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Automatic Fan Speed Control System Using Microcontroller

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Abstract*:Automatic control plays an ever-increasing role in a person's lifestyle. Automatic control is a vast technology area with a central focus on developing control strategies that increase productivity when applied to a system. A distinctive feature of automatic control is that it reduces the number of people-operators. One such gadget is a fan. Fans are usually available with variable speed, depending on the requirements of the set speed. Typically, at high temperatures, the fan runs at high speed, and at lower temperatures, the fan runs at a lower speed. This is done manually with the help of a human. This article proposes a solution for automatic fan speed control. A circuit with LM35DZ temperature sensor, PIC16F877A microcontroller, brushless DC motor and several electronic components is designed and implemented for automatic fan speed control. An LCD display is used as an optional feature to display temperature and fan speed. Finally, the developed system circuitry was tested many times and worked very well.*

Keywords**:***Fan speed, microcontroller, LM35DZ, BLDC motor AND circuit design.*

I. INTRODUCTION

The ELECTRIC fan is one of the most popular electrical devices due to its cost effectiveness and low power consumption advantages. It is a common and widely used circuit in many applications. It is also one of the most sensible solutions to offer a comfortable and energy efficient environment. In fact, the fan has been used for a long time and is still available on the market. Today, the demand for precise temperature control and air freshener control has conquered many of the industrial domains, such as process heat, automotive, industrial locations, or office buildings where air is cooled to maintain a comfortable environment for its occupants. One of the most important concerns involved in the area of heat is the achievement of the desired temperature and the optimization of consumption [1]. The fan can be controlled manually by pressing the switch button. Where in this method, any change in temperature will not give any change in fan speed. Except that use changes the fan speed which is manually. Therefore, an automatic temperature control system technology is needed to control the fan speed according to changes in temperature.

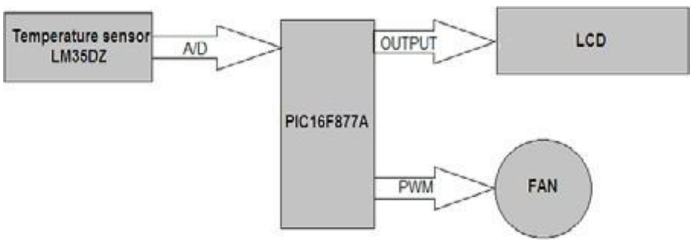

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Figure no 1: Block diagram of fan speed control system

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II. Material And Methods

This prospective comparative study was carried out on of Department of general Medicine at SileverJubali Hospital, Baramati, Pune, Maharashtra from November 2014 to November, A total 50 rooms, years were for in this study.

Regulated Power Supply
FAN SPEED CONTROL SYSTEM COMPONENTS
PIC16F877A Microcontroller
Brushless DC Motor
9BLiquid Crystal Display (LCD)
FAN SPEED CONTROL SYSTEM CIRCUIT DESIGN

Study Design: Prospective open label observation study.
Study Location: This was a tertiary care teaching hospital base study done in Department of General Medicine, at SileverJubali Hospital, Baramati, Pune, Maharashtra.
Study Duration:oct 2020 to Jan 2021
Sample Size: 50 Rooms.

Procedure Methodology:

Regulated Power Supply
let's start with an unregulated power supply ranging from 9-volt DC to 12-volt DC. To realize a 5-volt power supply, the KA8705 voltage regulator IC was used as shown in. 3 Power regulator The KA8705 is simple to use. Just connect the positive wire in the form of unregulated DC power supply (anything from 9VDC to 24VDC) to the input pin, connect the negative wire to the common pin and then turn on the power, 5 power supply will be performed volts from the output pin of the microcontroller

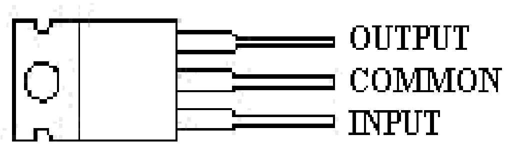

Figure no 2: Power supply regulator

Temperature Sensor (LM35)
The temperature sensor chosen for the project is the popular LM35 IC temperature sensor as shown in fig. LM35 is a three terminal integrated circuit temperature sensor that provides a linear voltage output of 10mv per degree Celsius. Available in two versions, one operating from 0 ° C to 100 ° C (DZ version), and the other is from -40 ° C to + 110 ° C. These devices are housed in TO-92 plastic packages and provide a solution for low cost for temperature measurement. The function is that it provides an analog voltage output per degree of temperature change. The output voltage of the LM35 temperature sensor has a linear relationship between the Celsius temperature scales, 0 ° C, the output is 0 V, for every 1 ° C increase in the output voltage of 10 mV.
VoutLM35 = $10 mv°C \times T°C$
With microcontrollers, which means it cannot be driven by standard IC circuits. Used to display different messages on a miniature LCD screen. It can display messages on two lines with 16 characters each. It can also display all the letters of the alphabet, Greek letters, punctuation marks, math symbols, etc. illustrates the LCD screen (2 x 16 characters) and its connection.

