WIRELESS SMOKE DETECTOR USING MICROCONTROLLER

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DEDICATION

Specially dedicated to my father, mother, brother, sister and my friends for their loving, understanding, cares and support.

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ABSTRACT

Basically, most practical smoke detector circuits consist of three basic elements, the sensor, control circuitry and alarm sounding device. This project adds an additional microcontroller at the sensors parts and at the control panel, a system that can cover more than one zone in the house, a remote control for arming and disarming functions and a pair of RF transmitter and receiver to make the entire system wireless. With Universal Asynchronous Receiver Transmitter (UART) function provided internally by the microcontroller, there is no need to use decoder and encoder pair to vary the signal. This function is enough to make both microcontrollers in transmitter and control panel to work in pair. This whole system was designed to be small and convenient so that it can be handled easily especially with additional remote control function.

ABSTRAK

Sistem penggera asap yang praktikal biasanya terbahagi kepada tiga bahagian utama iaitu bahagian pengesan, bahagian kawalan keseluruhan sistem dan juga bahagian penggera. Beberapa penambahan dilakukan dalam projek ini seperti penambahan pengawalmikro di bahagian pengesan selain yang sedia ada di bahagian kawalan sistem keseluruhan, mereka sistem yang dapat mengawal lebih dari 1 zon yang berbeza di dalam rumah, penggunaan alat kawalan jauh untuk mematikan dan menghidupkan penggera dan juga penggunaan sepasang alat pemancar dan penerima isyarat radio. Dengan adanya fungsi Universal Asynchronous Receiver Transmitter (UART) yang sedia ada di dalam pengawalmikro, penggunaan pengkod dan penyahkod tidak lagi diperlukan untuk mempelbagaikan isyrat radio. Fungsi ini telah cukup untuk membolehkan kedua-dua pengawalmikro di bahagian pengesan dan bahagian kawalan sistem keseluruhan untuk berfungsi sebagai sepasang alat. Keseluruhan system penggera ini direka supaya bersaiz kecil dan menyenangkan pengguna lebih-lebih lagi dengan adanya penambahan alat kawalan jauh.

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CHAPTER 1

INTRODUCTION

1.1 Background Study

What are the differences between wireless alarm system and the common hardwired alarm system? Hardwired alarm system usually had to be installed or mounted in the walls of your house before your house is built. This is to hide away the wire connection inside the wall and because of this; hardwired alarm system is difficult to troubleshoot in case there are problems with the system. Basically, the main difference between hardwired and wireless alarm system is the connection link from sensors to the control panel of the alarm system.

Wireless alarm system is a new approach in home security system. The newly developed alarm for homes / commercial digital wireless intelligent alarm system model has a micro-processor chip and wireless radio frequency (RF) control technology to ensure the reliabilities, easy installation and operation of the system but a little bit expensive compared to hardwired alarm system.

1.2 Objective

The objective of the project is:-

1. To understand the operation principle of smoke detector, RF amplifier and PIC16F876A.
2. To understand the operation of each component used in the circuit.
3. To use the most suitable for each circuit to function properly according plan
4. To design the required circuit for sense smoke and beep loudly when it detected smoke

1.3 Problem Statement

Problem Statement:

1. Installing smoke detector system using cable is difficult and expensive.
2. Smoke detector and the buzzer are combining in one circuit and don't have the control unit.
3. Many smoke Detector systems now days still can't show which one smoke detector give the warning.
4. Besides that, the use of hardwired alarm system is not too practical in nowadays technology because it cannot cover all places in a house.

5. Besides that, it is too messy, costly and also difficult to troubleshoot. Usually the wire is installed inside the wall and if a problem occur in the system, to repair it user will need to hack the wall to inspect the wiring.

1.4 Scope

1. Use PIC16F876A.
    - 256 bytes of EEPROM data memory.
    - It is a Universal Asynchronous Receiver Transmitter.
2. Use two smoke detector (Ionization type)
3. This smoke detector is using 9V battery to operate.
4. This project is using an IC remote control (PT2272) to encode data.

1.5 Methodology

First phase: Literature review

- Gather the information about the project via Internet, journals, magazines, published work and reference books
- Make research to know more detail about designing all the parameters
- Search for suitable and practical circuits

Second phase: build the component and software

- Use software MPLAB Compiler to write a program for the alarm system.
- Components and parts identification
- Building the Hardware

Third phase: Project tested

- Testing of prototype in operation, application and result
- Assembly the component on the board and test run the operation. If any problems occur after testing the circuit, the process of troubleshooting must be held.

