to provide 8 address bits and 4 data bits of address information.

#### 2.2.2.2 Transmitter and Receiver Circuit

Basically, a transmitter is the device which modulates the signal information onto the carrier frequency before it is transmitted. The transmitter module used in this project is TWS-BS-3. It modulates data using Amplitude Shift Keying (ASK) modulation technique. It is complete single in line board module capable of transmitting analog or digital data up to 200 meters. It is suitable for remote wireless monitoring where small size and high data rates are required. Therefore it is the most suitable option for this project. The transmitter is designed to be used in conjunction with receiver at the same frequency. The carrier frequency for this module is 433.92 MHz, which will not be interfered by local radio stations.

In contrast, receiver is a part that demodulated the modulated signal so that the data can be obtained. The receiver module is used must be operated in similar frequency as the transmitter. This is important so that the receiver module can be used to capture R.F data from the transmitter.

The range achieve from the system depends on the choice of antenna. The space around the antenna is as important as antenna itself. The optimum position is to locate the antenna so that it protrudes directly out of the transmitter. Batteries are kept away from the antenna to get the best range. There are many type of design antenna such as monopole, dipole, helical, loop and whip antenna. However, the design uses monopole antenna due to its simplicity and cost. Thus, the size of the antenna for optimum range is 17.28 cm that is design based on formula (2.1). A simple core wire is used for the antenna.

$$\lambda = c/f \quad \text{(2.1)}$$