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Development of an Automated Temperature Controller and Smoke Detection System

Tanvir Zaman Khan[1], Subrata Bhowmik[2], Md. Osman Ali[3]

Dept. of ICE, Noakhali Science and Technology University, Noakhali, Bangladesh[1]

Dept. of EEE, Noakhali Science and Technology University, Noakhali, Bangladesh[2,3]

Abstract: Automatic Temperature Controller and Smoke Detection (ATCaSD) system, as an embedded mechanism, is quite interesting, yet essential in the modern era. It is expected to be very handful in the tropical and sub-tropical countries, where temperature always remains high. In addition, the use of minerals, such as kerosene, coal, or forested resources, like woods, as fuel in home and in factories often generate high temperature that eventually hampers the well-being and health of the people, involved in those works. ATCaSD is a micro-controlled automatic system, designed primarily to control the increasing temperature within a defined room-environment as well as to detect the smoke to prevent suffocation and to re-fresh the air quality.

Keywords: Automation, Smoke Sensor, Temperature Sensor, Embedded System, Temperature Controller

I. INTRODUCTION

Ventilation is a process of drawing fresh air in an interior and to expel the air inside to exterior. It has some basic principles. The crucial one, however, is to create partial vacuum within the space as they expel the air outside. Fresh air is taking the place of the space because of this kind of vacuum. Outside pressure and inside pressure difference is static pressure. This static pressure acts as resistance that ventilation system must overcome to move air through the space and circulate as well [1]. Sometimes outdoor air passes in association of infiltration, natural ventilation. The movement of air is connected with infiltration and natural freshening is generally caused due to the temperature difference between outdoors and indoors. Generally, ventilation system is used in kitchen, school, factory and many other places for ensuring human comfort [2].

The automation of ventilation system is a very essential feature of those places. In most cases, the temperature plays a vital role in the course of manufacturing or the process carried out in that factory or industry. Kitchens have additional problems to deal with, such as smoke and gases.

The most promising, yet simplest way of controlling temperature is by using a fan which is automatically connected to a network, capable to control the entire environment by switching on or off, depending on the increase or decrease of temperature to a certain limit [3].

II. OVERALL DESIGN OF THE SYSTEM

A. *Components of system hardware*

Automatic Temperature Controller and Smoke Detection (ATCaSD) system is composed of Microcontroller, temperature sensor, MQ series of semiconductor gas sensor module, Matrix Keypad, LCD Display. This is the overall system block diagram, depicted in the Figure 1.

The working principles of the system is at first, the temperature sensor converts the temperature signals into current signals, which is immediately processed to send into the central processing unit, i.e. microcontroller for further processing [4]. Temperature range can be set through keypad matrix and it is shown in Liquid Crystal Display (LCD). MQ series of gas sensors measures the concentration of targeted gas in the room temperature. When it detects gas or smoke, it instantaneously propelled the exhaust fan to draw fresh air to maintain the indoor air quality [5].

B. *Temperature and Smoke sensors*

The change in temperature of the surroundings can be sensed by various ways, e.g. transducer or any sensor, such as LM35 (analog), DS18B20 (digital 1-wire protocol) [6]. These electronic components sense the temperature of the surroundings. When there is a change in the temperature, these sensors start to conduct the electric current. This is the main principle of the automatic control devices. These devices can be extended to an extent to set the expected temperature after which the fan should rotate.

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This system should possess the quality of sensing smoke which can be sensed by a MQ series of gas sensor module [5][7]. A small heater with an electro-chemical gas sensor is used in these gas sensors. It measures the concentration of targeted gas by oxidizing and measuring the electrode current. Sensors are sensitive for a range of gasses at room temperature. It is simple to use Gas Sensor Module (GSM) which can sense the presence of combustible/ flammable gases such as LPG, isobutene (C4H10), and propane (C3H8) as well as smoke in the air. Module can be calibrated more or less by a sensitivity potentiometer with a known concentration of the measured gasses. The output is an analog signal but digital output can be read with an analog input of the module [5].