Final phase

- Presentation on outcome of project
- Prepare for final report

1.6 Report Structure

Chapter 1 briefly explains the introduction of the Network wireless smoke detector using radio frequency (RF). It consist objectives of the project, research or background study of network wireless smoke detector using radio frequency (RF) that had been done before, problems statement of the project, the scope and the methodology of the project.

Chapter 2 will be discussed about general knowledge on literature review of network wireless smoke detector using radio frequency (RF). It will be explained on the method

and approach that had been used in previous research and also explained on the relationship of the research information and the theory.

Chapter 3 will be discuss on methodology in more detail by using the data collection method, data process method, analyze the data, and flow chart. All this will describe the process in detail of each part starting from the scratch until complete.

As for the chapter 4, it will be covered the entire conclusion, finding project analyze the project progress, suggestion or opinion and also further research in future.

CHAPTER 2

LITERATURE REVIEW

2.1 Chapter Overview

Basically, wireless alarm systems consist of a wireless transmitter and receiver, a control panel, sensors or switches and siren or bell. The wireless alarm system project contains all the parts mentioned above.

This wireless alarm system works the same way like the ordinary wireless alarm system where a sensor will act as an input to transmit signal to the compatible receiver when it is triggered. The control panel will automatically trigger all the outputs which are the siren and flashing LED light.

Radio frequency (RF) is used for transmitting signal in this project as it is more practical. Signal can be transmitted up to 20 - 30 meters in range and the receiver is connected to the microcontroller on the control panel.

2.2 Smoke Detector

In home security, there are several type of detector which like flood detector, smoke detector and temperature detector. This project is focus to create a network wireless smoke detector by using RF signal.

There are two type of Smoke Detector which are ionization type and photoelectric type.

2.2.1 Ionization Detectors

Ionization detectors have an ionization chamber and a source of ionizing radiation. The source of ionizing radiation is a minute quantity of americium-241 (perhaps 1/5000th of a gram), which is a source of alpha particles (helium nuclei). The ionization chamber consists of two plates separated by about a centimeter. The battery applies a voltage to the plates, charging one plate positive and the other plate negative. Alpha particles constantly released by the americium knock electrons off of the atoms in the air, ionizing the oxygen and nitrogen atoms in the chamber. The positively-charged oxygen and nitrogen atoms are attracted to the negative plate and the electrons are attracted to the positive plate, generating a small, continuous electric current. When smoke enters the ionization chamber, the smoke particles attach to the ions and neutralize them, so they do not reach the plate. The drop in current between the plates triggers the alarm.

2.2.2 Photoelectric Detectors

In one type of photoelectric device, smoke can block a light beam. In this case, the reduction in light reaching a photocell sets off the alarm. In the most common type of photoelectric unit, however, light is scattered by smoke particles onto a photocell, initiating an alarm. In this type of detector there is a T-shaped chamber with a light-emitting diode (LED) that shoots a beam of light across the horizontal bar of the T. A photocell, positioned at the bottom of the vertical base of the T, generates a current when it is exposed to light. Under smoke-free conditions, the light beam crosses the top of the T in an uninterrupted straight line, not striking the photocell positioned at a right angle below the beam. When smoke is present, the light is scattered by smoke particles, and some of the light is directed down the vertical part of the T to strike the photocell. When sufficient light hits the cell, the current triggers the alarm.

2.2.3 Which type is better?

Both ionization and photoelectric detectors are effective smoke sensors. Both types of smoke detectors must pass the same test to be certified as UL smoke detectors. Ionization detectors respond more quickly to flaming fires with smaller combustion particles; photoelectric detectors respond more quickly to smoldering fires. In either type of detector, steam or high humidity can lead to condensation on the circuit board and sensor, causing the alarm to sound. Ionization detectors are less expensive than photoelectric detectors, but some users purposely disable them because they are more likely to sound an alarm from normal cooking due to their sensitivity to minute smoke particles. However, ionization detectors have a degree of built-in security not inherent to photoelectric detectors. When the battery starts to fail in an ionization detector, the ion current falls and the alarm sounds, warning that it is time to change the battery before the detector becomes ineffective. Back-up batteries may be used for photoelectric detectors.

