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Design and Implementation of Automatic Fire-Fighting for Building using Peripheral Interface Controller

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ABSTRACT

In this project, we have designed and implemented automatic fire-fighting for building using PIC. It intended to prevent accidents and emergency cases of fire. It consists of gas sensor for detecting the fire, temperature sensor for sensing the environmental temperature, relay driver for pump control, alarm system and fire extinguishing system. When the temperature sensor detects a predefined temperature, the LED and buzzer will be turn on. When the smoke detector (gas sensor) senses a certain amount of smoke, the LED and buzzer will turn on. If both the temperature and smoke reach a predefined level, the alarm will ring and the extinguishing system will also activate, too. The advantage of this project is to reduce the amount of damages done by fire. The weak point of this project is the power supply using AC, so it will not work when electricity is out.

KEYWORDS: *Arduino UNO, Gas Sensor, Temperature sensor, Alarm system, Fire extinguishing system, Peripheral Interface Controller*

I. INTRODUCTION

Nowadays, fire can take place in any house, school, or any place. It is mostly caused by electric short circuits, or combustible gases that we use at home for heating. We need a safe fire-fighting system to detect and extinguish fires before they spread.

This circuit is mainly consists of PIC (16F887), gas sensor (MQ2), temperature sensor (18B20), buzzer, LED and solenoid. As soon as the circuit has been connected to the power supply, all components start working. When the temperature sensor senses the temperature over 40 Degree Celsius, LED and buzzer will turn ON. If the gas sensor senses the smoke including 65% in air, it will produce low level. Then, smoke LED and buzzer will turn ON. If the both situations work at the same time, the solenoid will turn ON. The circuit does not work when the power is off. Both hardware and software to bring about the entire project are presented in this paper.

II. Methodology

The system is composed of two part, software and hardware. In the hardware, sensor circuitry is to be designed to develop system awareness and capability to detect over-temperature, smoke. A microcontroller (16F887) is used to process the various sensor signals and control the system actuators accordingly. Fire-fighting pump will be interfaced to the microcontroller through a relay. A software code is developed to control the overall system functions.

III. System Layout

The block diagram of the hardware implementation of the entire system is shown in figure (1).

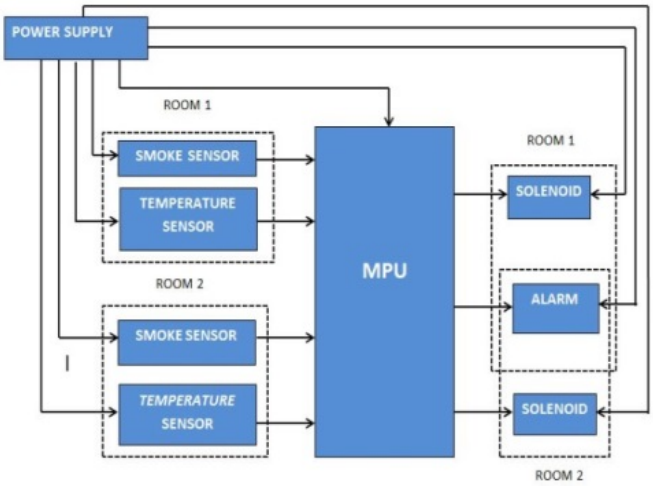

Fig.1: Overall Block Diagram

A. Gas Sensor

Sensitive material of MQ-2 gas sensor is SnO2, which with lower conductivity in clean air. The MQ-2 gas sensor is sensitive to LPG, i-butane, propane, methane, alcohol, Hydrogen and smoke. It is used to detect smoke, typically as an indicator of fire. It is low cost and suitable for different application. The applications of the MQ2 are Domestic gas leakage detector, Industrial Combustible gas detector and Portable gas detector.

