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Technical Overview of A Microcontroller Based Room Temperature Fan Speed Regulator

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ABSTRACT: *Ceiling fans are used in the daily purposes to control the room temperature. Voltage regulators which have different stages of speed are manually used to control most of the Fans available these days which could be a tedious task for the user and most at times damages the regulator as a result of repeatedly change of the fan speed. This non-innovative feature makes it unable to automatically OFF / ON or change the fans speed according to temperature changes. So, an efficient microcontroller based Fan speed control system that automatically off / on the fan in the absence / presence of the user or changes the speed level according to the change in room temperature is required to solve the problems associated with Fan speed manual control system. This paper explain how a Microcontroller is used to control the speed of a fan based on the data from the Omron D6T thermal sensor and temperature sensor (LM 35), to monitor and regulates the speed of a Ceiling Fan depending on the room temperature at any point in time.*

KEYWORDS*: Fans, Microcontroller, Omron D6T thermal Sensor, Speed Regulator, Temperature Sensor*

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I. INTRODUCTION

Nowadays, the humankind is moving towards the new technologies by replacing the manual operations to automatic controlled devices. One of the basic requirements of the people during hot weather is a cooling fan.

A fan is one of the most popular electrical devices 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 demand for accurate temperature control and air freshening control has conquered many of industrial domains such as process heat, automotive, industrial places or office buildings where the air is cooled in order to maintain a comfortable environment for its occupants [3]. One of the most important concerns involved in heat area consist in the desired temperature achievement and consumption optimization. Basically, fan is operated manually with the help of regulators as the temperature changes. Any change in the temperature will not give any change in the fan speed except the user change the speed of the fan manually and this require a repeatedly extra effort for regulating the fan speed which acts as burden to the user. Generally, the activities of ceiling fan is been controlled by Centrifugal switch. The user can select the interested speed by switching the appropriate level in switch centrifugal. Normally, a ceiling Fan has four or six speed switches depending on the design. There are speed 0, speed 1, speed 2 and speed 3, or speed 0, speed 1, speed 2, speed 3, speed 4 and speed 5. The speed 0 is especially for switching off the ceiling Fan. The slowest is for speed 1 and the fastest is speed 3 or speed 5 in that order [6].

More also, during the night, the metabolic rate of one's body decreases, and one is expected to wake up from time to time to regulate the speed of the Fan with respect to room temperature. The users do not understand the difference in temperature and as such many people have died as a result of this, and the disabled / physically challenged persons are affected the most because of the inconveniences associated in changing the Fan speed level manually [7]. Besides, there are times the user of manually operated fan forget to turn off the fan while been away thereby making the fan to runs continuously which is consider to be waste of energy and thus lead to a higher electricity bill and at times fire outbreak which may cause havoc in homes and offices. In order to reduce this extra effort, add comfort to the user and reduces the risk of fire outbreak at homes and offices, an efficient and reliable system that automatically OFF / ON a fan or changes the Fan speed level according to the change in room temperature is required to solve the problems and shortcomings associated with manually method of Fan speed control and this concept is particularly applicable in areas where temperature changes radically during day and night time.

With the invention of the microcontroller based fan automated system using temperature sensor and Omron D6T thermal sensor, one does not have to change fan speed manually, it can change fan speed to lower or higher speed according to the temperature and also ON / OFF the fan automatically when the user is or not within the vicinity. Hence, effort is been made in this work to convert the manual fans into automatic fans and the automatic fans will change its speed according to the temperature of the room.

1.1 Problem statement

Technical planning for conversion of manually controlled fan to automatic speed controlled fan in order to control the room temperature will include the following process requirements;

a. Designing of the automatic speed control by allowing a chamber temperature set-point to be entered

b. Definition and understanding the automatic speed control in relation to the existing manually controlled fan speed.

c. The inclusion of the innovative feature to the switching circuit that will be able to turn on automatically according to temperature changes.

d. Temperature sensor display

e. Track step changes in set-point temperature with acceptable rise time.

1.2 Objectives

The objective of this work is to help in knowing the usefulness of automatic fan speed control and the task ahead of the designer. Many engineers familiar with manually fan speed regulator now faced with designing, developing and maintaining of automatic speed control fan. More also, the objective is to address the problem caused by manually speed fan regulator as user has to wake up from time to time to adjust the regulator.