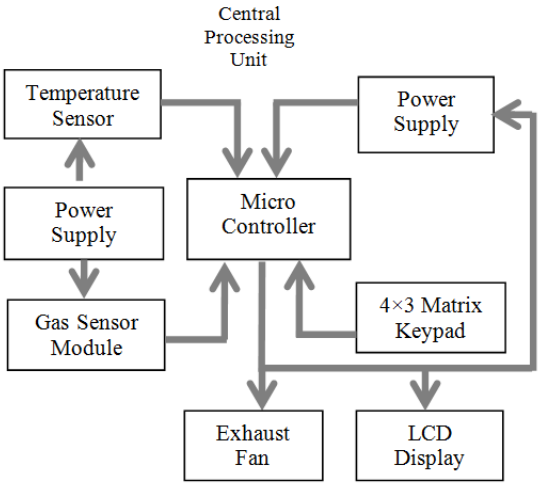

Fig. 1: System Block Diagram

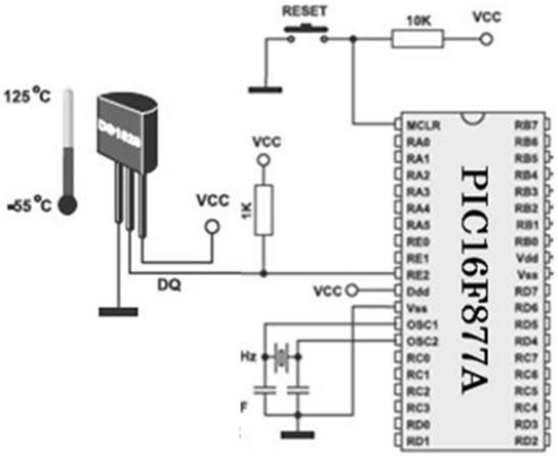

Fig. 2: Temperature Sensor Circuit

III. SYSTEM OVERVIEW

The presence of temperature/smoke was sensed by temperature sensor (DS18B20) or smoke sensor (MQ-9) which gives digital signals or falling edge voltage pulse respectively to the microcontroller [8]. The overall system can be subdivided into four different subsystems.

A. Temperature Sensor

The communication of DS18B20 performs over a 1-Wire bus. In other words it requires only one data line (and ground) with a central microprocessor. It has unique 1-Wire Interface Requires Only One Port Pin for Communication. It has an operational temperature range of -55°C to +125°C and is accurate to ±0.5°C over the range of -10°C to +85°C [6] [9]. The connection diagram is portrayed in the Figure 2.

B. Smoke/gas sensor

MQ series of gas sensor can detect a various range of different gases as well as smoke. Such as MQ-2 is sensitive for Methane, Butane, LPG; MQ-3 for Alcohol, Ethanol; MQ-4 for Methane, CNG; MQ-7 for Carbon Monoxide; MQ-8 for Hydrogen Gas; MQ-9 for Carbon Monoxide, flammable gasses etc.

These modules are different simply in the various MQ sensors onboard. The MQ series sensor usually used onboard functionalities to determine what type of gas the module can detect. The Gas Sensor Module has all the necessary power supply and additional circuitry required to function both digital and analogue output from these sensors. These additional onboard features make the module popular to work with these sensors [5] [7] [10]. It provides a simple 4 pin interface shown in the Figure 3.

C. LCD and keypad with microcontroller

At first the sensor DS18B20 will sense the current environment temperature and is shown in LCD display. Then it is applied to the specific port of microcontroller to control the temperature by operating an Exhaust fan. Temperature range can be set through 4×3 keypad matrix.