Fig2: MQ-2 gas sensor

B. Temperature Sensor

The core functionality of the DS18B20 is its direct-to-digital temperature sensor. The DS18B20 has an operating temperature range of -55°C to +125°C. The resolution of the temperature sensor is user-configurable to 9, 10, 11, or 12 bits, corresponding to increments of 0.5°C, 0.25°C, 0.125°C, and 0.0625°C, respectively. The default resolution at power-up is 12-bit. The DS18B20 powers up in a low-power idle state. To initiate a temperature measurement and A-to-D conversion, the master must issue a Convert T [44h] command. If the DS18B20 is powered by an external supply, the master can issue "read time slots" after the Convert T command and the DS18B20 will respond by transmitting 0 while the temperature conversion is in progress and 1 when the conversion is done.

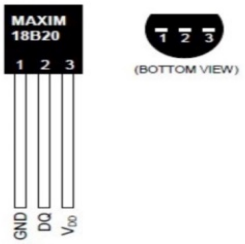

Fig.3: Temperature sensor (18B20)

C. Peripheral Interface Controller (PIC)

PIC 16F887 is one of the latest products from microchip and it has 40 pins. It has 35 pins I/O, 2 pins Ground, 2 pins Supply, 1 pin Input. Operation frequency is 0-20M Hz. The software selectable frequency ranges from 8M Hz to 31k Hz. This microcontroller has three types of memory ROM, RAM and EEPROM. All of them will be separately discussed that each has specific functions, features and organization. ROM (read only memory) memory is used to permanently save the program being executed. PIC16F887 has 8kb ROM (in total of 8192 location). Since this ROM is made with FLASH Technology, its contents can be changed by providing a special programming voltage (13V). Similar to program memory, the contents of the EEPROM can be changed during operation of the microcontroller. That is why this memory (256 locations) is a perfect one for permanently saving results created and used during the operation. RAM memory is that third and most complex part of microcontroller memory. In this case, it consists of two parts: general purpose registers and special function registers (SFR). Master synchronous serial port (MSSP) supports SPI and I2C mode.

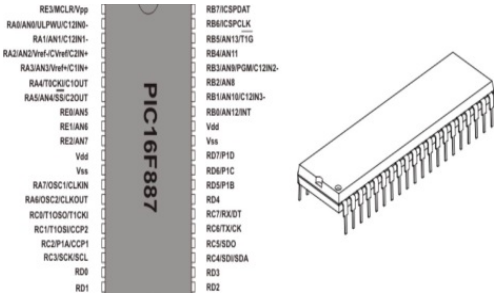

Fig.4: PIC (16F887)

D. Alarm System

Alarm system is designed by buzzer and LED in fig:5. A buzzer is an audio signalling device. The device is an alarm that to know accidents and emergency case of fire for people. In output, RB7 of PIC is connected resistor (1k) and transistor (C945) in front of the buzzer. Transistor (C945) is used as a switch for buzzer on-off. The output current of PIC is 1A although the receive current of buzzer is 20mA. Resistor (1k) is used between transistor of base and PIC because of reduced the current gain. When C945 is turned on, collector voltage of C945 is 0.7V. Emitter of C945 is ground. If C945 will turn on, buzzer will ring.

LEDs are very small light bulbs that fit into an electrical circuit. This is a very basic 5mm LED with a red lens. It has a typical forward voltage of 2V and a rated forward current of 10mA. Working voltage of PIC is 5V. Receiving voltage of LED is 2V. So, resistor (330) is used in front of the LED.

V = IR
R = V/I
= (5-2) V /10mA
= 300Ω

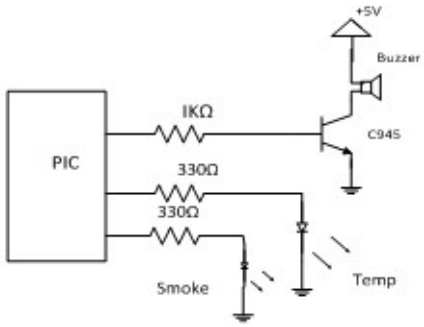

Fig5: Overall circuit diagram of Alarm System

E. Fire Extinguishing System

Solenoid is used for the fire extinguishing system in fig:6. It offers fast and safe switching, high reliability, long service light, low control power and compact design. One pin of solenoid is connected AC and next pin is connected NO of relay. The solenoid follows by the relay and transistor (C945). If transistor will saturate, relay will start to work. When the current is flowing in the relay, the magnetic field is occurred. So, the bar in the relay is ON. When the relay is working, the common is attached to normally open (NO). So, the solenoid receives AC signal and work. Wire is wrapped around the nail in solenoid in which AC flows. This leads to electromagnetic field which in turn causes it to stick upwards. Consequently, bar is turned ON and water in solenoid starts flowing. This solenoid sprays water. The higher the value of the resistance, the lower the values of the current.