The major reason for this paper is to eliminate the inconveniences associated in changing the Fan speed level manually. The idea is based on the problem occurs in human's life nowadays by improving the existing technology by including an intelligent circuit that can automatically switch OFF or Regulate a fan speed as the room temperature falls below critical value thereby conserving electrical power.

II. MATERIALS AND METHODS

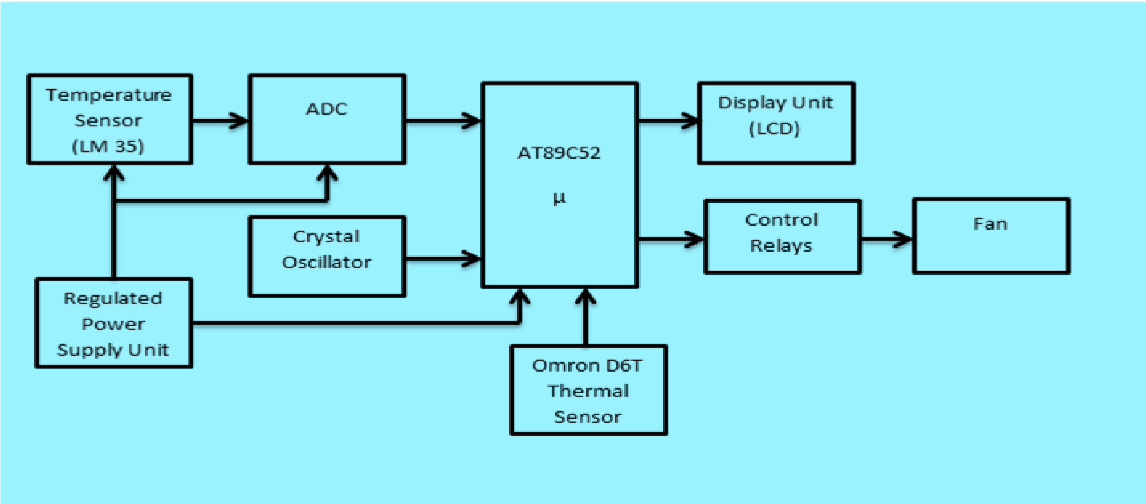

Figure 1: System Architecture

The overall system consists of several components as shown in Figure 1.

AT89C52 microcontroller form the heart of the system and it accepts inputs from the Omron D6T thermal sensor and the temperature sensor (LM 35). The D6T thermal sensor detects the presence or absence of the user while the LM 35 temperature sensor senses the current room temperature and converts it into an electrical signal. The output of the LM 35 is analogue in nature which needs to be converted to digital signal required by the microcontroller and as such, the output of the LM 35 is fed to the input of the ADC which converts the analogue temperature values from the temperature sensor to its digital equivalent. Thus, the output of the ADC is fed to the microcontroller whose main task is to drive or control the Fan speed via the control relay by means of ULN driver according to the setting values in the programming. The fan RPM increases with increase in temperature and vice versa. The LCD is used to display the fan speed and room temperature at all point in time.

2.1 Power supply unit

The power supply unit comprises of a step down transformer, rectifier, filter and the regulator. The transformer step-down the voltage from 240V AC to 12V AC. This 12V AC voltage is given to the bridge rectifier which converts it to 12V dc. A Capacitor filter is used to remove ripples from the rectified signal and then further regulated by 7805 regulator to get the require 5V dc which is needed by the microcontroller for its proper operation. Red LED acts as a power indicator

