Design an Automatic Temperature Control System for Smart Electric Fan Using PIC

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Abstract: ***This paper presents an innovative prototype design of electric fan with smart characteristics. This electric fan uses a microcontroller to produce an automation function. It also has a unique double feature designs, such as using 2 fans, 2 Light Emitting Diodes (LED) and 2 sensors. This is to ensure the cooling process operates more efficiently and effectively, especially for a large space application and in hot weather due to global warming. By applying the circuit, it offers a better life for human. It is really practical for senior citizens to make their life simpler. The circuit is also suitable for disabled people who have difficulty to switch on the fan manually. Lastly, the circuit can be manipulated by diversifying its function as a detector, where it can produce an alarm signal when emergency case occurs such as the house or premise is on fire.***

Keywords: Automatic, Temperature, Fan, PIC.

1. Introduction

Electric fan is one of the most popular electrical appliances due to its cost effectiveness and low power consumption advantages [1]. It is a common circuit and widely used in many applications [2]. It is also one of the most sensible solutions to offer a comfortable and energy efficient. In fact, the fan has been long used and still available in the market.

Nowadays, the usage of fan is controlled manually by pressing on the switch button. This non-innovative feature makes it unable to turn on automatically according to temperature changes. So, an automatic temperature control system technology is applied for the switching purpose in this circuit. Due to its advantages, many researches focusing on automatic temperature control system application in different fields will gain the benefits. For examples, an automatic temperature controller for multielement array hyperthermia systems [3], multi-loop automatic temperature control system design for fluid dynamics [4], automatic temperature control for transport airplanes [5], design of automatic temperature control system on laser diode of erbium-doped fiber source [6], design of automatic-temperature-control circuit module in tunnel microwave heating system [7], development of automatic temperature control system in blast furnace [8], the automatic temperature system with Fuzzy self-adaptive Proportional-Integral-Derivative (PID) control in semiconductor laser [9], the constant temperature automatic control system design of 3G base station without man' s guard [10], automatic body temperature control system for small animal studies using dual mode Proportional-Integral (PI) control [11], automatic temperature and humidity control system using air-conditioning in transformer substation [12] and so forth. There is also a case study of automatic temperature control system on diagnosable discrete event system design [13].

This paper proposes an invention of Smart Electric Fan for various applications. It has an automation operation by using a microcontroller. It uses a unique design such as 2 fans, 2 LEDs and 2 temperature sensors. This is to enhance its functionality to become more efficient and effective for large space and hot weather condition. The circuit provides a comfort for human's life, especially for senior citizens. It really helps to solve the problem of handicapped person when to switch on the fan. Finally, the circuit can also detect when fire occurs by alarming the buzzer.

2. Methodology

The circuit presents the design, construction, development and control of automatic switching electric fan. The idea is based on the problem occurs in human's life nowadays by improving the existing technology. The Peripheral Interface Controller (PIC) based automatic fan system is applied to upgrade the functionality to embed automation feature. The electric fan will automatically switch on according to the environmental temperature changes. The circuit is using a microcontroller to control the fan according to the temperature variation. The system measures the temperature from the Integrated Circuit (IC) LM35, where it will control the fan according to the setting values in the programming.

The system indicates the temperature from the PIC16F876A, and it will display it on the Liquid Crystal Display (LCD). The temperature then is compared with the setting value. If the room temperature goes beyond the preset temperature, then the fan will turn on. It also provides a security characteristic, where it detects an extremely high temperature, for example when the room is on fire, which the buzzer will instantly produce an alarm sound to alert people of the danger.

For the voltage regulator circuit as shown in Figure 1, the voltage range of power supply is between 7V and 15V. Higher input voltage will produce greater heat on LM7805 voltage regulator. So, normally the ideal voltage is 9V. The LM7805 will regulate the given voltage to 5V for supplying to the PIC16F876A and pull up the push button. The purpose of using diode is for circuit protection, in case the polarity of the power source connection is incorrect. Capacitor is used to stabilize the voltage input and output of the LM7805. Red LED acts as a power indicator.