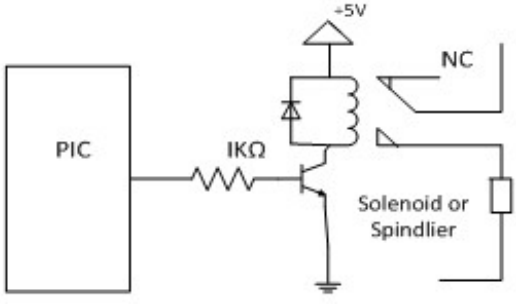

Fig.6: Circuit Diagram of Fire Extinguishing System

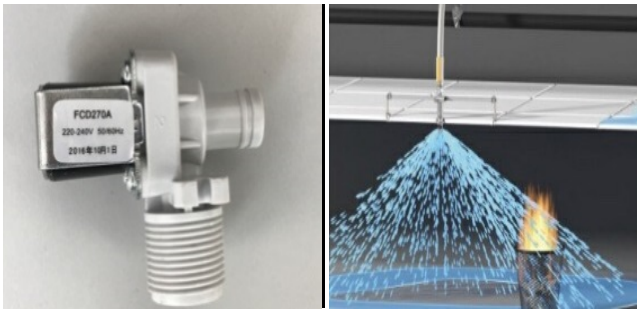

Fig.7: Solenoid and its working

IV. Operation of the system

When giving AC 220V to the step down transformer, it induced in the secondary coil. It can produce 12V. This circuit is used AC 12V and since it passed through the centre-tapped full-wave rectifier diode to get DC 12V. Filter capacitor is used to get pure DC. Regulator LM 7805 is used to get DC 5V (stable). The power supply DC 5V is connected to the power supply pin of the PIC and the ground pin of the PIC. The power supply is connected to the GND pin of the PIC. When the circuit is connected to the power supply, all components start working. Smoke sensor is connected to the RE3 pin (for Room 1) RD7 pin (for Room 2) of the PIC, LED of the smoke sensor is connected to the RB5 pin (for Room 1) RC5 pin (for Room 2) of the PIC. Temperature sensor is connected to the RD1 pin (for Room 1) and RD2 pin (for Room 2), LED of the temperature sensor is connected to the RB6 pin (for Room 1) and RC4 pin (for Room 2) of the PIC. RB7 pin of the PIC is connected to the buzzer. Solenoid is connected to the RD0 pin (for Room 1) and RD3 pin (for Room 2) of the PIC.

When 18B20 receives command from the PIC, it starts sensing. To initiate a temperature measurement and A-to-D conversion, the master must issue a Convert T [44h] command. Converting temperature enters the PIC. According to the program in the PIC, PORTB.B6 and PORTB.B7 are equal to '0' when the temperature is less than 40 Degree Celsius. LED and buzzer will turn off. If enter temperature is greater than 40 Degree Celsius, PORTB.B6 and PORTB.B7 will equal '1'. LED and buzzer will turn on shown in figure (9).

If smoke sensor receives the supply voltage, LED will turn on in the smoke sensor circuit. When the smoke detector senses a critical amount of smoke, next LED will also turn on. Then, PIC receives the signal. According to the program in the PIC, PORTB.B5 is equal to '1' and PORTB.B7 is equal to '0' when the smoke sensor has not smoked. LED and buzzer will turn off. If the smoke sensor senses the smoke including 65% in air, PORTB.B5 will equal '0'. PORTB.B7 is equal to '1'. LED and buzzer will turn on shown in figure (10). Preset is adjusted so that smoke sensor senses in critical amount of smoke.