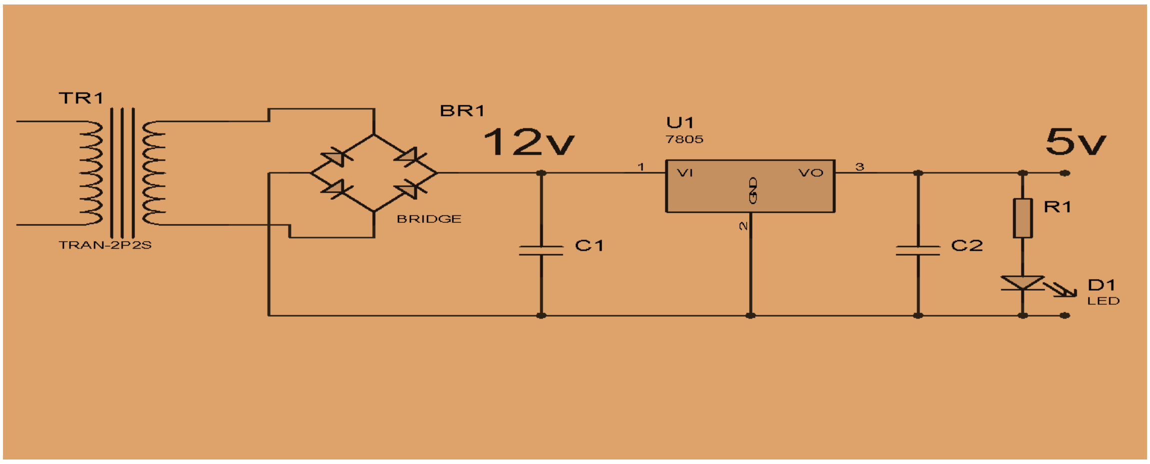

Figure 2: Power Supply Schematic

2.2 Temperature Sensor (LM35)

The LM35 is a precision IC temperature sensor whose output voltage is linearly proportional to the temperature in Celsius [4]. LM35 sensor is interfaced with the microcontroller to measure the room temperature.

The output voltage of the LM35 will vary at a rate of 10mV per degree Celsius.

$$\mathrm{Vout}_{\mathrm{LM35}} = \frac{10\mathrm{mV}}{{}^{\mathrm{o}}\mathrm{C}} \times \mathrm{To}_{\mathrm{C}}$$

The sensed change in room temperature is in analogue form, hence the output of the LM35 is directly coupled to the ADC for further processing.

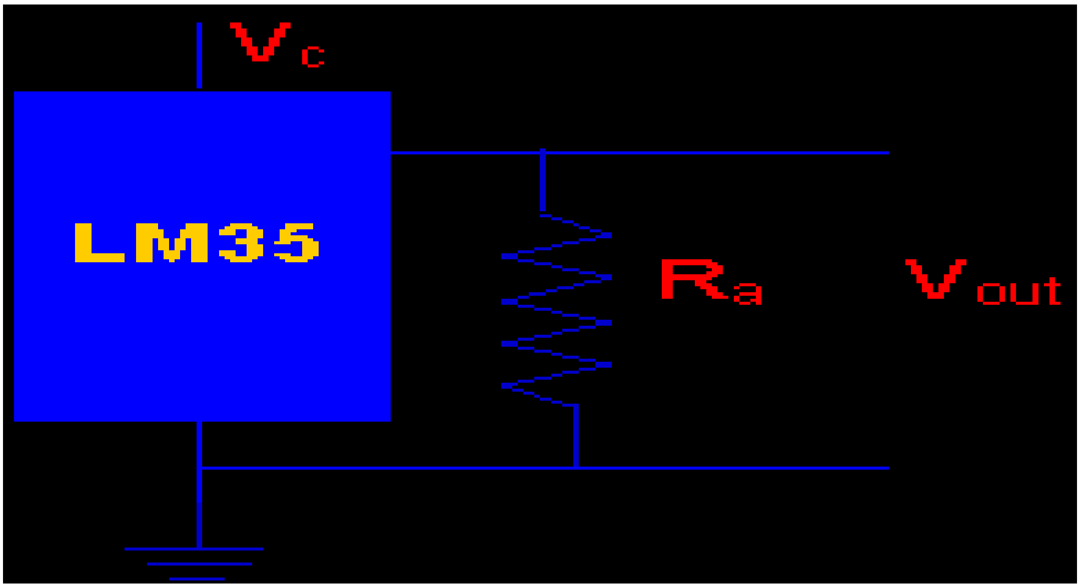

Figure 3:LM35 temperature sensors

2.3 Omron D6T thermal sensor

D6T thermal sensor is a non-contact thermal sensor used to detect the presence of humans by detecting the body heat. The sensor recognizes the heat signature of a human wavelength. If there is user in the room or within the area, the sensor recognise the wavelength of the user and send the data to the microcontroller and then the microcontroller will signal the relay thereby making the fan to rotate but in the absence of the user, the sensor will not sense the presence of the wavelength of the human body as such, the fan stops rotating after some minutes.