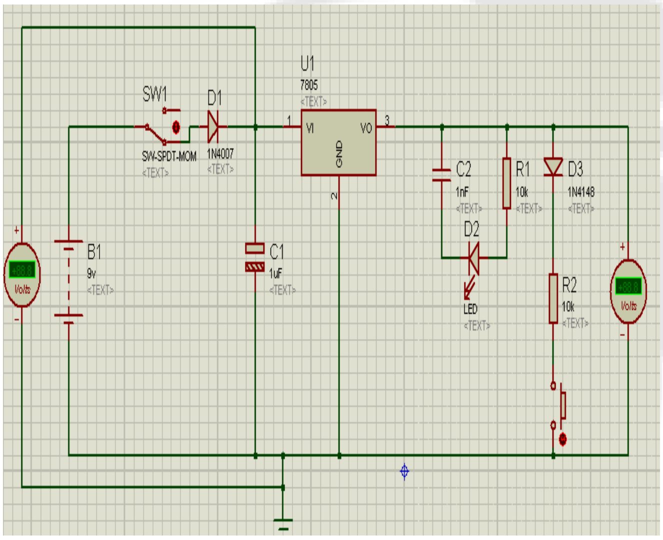

Figure 1: The voltage regulator circuit

An input/output (I/O) pin is required for a push button, which as an input for PIC microcontroller. The connection of the push button to the I/O pin is illustrated in Figure 2. The I/O pin should be pulled up to 5V using a resistor with a value range of 1kΩ to 10kΩ. This configuration will result an active-low input. When the button is pressed, the I/O pin will result a logic 0 and vice versa.

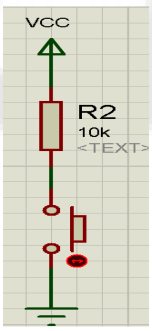

Figure 2: The push button as an input for PIC

An I/O pin is applied for one LED, as an output for PIC microcontroller. The connection of the LED to the I/O pin is shown in Figure 3. The function of resistor is to protect the LED from over current that will burn the LED. When the output is in logic 1, the LED will ON, and vice versa.

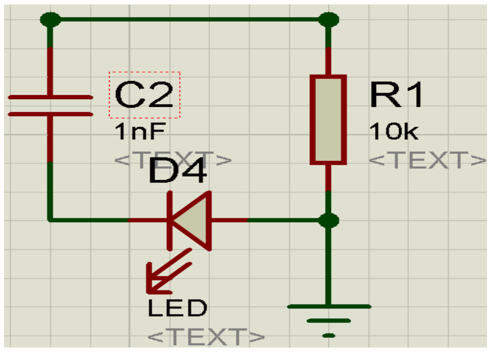

Figure 3: The LED as an output for PIC circuit

3. Results and Discussion

The circuit starts to function when the 9V Direct Current (DC) battery supply is turned on. It is connected to the IC regulator circuit to produce 5V stable voltage. Then, the LM35 sensor functions to measure the changes of temperature surrounds the area. All the operations are controlled by the PIC16F876A to produce the output. The PIC is as a brain of the circuit. The LCD, fans and buzzer are the output where they are set with the pseudocode of PIC. The LCD is used to measure and show the changes of temperature value. The fan starts to function when the switch is turned on. The high value of temperature causes both fan A and fan B to turn on automatically. Then, the buzzer will only show the emergency feature if the temperature reaches an unusual value. The complete design of Smart Electric Fan circuit is shown in Figure 4.