When both the temperature and smoke amount reach to a critical level, the alarm will ring and the extinguisher system will also be activated too shown in figure (11 and 12). Either smoke LED or temperature LED turns on that buzzer turn ON and solenoid turn OFF. Both temperature LED and smoke LED will not be activated, buzzer and solenoid turn OFF.

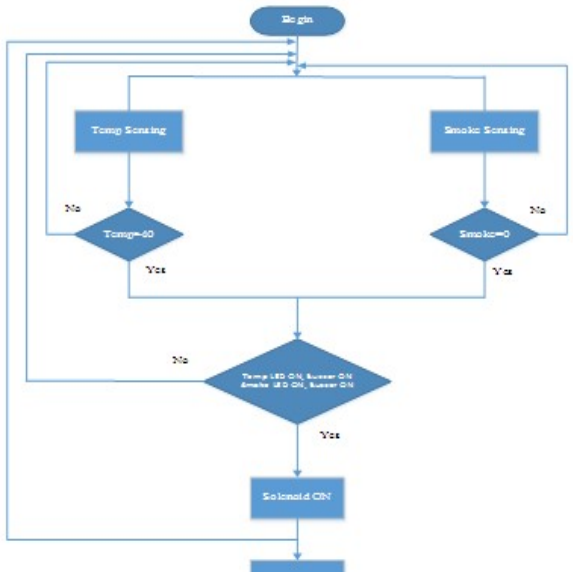

Fig.8: Program Flow Chart

V. SIMULATION RESULTS

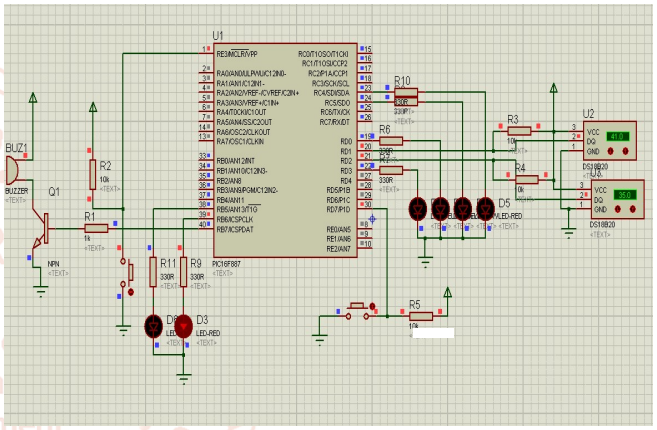

Fig.9: Testing of Temperature sensor

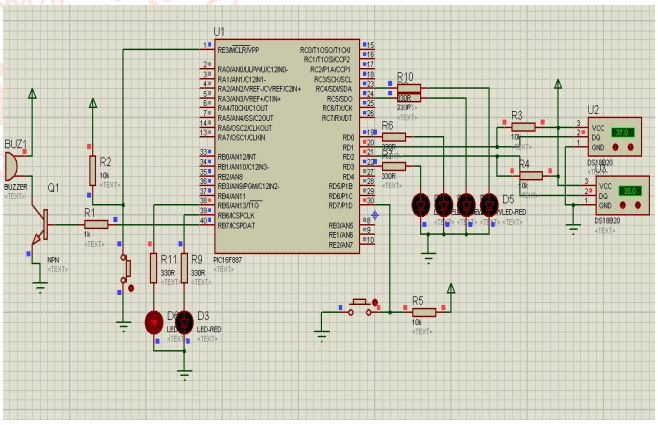

Fig.10: Testing of Smoke Sensor

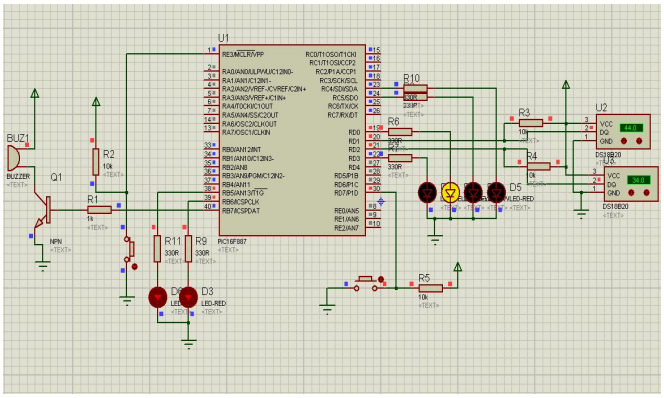

Fig.11: Testing for Room1

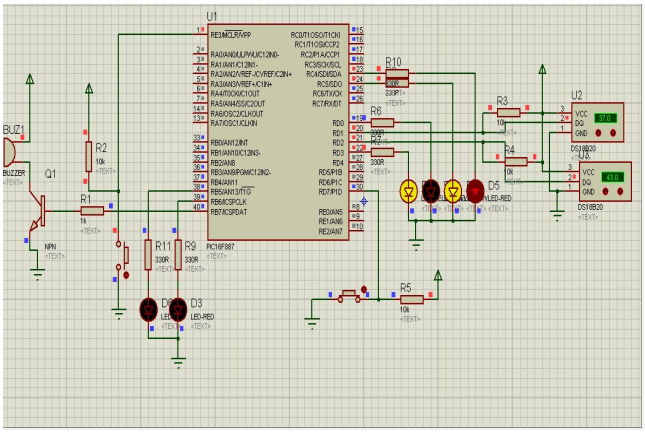

Fig.12: Testing for Room2

VI. Experimental Results

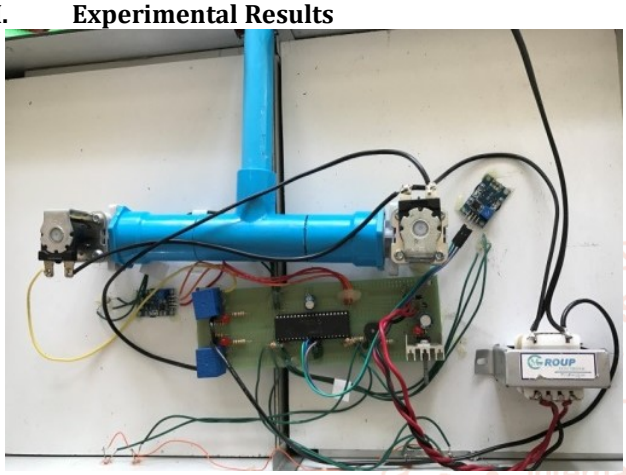

Fig.13: Testing of Overall Circuit

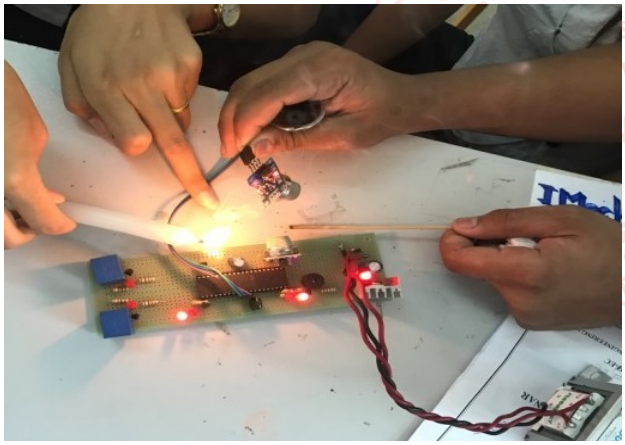

Fig.15: Testing of Room1

Fig.16: Testing of Room 2

Fig.17: Fire Extinguishing

VII. Conclusions

The fire-fighting using Peripheral Interface Controller (PIC) are available at reasonable price in the market. In this system, there is no complexity on design features. First of all, requiring components in the circuit are collected. As soon as the fire starts, people can know immediately. As the system is installed inside the home or the building, we will feel safer. If the number of houses which set up this system increased, the incidence of fire outbreaks will be reduced. So, we can prevent the residents and their properties of these homes from fire damage. And, the weak point is the power supply is designed to use AC, it will not work when electricity is out.

Acknowledgement

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