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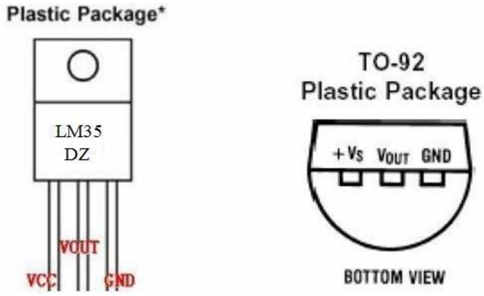

Figure no 3: Temperature sensor LM35 DZ

FAN SPEED CONTROL SYSTEM CIRCUIT DESIGN:

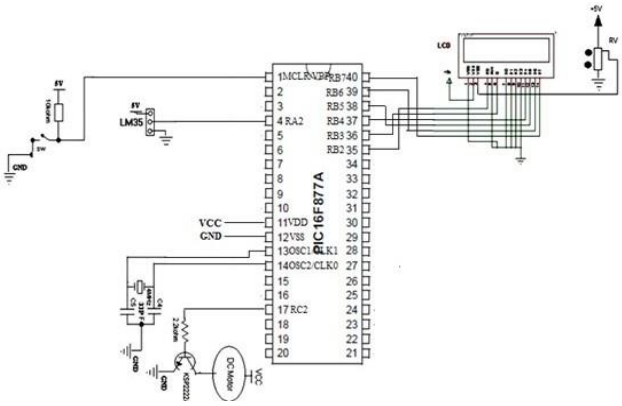

Figure no 4: Schematic circuit diagram of fan speed control system

This section describes how the fan speed is controlled by the PWM output from the microcontroller, with the variation of the ambient temperature. The schematic diagram of the fan speed control system shown in fig.
Schematic diagram of the fan speed control system in this circuit the microcontroller is used to control the fan according to the temperature change. The voltage from the mains (220 / 240V AC) is reduced by a 12V transformer. Then the 12V DC passes through the voltage regulator to provide a clean 5V DC. The LM35 functions to measure changes in temperature surrounds the area. All operations are controlled by the PIC16F877A to produce the output. The LCD, the fans are the output where they are set with the pseudo code of PIC. The LCD display is used to measure and show changes in the temperature value. As a principle of operation, the temperature sensor detects the ambient temperature and displays it on the LCD display. The fan speed is controlled using the PWM technique based on the variation of the ambient temperature. For the processing of analog signals, also another method to calibrate this work, was an external temperature sensor (thermometer) to measure the ambient temperature. Describes the calibration process using the voltmeter and thermometer. Calibration process using voltmeter and thermometer. The calibration process wasperformed at different times of the day which can be summarized in Table 1.

FAN SPEED CONTROL SYSTEM COMPONENTS

The PIC16F877A microcontroller is the heart of the system. Accepts inputs from the temperature sensor, LM35 which allows measurement of the current room temperature, then the controller will give the action to maintain the required fan speed. The LCD screen is used to display the fan speed and ambient temperature. All of these can be summarized in a fig as shown.

A microcontroller is a control system on a single computer chip. It has many integrated electronic circuits, which can decode written instructions and convert them into electrical signals. The microcontroller will then go through these instructions and execute them one by one. As an example of this, a microcontroller could be used to control the fan speed according to the room temperature. Microcontrollers are now changing electronic designs. Instead of wiring multiple logic gates together to perform some function, we now use instructions to wire the gates electronically. The list of instructions given to the microcontroller is called a program. There are different types of microcontrollers, this research focuses only on the PIC16F877A microcontroller.

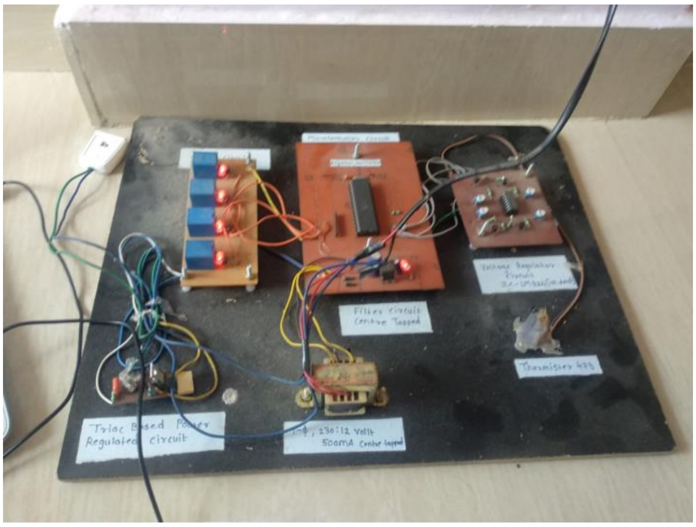

Figure no 5: Hardware circuit of fan speed control system

Brushless DC Motor

Brushless DC motors are electronically commutated, they do not use brushes, which is called a brushless DC motor. These motors provide better characteristics of speed compared to torque, quiet operation, and high efficiency compared to brushed DC motors. The magnetic field generated by the stator and the rotor has the same frequency, so BLDC motors are synchronous motors. shows the cross section of the BLDC motor.