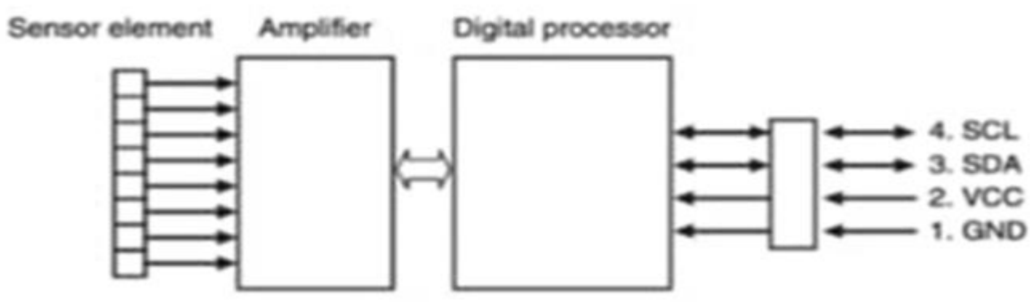

Figure 4: Thermal Sensor Configuration Diagram

2.4 Analogue to Digital Conversion (ADC)

The microcontroller acts as a medium for digital signal processing and as such, only a binary code can be read in the microcontroller. Hence, the small analogue output voltage generated from the temperature sensor (LM35) has to be converted into digital form so that the microcontroller can use it to perform a simple comparison task. Thus, the requirement for ADC0804.

ADC0804 is a very commonly used 8-bit analog to digital converter. It is a single channel IC, i.e., it can take only one analog signal as input. The digital outputs vary from 0 to a maximum of 255. The step size can be adjusted by setting the reference voltage at pin9. When this pin is not connected, the default reference voltage is the operating voltage, i.e. Vcc [6]. The step size at 5V is 19.53mV (5V/255), i.e. for every 19.53mV rise in the analog input, the output varies by 1 unit. To set a particular voltage level as the reference value, this pin is connected to half the voltage. For example, to set a reference of 4V (Vref), pin9 is connected to 2V (Vref/2), thereby reducing the step size to 15.62mV (4V/255).

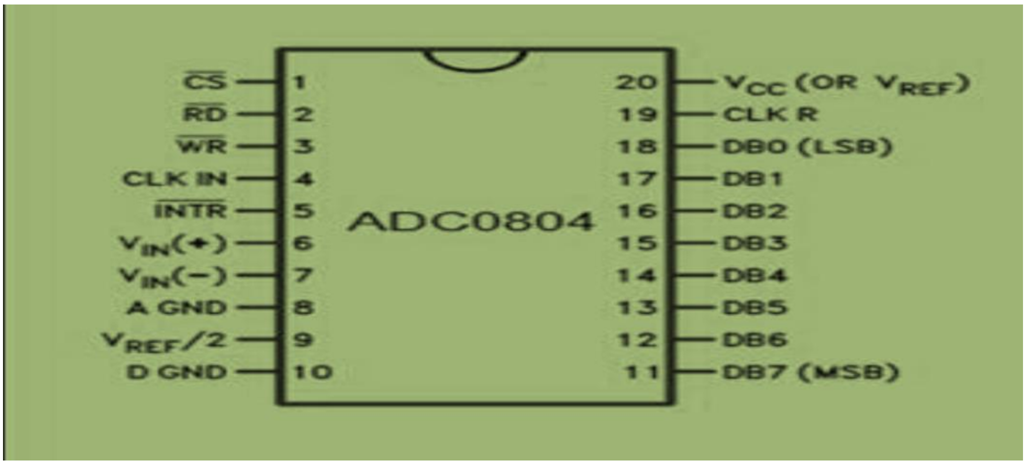

Figure 5:ADC0804 Pin Diagram

2.5 Crystal Oscillator

A crystal oscillator is an oscillator circuit which uses the mechanical resonance of a vibration to create an electrical signal with a very precise frequency. The crystal oscillator is used in the system to provide clock signal to AT89C52 microcontroller.