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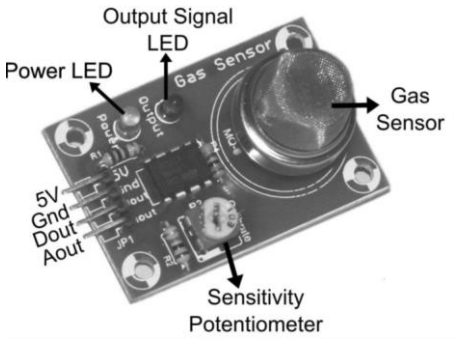

Fig. 3: Gas Sensor Module

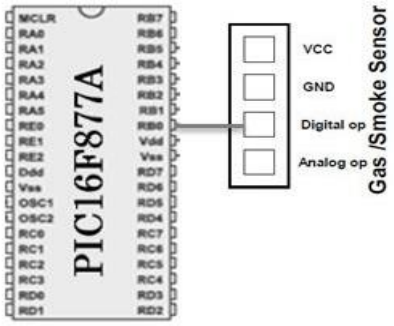

Fig. 4: Smoke Sensor Circuit

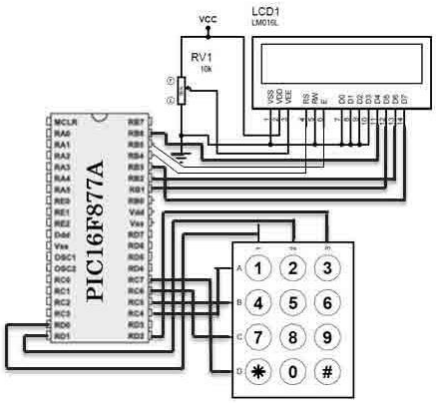

Fig. 5: LCD and Keypad Circuit

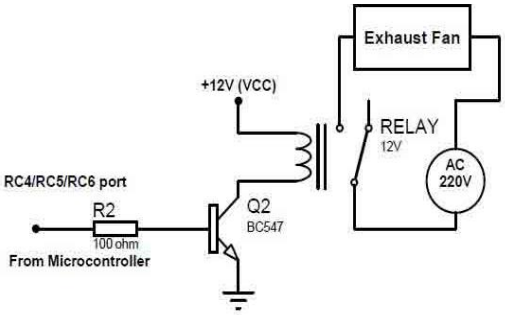

Fig. 6: Exhaust Fan Activation

D. Ventilation and Exhaust Fan system

The output from the microcontroller port is directly connected to a transistor (BC547) through a current limiting resistor which acts as an automatic switch. The Exhaust fan (Ventilation system) is connected to AC power source via a relay switch. This relay switch is activated by microcontroller via transistor when the temperature cross the predefined limit and smoke sensor detects smoke or gas [11] [12].

Another important subsystem is DC voltage source. This Voltage is used in different subsystems for their working.

By using a simple circuit, the AC 220V is made to DC 5V and 12V. The constant 5V is used for operating the microcontroller and the 12V is used to drive the relay switch. The Dc Power source circuit is illustrated in the Figure 7.