BLDC motors have mainly two parts that is stator and rotor. Some of the motors consist of hall sensors. BLDC fans do not present problems related to sparks, brush wear or electromagnetic interference (EMI), since they use the electrical switching presented by the BLDC fan used for this investigation.

The rotor the motor turns. The rotor is made of permanent magnet with alternating north (N) and south (S) poles on the circular core. The BLDC fan uses permanent magnets, so it has a lighter rotor than conventional DC fan, making them suitable for desktop and laptop cooling fan application. Hall sensors detect the position of the rotor at the south and north poles and the exact switching sequence is determined based on their position. This commutation sequence is important in rotating BLDC motors, as they use electronically controlled commutation.

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Figure no 6: BLDC Motor

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Liquid Crystal Display (LCD)

This component is manufactured specifically to be used. The microcontroller has an analog-to-digital converter that converts analog signals to digital. The LM35 gives 10mv for every 1 ° C change in temperature; this value is an analog value and must be converted to digital. Any change in temperature will be sent to the microcontroller through PORTA pin 2, which we have specified in the program using TRISA. The microcontroller used in this system has a built-in PWM module that is used to control the speed of the fan by varying the duty cycle. Based on the temperature sensor readings, the duty cycle is automatically varied thereby controlling the fan speed. The microcontroller will send the PWM signal through the RC2 pin on port C to the transistor that functions as the fan switch.

The crystal oscillator is connected between pin 13 (osc1) and pin 14 (osc2) of the PIC16F877A, those are the pins if we want to provide an external clock to the microcontroller. 0.1 μF bypass capacitor used on the voltage regulator +5 V output pin to smooth the supply voltage to the microcontroller and LCD. The Vout pin of the LM35 temperature sensor is connected to the RA2 pin which is ADC0 of all the ADC input pins. LCD screen pin 3 is grounded through a 1Kohm resistor to set LCD screen contrast to display temperature on LCD screen. Pins RB2 to RB7 are connected to the remaining pins on the LCD screen that are used for data and control signals between the LCD screen and the microcontroller.

III. Results and Discussion

Since the calibration process must be carried out in any investigation. So, two methods were used to measure research performance. One method was to use the voltmeter to measure the output of the LM35DZ temperature sensor. Since the output of this sensor is 10 mv for every 1 ° C.

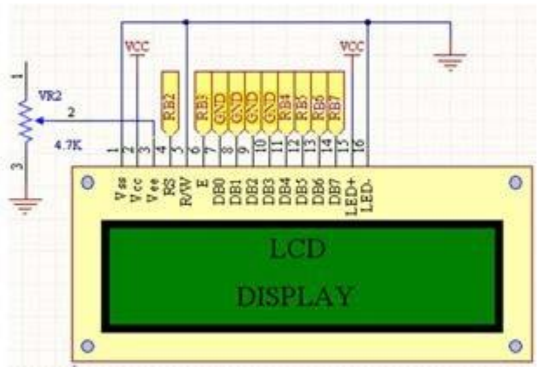

Figure no 7: LCD

Table no 1: Result

Calibration NO	Temp. on LCD	Relay status	Fan speed
1	25°C	RL1 energized	175 rpm
2	29°C	RL2 energized	181 rpm
3	33°C	RL3 energized	187 rpm
4	37°C	RL4 energized	193 rpm

Upon initial inspection of the circuit operation, various problems were noted. To isolate causes of circuit failuretroubleshooting of the circuit was undertaken. The original and expected results of various components of the circuit are as follows

1) **Power Supply: -** The power supply is mainly used to give the regulated 5V output to all the components. But due to interference between ground and output there is bug in the output. So we have used capacitor to decouple them and hence the power supply gives the 5V regulated output.

2) **Microcontroller:** - The microcontroller is mainly used for controlling and performing the action of motor driver. But due to wrong selection of crystal oscillator and decoupling. The controller time cycle is disturbed. So, by using capacitor to decouple these problems were solved.

3) **Relay Driver:** - The relay driver is mainly used for the controlling of the supply to transformer. The relay driver requires signal from microcontroller to operate. The relay takes 12v and 20ma. So we have connected it directly to relay driver ckt cannot connect directly to microcontroller. So that it will satisfy the surge current requirement of the transformer

4) **Result of Debugging:** - After debugging the circuit's individual modules, it was found that each of them functions as were expected, and with some modifications the output of each component is right and consistent.

IV. Conclusion

This article elaborates on the design and construction of the fan speed control system to control the ambient temperature. The temperature sensor was carefully chosen to measure the ambient temperature. Furthermore, the PIC microcontroller had been used to control the fan speed using the PWM, the fan speed in rpm and the room temperature was successfully programmed using the C language and its values displayed on the LCD screen. Two methods were used as the calibration process, where the calibration results showed that the room temperatures were close to each other using the LCD screen, the thermometer and the voltmeter at each test time. Also, the fan speed will automatically increase if the room temperature is increased. In conclusion, the system that

Designed in this work it performed very well, for any change in temperature and can be classified as automatic control.

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