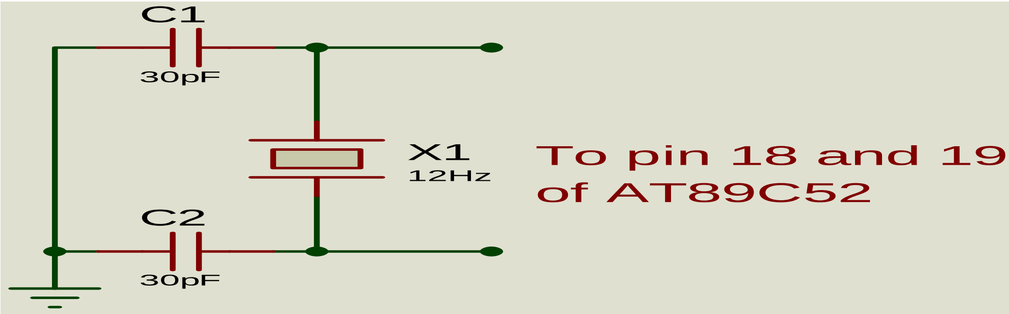

Figure 6: Crystal Oscillator connections

2.6 AT89C52 Microcontroller

A microcontroller is a computer control system on a single chip. It has many electronic circuits built into it which can decode written instructions and convert them to electrical signals. The microcontroller will then step through these instructions and execute them one by one. Nowadays, instructions sets (program) are used to wire the gates electronically to perform some function instead of hard wiring a number of logic gates together [5]. As such, a microcontroller could be used to control the fan speed according to the temperature of the room. This research focus on the AT89C52 Microcontroller.

AT89C52 is a 40 pin Microcontroller. The pins are divided into four ports (port 0, port 1, port 2 and port 3) with each port made up of 8 pins. Within the 40 pins, 8 pins are special pins while 32 pins are I / O pins which you can connect any input device or output device to. The 8 special pins are pin 9, pin 18, pin 19, pin 20, pin 29, pin 30, pin 31 and pin 40.

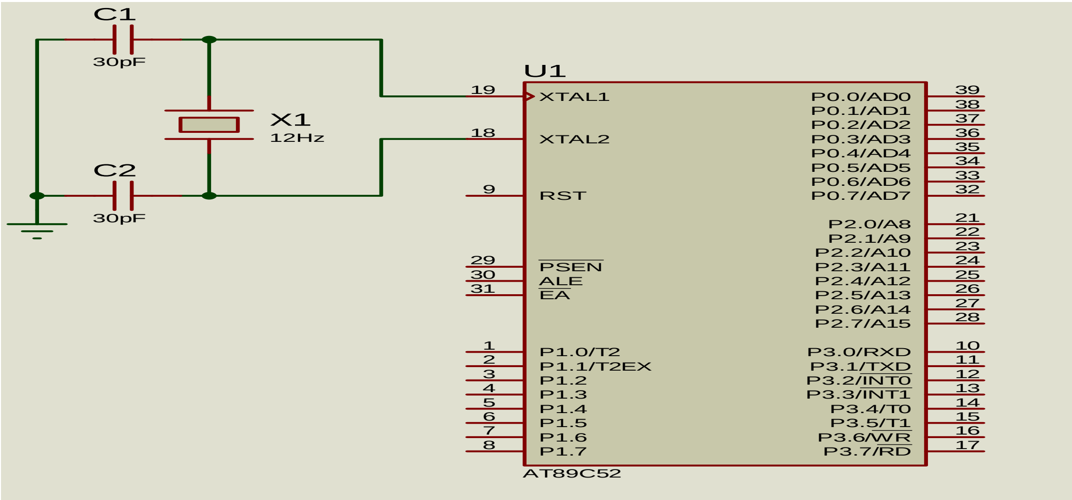

Figure 7:AT89C52 and crystal Oscillator connection

2.7 Liquid Crystal Display (LCD)

This is a dot matrix liquid crystal display that shows alphanumeric letters and also symbols [5]. A 2 X 16 LCD digital display is used in this work to show the temperature of the room as well as the speed of the fan at any given time.