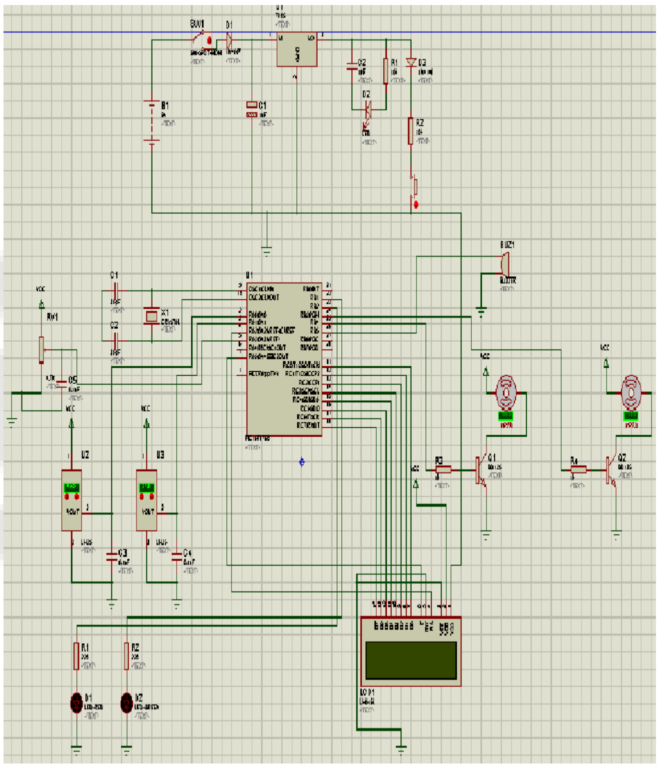

Figure 4: The complete circuit design of Smart Electric Fan

Temperature sensors will detect the temperature from the surrounding while PIC will measure the temperature. PIC is an interface with NPN power transistors whether to on or off the fans. If the temperature sensor A detects the temperature is higher than 40oC, and the temperature sensor B detects the temperature lower than 35oC, LED A and fan A will be on while LED B, fan B and buzzer are off. If the temperature sensor A detects temperature lower than 40oC, and the temperature sensor B detects the temperature higher than 35oC, LED B and fan B will be on while LED A, fan A and buzzer are off. If the temperature sensor A detects the temperature higher than 40oC, and the temperature sensor B detects the temperature higher than 35oC, both LEDs and fans will be on as well as the buzzer and vice versa. The higher input voltage will produce excessive heat at LM7805 voltage regulator. Typically, the voltage used is 9V. The LM7805 regulates the given voltage of 5V to supply for the PIC16F876A and push button. The purpose of using diode D1 is for the circuit protection when the polarity of the power source is incorrect. Capacitor C1 and capacitor C2 are used to stabilize the voltage input and output of the LM7805. D2 is a green LED, which functions as a power indicator.

Referring to Table 1, the level 0 indicates that all fans and LEDs A and B are off. It is because both sensors do not detect the actual set of temperature for both fans and LEDs to turn on. Both fans and LEDs will turn on when the actual set of temperature in both sensors are detected. The setting temperature for sensor A is above 40oC to turn the fan and LED A on, while the temperature for sensor B is set to be above of 35oC to turn on the fan and LED B. Level 1 is when the fan and LED A are turned on, while level 2 is a condition where the fan and LED B are turned on. If both temperature sensors detect the temperature above 40oC and 35oC, both fans and LEDs will also turn on. This is known as level 3, which indicate a fire case situation. The buzzer will act as an alarm to alert people about the emergency occur.

4. Conclusion

In conclusion, the process in developing this innovative circuit is succesfully done. The hardware implementation and its operation is functioning accordingly and smoothly following the procedure. High priority has been given to make the circuit simple but efficient with high reliability. Some slight of modifications have been made from the current and existing technology features to improve its performance. The circuit has fulfilled the main objective, which to control the speed of fan using the temperature controller with PIC. It has a special safety feature by using a buzzer to produce the alert signal if the temperature become overheat. This circuit is really practical to be applied, especially in today's hot condition.

In the future, there are several improvements can be made in order to upgrade the features such as using a wireless technology to interface sensor and microcontroller, monitor and control the temperature via internet and using an USB to link microcontroller and computer.

Table 1: The different level of condition in Smart Electric Fan circuit

Operation of fan		*Operation of LED*		*The actual temperature of sensor (oC)*		*Level of condition*
Fan A	*Fan B*	*Led A*	*Led B*	*Sensor A*	*Sensor B*	
Off	Off	Off	Off	< 40	< 35	Level 0
On	Off	On	Off	> 40	< 35	Level 1
Off	On	Off	On	< 40	> 35	Level 2
On	On	On	On	> 40	> 35	Level 3

5. Acknowledgment

The author would like to thanks to Universiti Teknologi MARA (UiTM) Melaka Malaysia for organizing a Research, Invention, Innovation & Design (RIID) 2012 exhibition and competition, where this circuit has been awarded a silver medal and certificate.

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