So in this case, I have choose Ionization type because it more suitable for my project.

2.3 Microcontroller

A microcontroller (also MCU or μC) is a functional computer System-on-a-chip. It contains a processor core, memory, and programmable input/output peripherals. Microcontrollers include an integrated CPU, memory (a small amount of RAM, program memory, or both) and peripherals capable of input and output.

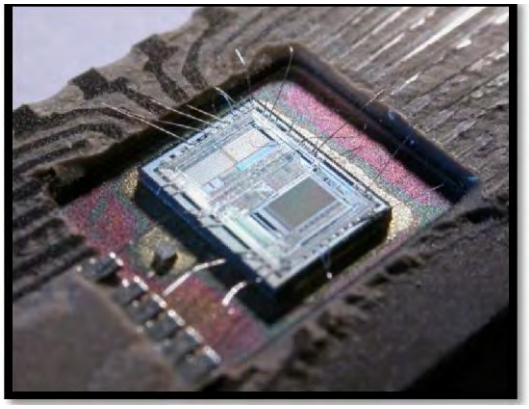

Figure 2.3: Microcontroller

It emphasizes high integration, in contrast to a microprocessor which only contains a CPU (the kind used in a PC). In addition to the usual arithmetic and logic elements of a general purpose microprocessor, the microcontroller integrates additional elements such as read-write memory for data storage, read-only memory for program storage, Flash memory or permanent data storage, peripherals, and input/output interfaces. At clock speeds of as little as 32 KHz, microcontrollers often operate at very low speed compared to microprocessors, but this is adequate for typical applications. They consume relatively little power (milliwatts or even microwatts), and will generally have the ability to retain functionality while waiting for an event such as a button press or interrupt. Power consumption while sleeping (CPU clock and peripherals disabled) may be just nanowatts, making them ideal for low power and long lasting battery applications.

Microcontrollers are used in automatically controlled products and devices, such as automobile engine control systems, remote controls, office machines, appliances, power tools, and toys. By reducing the size, cost, and power consumption compared to a design using a separate microprocessor, memory, and input/output devices, microcontrollers make it economical to electronically control many more processes. In contrast to general-purpose CPUs, microcontrollers may not implement an external address or data bus as they integrate RAM and non-volatile memory on the same chip as

the CPU. Using fewer pins, the chip can be placed in a much smaller and cheaper package. Integrating the memory and other peripherals on a single chip and testing them as a unit increases the cost of that chip, but often results in decreased net cost of the embedded system as a whole. Even if the cost of a CPU that has integrated peripherals is slightly more than the cost of a CPU + external peripherals, having fewer chips typically allows a smaller and cheaper circuit board, and reduces the labor required to assemble and test the circuit board.

A microcontroller is a single integrated circuit, commonly with the following features:

- Central processing unit - ranging from small and simple 4-bit processors to complex

32- or 64-bit processors

- Discrete input and output bits, allowing control or detection of the logic state of an individual package pin
- Serial input/output such as serial ports (UARTs)
- Other serial communications interfaces like I²C, Serial Peripheral Interface and Controller Area Network for system interconnect
- Peripherals such as timers, event counters, PWM generators, and watchdog
- Volatile memory (RAM) for data storage
- ROM, EPROM, EEPROM or Flash memory for program and operating parameter

Storage

- Clock generator - often an oscillator for a quartz timing crystal, resonator or RC circuit
- Many include analog-to-digital converters
- In-circuit programming and debugging support

This integration drastically reduces the number of chips and the amount of wiring and circuit board space that would be needed to produce equivalent systems using separate chips. Furthermore, and on low pin count devices in particular, each pin may interface to

several internal peripherals, with the pin function selected by software. This allows a part to be used in a wider variety of applications than if pins had dedicated functions. Microcontrollers have proved to be highly popular in embedded systems since their introduction in the 1970s.

Some microcontrollers use Harvard architecture: separate memory buses for instructions and data, allowing accesses to take place concurrently. Where a Harvard architecture is used, instruction words for the processor may be a different bit size than the length of internal memory and registers; for example: 12-bit instructions used with 8-bit data registers.

The decision of which peripheral to integrate is often difficult. The microcontroller vendors often trade operating frequencies and system design flexibility against time-to-market requirements from their customers and overall lower system cost. Manufacturers have to balance the need to minimize the chip size against additional functionality.