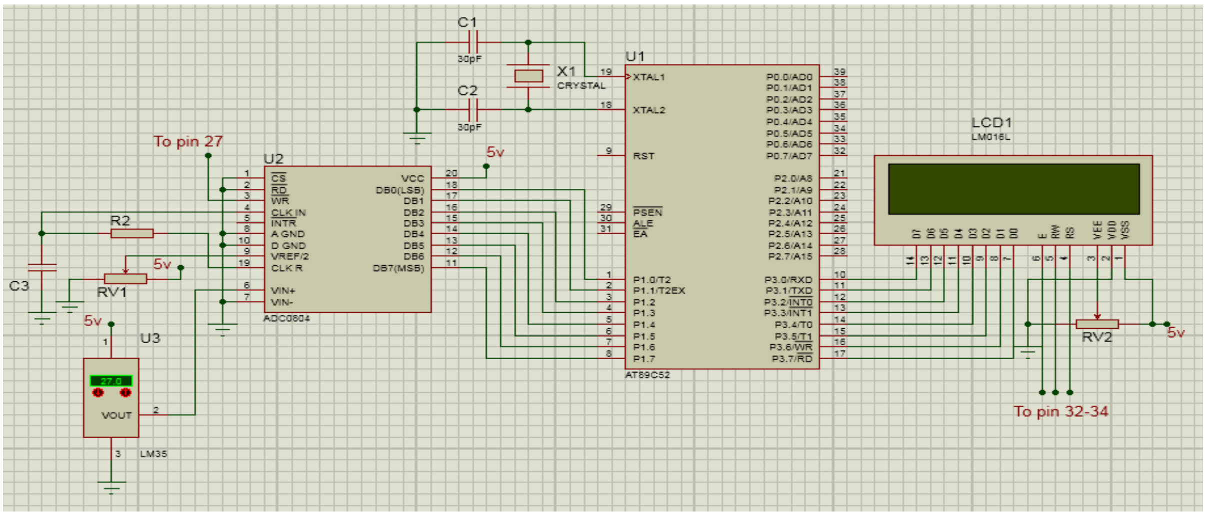

Figure 8: Interfacing LCD and ADC to AT89C52

2.8 Control relays

Control relays are connected to the microcontroller through a ULN driver circuit. The relays require 12 volts at a current of around 50Ma which cannot be provided by the microcontroller. So the ULN driver circuit is added to the requirement. The relays are then used to connect or disconnect the Fan terminals from supply. The relays remain at OFF state when the pin of the microcontroller is low but as soon as pin of the microcontroller goes high, the relays operate.ULN2003A IC is used for the driver circuit

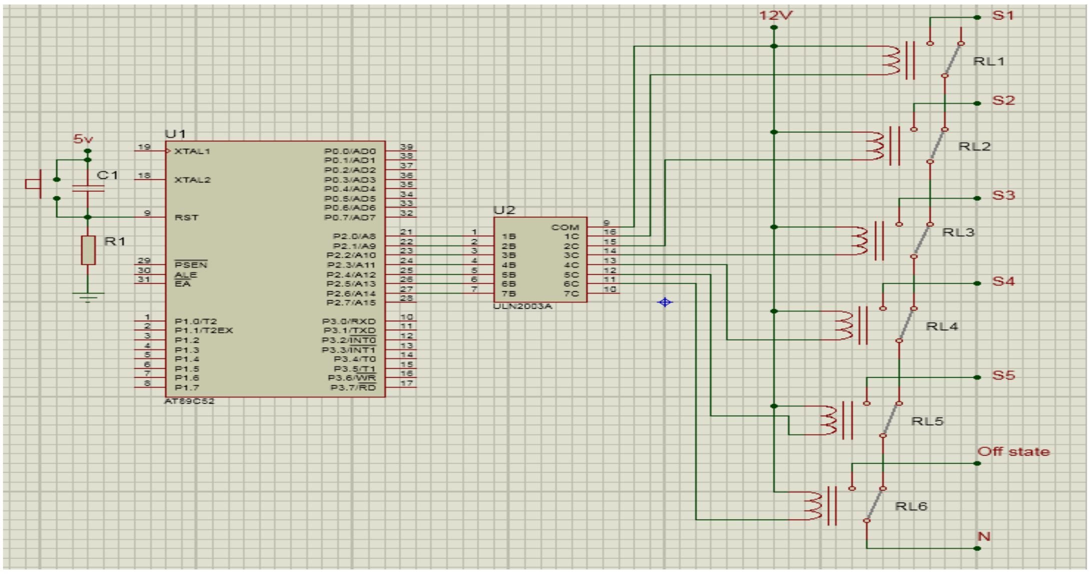

Figure 9: Relays connection to the ULN2003A driver

2.9 Output Unit (Ceiling Fan)

The output unit consists of the Fan and the regulator. Depending on the number of speed used on design which can either be 4 or 6 speed, the outputs from the ULN2003A IC are connected to each of the speed on the regulator. Inside the regulator, each speed has a terminal and those terminals are connected to the circuit via the relay. The relays that control the Fan speed are controlled by the microcontroller via the ULN2003 IC.