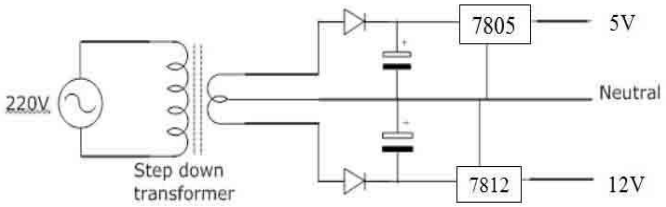

Fig. 7: DC Power Source

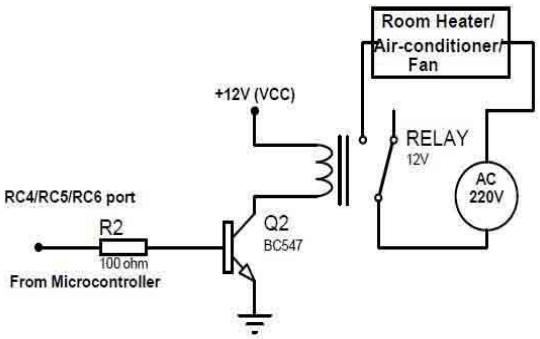

Fig. 8: Proposed Model for Future Development

IV. SUMMARY AND RECOMMENDATIONS

This automated model is proposed and successfully implemented using different circuits as demonstrated in the aforementioned figures. It is found that this system would be very useful for domestic as well as commercial appliances, such as kitchen, living room and processing zone. It has both its advantages. (a) The microcontroller is used for better control. (b) The 40 pins microcontroller (PIC16F877A) is capable of giving more pins to add more options [13] [14] [15]. (c) The use of MQ-series gas sensor and digital 1-wire protocol temperature sensor (DS18B20) is really making this system highly effective. Despite some advantages, it has limitation as well. The use of high performing and effective sensors make this system a little costly. In Embedded System design, indeed, there is no limit of developing. Newer forms of sensors as well as program syntax are being invented day by day. Also more effective technology will be invented as well.

However, there are certain areas for further improvement:

- Dual Tone Multi Frequency (DTMF) will give remote controlling by using radio frequency signal.
- More than one sensor can be included for controlling more than one room or kitchen.
- GSM module can be implemented for sending a SMS to user to notify the sensors status or when anything goes wrong.

This project can also be used as automatic temperature controller by controlling room heater, air conditioner, fan in hospitals, houses, hotels, industries, offices etc. The proposed model is shown in the Figure 8. It is possible to add more and more options in this embedded system such as firefighting, alarm, DTMF for remote control etc.

REFERENCES

[1]. Asfour, Omar, “Natural ventilation in buildings: An overview” , Publisher: NOVA Publication, New York, 2015., pp.1 -25
[2]. Krūmiņš, Andris and Pelīte, Uldis and Dzelzitis, Egils and Lešinskis, Artūrs and Brahmanis, Arturs, “case study of ventilation system development of archive premises”, 2009, pp. 2-11
[3]. Per Heiselberg (2004) Natural Ventilation Design, International Journal of Ventilation, 2:4, 295-312
[4]. Dogan Ibrahim, Microcontroller-based Temperature Monitoring and Control, Newnes, 2002.
[5]. Mohammad Jane Alam Khan, Muhammed Rifat Imam, Jashim Uddin, & M. A. Rashid Sarkar, “Automated Fire Fighting System with Smoke & Temperature Detection,” in 2012 7th International Conf on Electrical & Computer Engineering. 20-22 December, 2012, Dhaka, Bangladesh.
[6]. “DS18B20 Programmable Resolution 1-Wire Digital Thermometer datasheet”, Maxim Integrated Products, 120 San Gabr iel Dr ive, Sunnyvale, CA 94086 408-737-7600
[7]. Nayyar, Anand and Puri, Vikram and Le, Dac-Nhuong, "A Comprehensive Review of Semiconductor-Type Gas Sensors for Environmental Monitoring", Review of Computer Engineering Research, 3(11), pp.55-64, 2016
[8]. Wenlian Li, Yang Li and Fan Xiao, “The Design and Implementation of Digital Temperature Measurement and Automatic Control System”, 2010 International Conference on Computer Application and System Modeling (ICCASM 2010).
[9]. Temperature measurement using DS1820 sensor. Use of ‘1-wire’ protocol. [Online]. Available: http://www.mikroe.com/chapters/view/17/chapter-4-examples/
[10]. Li Feng, Zhou Hui, and Tao Yan, “Automatic temperature and humidity control system using air-conditioning in transformer substation”, Power and Energy Engineering Conference (APPEEC), 2012 Asia-Pacific.
[11]. Levărdă B. and Budaciu, “Temperature Control Application for a Ventilation System Using PIC18F6420”, Proc. ICSTC 2010, 282−286, 2010.
[12]. Zhen-fang XU, yan WANG, “Research On Auto-monitoring System For Cold Storage Temperature based On VB”, 2011 Fourth International Conference on Intelligent Computation Technology and Automation.
[13]. “PIC16F87XA Enhanced Flash Microcontrollers datasheet”, 2003 Microchip Technology Inc.
[14]. Milan Verle, PIC Microcontrollers-Programming in C, mikroElektronika; 1st edition (2009).
[15]. Myke Predko, Programming and Customizing the PIC Microcontroller, Third edition, McGraw-Hill Education, Sep 25, 2007.