Microcontroller architectures vary widely. Some designs include general-purpose microprocessor cores, with one or more ROM, RAM, or I/O functions integrated onto the package. Other designs are purpose built for control applications. A microcontroller instruction set usually has many instructions intended for bit-wise operations to make control programs more compact. For example, a general purpose processor might require several instructions to test a bit in a register and branch if the bit is set, where a microcontroller could have a single instruction that would provide that commonly-required function.

Microcontrollers typically do not have a math coprocessor, so floating point multiplication and division are carried out using a standard library, or the faster and more compact Horner method.

The microcontroller that I have chosen is PIC 16F876A.This is because the microcontroller is widely use, easy to get and also it has 28 pins which can be use to add additional application in this alarm system. The Figure 2.3.1 and 2.3.2 show the pin arrangement for PIC 16F876A and PIC16F87XA device features.

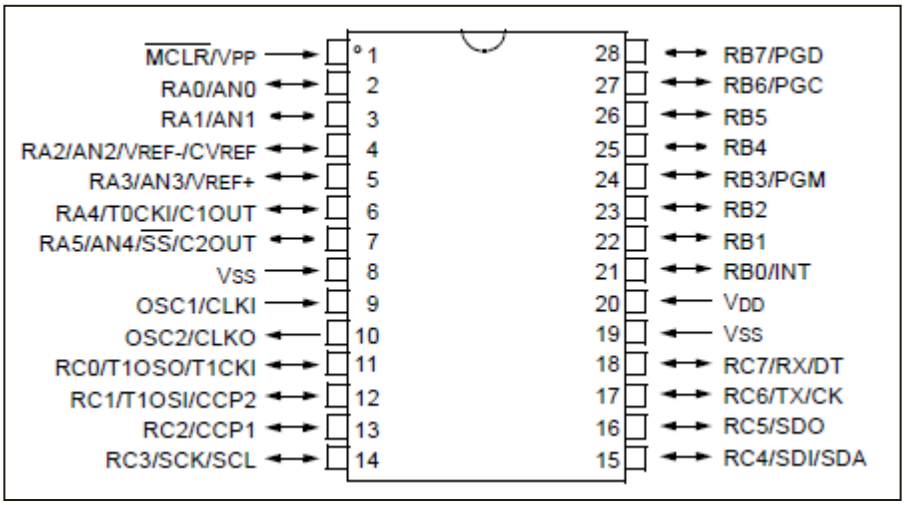

Figure 2.3.1: Pin Arrangement.

Key Features	PIC16F873	PIC16F874	PIC16F876	PIC16F877
MAX Operating Frequency	20MHz	20MHz	20MHz	20MHz
FLASH Program Memory (14-bit words)	4K	4K	8K	8K
Data Memory (bytes)	192	192	368	368
EEPROM Data Memory (bytes)	128	128	256	256
I/O Ports	RA0-5 (6) RB0-7 (8) RC0-7 (8)	RA0-5 (6) RB0-7 (8) RC0-7 (8) RD0-7 (8) RE0-2 (3)	RA0-5 (6) RB0-7 (8) RC0-7 (8)	RA0-5 (6) RB0-7 (8) RC0-7 (8) RD0-7 (8) RE0-2 (3)
Timers	3	3	3	3
CCP	2	2	2	2
Serial Communications	MSSP, USART	MSSP, USART	MSSP, USART	MSSP, USART
Parallel Communications	-	PSP	-	PSP
10-bit Analog-to-Digital Module	5 Channels	8 Channels	5 Channels	8 Channels
Instruction Set	35 Instructions	35 Instructions	35 Instructions	35 Instructions
Pins (DIP)	28 Pins	40 Pins	28 Pins	40 Pins

Figure 2.3.2: PIC16F87XA Device Features

2.4 Signal Link

Communication signal is divided depending on the signal link used, either wire communication or radio communication. In my project, I only focus on radio communication.

2.5 Wireless Communication Principle

Wireless communication is the transfer of information over a distance without the use of electrical conductors or wires. Wireless communications are based on the launch, propagation, and detection of electromagnetic waves emitted primarily at radio or microwave frequencies. The distances involved may be short (a few meters as in television remote control) or very long (thousands or even millions of kilometers for radio communications). Wireless communications 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. The term is commonly