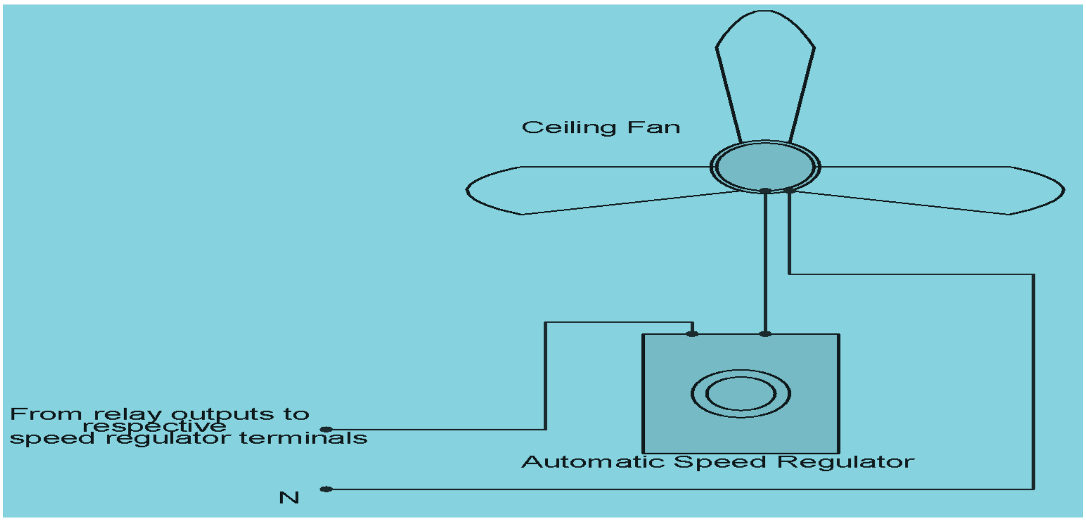

Figure 10: Fan connection

III. RESULTS AND DISCUSSION

The normal room temperature is in the range of $15^{O}C$ - $25^{O}C$. Owing to variation in humidity and air circulation, the range is taken as $23^{O}C$ – $25^{O}C$ for summer and $20^{O}C$ – $23^{O}C$ for winter. This is the temperature that one can comfortably stay in a room and these vary from place to place.

In any research work, it is useful to carry out test in order to measure the performance of the research work and as such, a test was conducted which shows that the room temperature increases as a blower which serves as heat source was brought in contact with the temperature sensor (LM 35) and decreases when the blower is replaced with a cool water thereby resulting to a change in Fan speed from lower to higher speed (speed 1 to speed 5) or from higher to lower speed (speed 5 to speed 1) at respective instance. Thermometer and Voltmeter were used to measure room temperature and the temperature sensor output respectively. Table 3.1 shows the result of the research performance.

Table 3.1: Speed for different ambient temperature

Ambient temperature (^{O}C)	Temperature Sensor output(input to AT89c52) (mV)	Speed
25 and below	250	OFF
26	260	1
27	270	2
28	280	3
29	290	4
30 and above	300	5

As seen from the Table 3.1, the fan speed increases as the temperature increases and decreases as the temperature decreases.

IV. CONCLUSION

The circuit used in this paper has fulfilled the main objective, which is to control the speed of fan automatically using temperature sensor with microcontroller. The temperature sensor was carefully chosen to gauge the room temperature. Microcontroller was used to control the fan speed through Relay driver. The Fan speed increases with increase in room temperature and decreases with decrease in room temperature and also automatically OFF when the D6T thermal sensor detects the absence of the user.

The method used in this paper is appropriate according to the modern needs and technology and should be adopted in order to explore all its numerous benefits such as cost effectiveness, low power consumption, energy management etc. A microcontroller fan regulator offers a potential mechanism through which a fan speed can automatically be regulated based on the room temperature at any point in time. It opens up a new world of opportunity for the Engineers to develop and improve on the existing fan speed controlling method.

The circuit is to be applied especially in today's hot condition and it works effectively in term of energy saving compared to the existing fan speed controlling method.

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