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Microcontroller-Based Temperature Controlled DC Fan Using Atmega328

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ABSTRACT: Technology at this time completely occupies the lifestyle of human beings. Even though there is such an advancement in technology, there are still people whose lifestyles are very far from this advancement. The goals of this research are to enable an electric fan to change its speed level automatically in response to temperature changes and to design an automatic fan system that can vary its speed level in response to changes in the environment's temperature. The designed technology creates an atmosphere in which the fan speed is controlled by the system rather than the user. This fan automatically controls itself by sensing the temperature of the room and regulating itself to suit the temperature of the room.

KEYWORDS: LCD, Transistor, Resistors, ATMega328P, LM 35, microcontroller, programming, Arduino.

I. INTRODUCTION

With the advancement in technology, automation has become part of our lives, and the popularity of controlling electrical devices automatically has been increasing due to high performance and reduced work. For the most part in various climatic conditions, individuals will attempt to control the speed of the fan in their room or office by physically controlling the fan controller. Yet, doing this physically is a somewhat repetitive undertaking and not exact. Switching Fan regulators more often through manual control may damage the regulator [4].

Areas of the house that are frequently used by people, such as the living room and bedrooms, must be kept at a comfortable temperature. These concerns are magnified in sections of the house where infants are present. Adults could find their way around “thermal discomforts”, but infants may not. Other areas of the home that are used as storage areas for perishable food items also need to be thermally regulated to prevent accelerated decay of such items. This makes it necessary the need for a Temperature Control System within the home [6].

In this work; a temperature-controlled DC fan using a microcontroller (ATMEGA328p) can have a huge effect on helping people continuously without interference with the operation of the fan. Not only that, this project can mainly help disabled people who sometimes are unable to reach the button that controls the fan. As a result, such a project can benefit a large number of people while also ensuring their comfort.

This system controls and monitors the room temperature using a microcontroller and a temperature sensor. The temperature sensor will sense the surrounding temperature and communicates with the microcontroller. The microcontroller reads the temperature and compares it with the desired value. Based on the reading from the temperature sensor, the DC fan switches to either high, medium, or low velocity. The goal of this work is to create a simple but effective solution to address a complicated problem. The need for a simple and cost-effective system tends toward the aspect of engineering design that looks into simple solutions that solve complex systems and also minimize the cost of designing a system by minimizing equipment and components in the design. This is an aspect of the 10 Principles of Sustainable and Cost-Effective Design [6].

II. REVIEW OF RELATED WORKS

[6] A paper on the design and modeling of an automatic heater control system. The purpose of this system is to allow the user to set the desired temperature which is then compared to the room temperature measured by a temperature sensor. In this study, the PIC microcontroller is used, and the system responds by turning ON any of the two (2) loads (Fan or a heater) automatically depending on the temperature difference. The Fan is switched ON when the room temperature is higher than the set temperature and the heater is switched ON when the room temperature is lower than the set temperature.

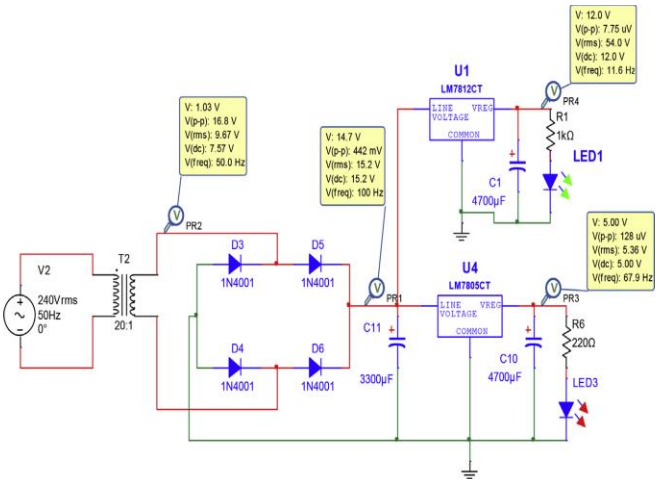

Fig 2.1. Block Diagram of Automatic Room Control Heater.

[3] present an innovative prototype for the design of an electric fan with smart characteristics. The electric fan uses a microcontroller to produce an automation function. It also has a unique double feature design, such as using 2 fans, 2 Light Emitting Diodes (LED), and 2 sensors which are to ensure the cooling process operates more efficiently and effectively, particularly in vast spaces and in hot weather owing to global warming. Applying the circuit, offers a better life for humans. The circuit is also suitable for old people and disabled people who have difficulty switching on the fan manually.

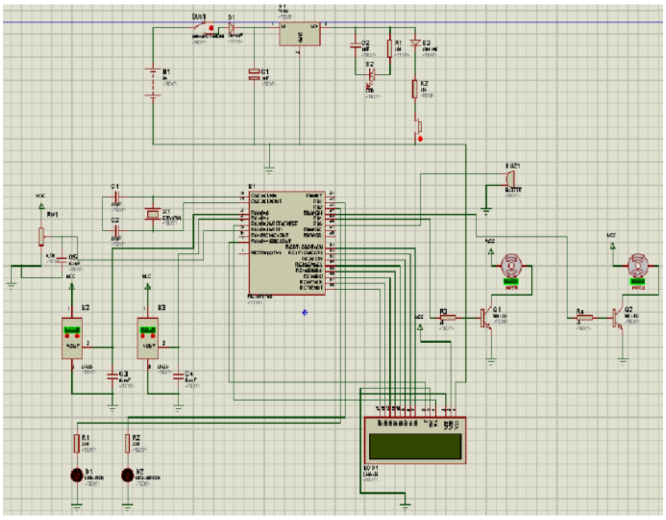

Fig 2.2. Circuit Diagram of Temperature Control System for Smart Electric Fan Using PIC

[2] Presented a study about speed control of induction motor using a universal controller. The purpose of this system is to control the speed of the induction motor using a universal controller. The operation of this circuit is controlled by using the AT89C51 microcontroller and the circuit have all capable of supplying 3 phases induction motor with a variable AC voltage.

It includes simple components which decrease the complexity of design and show its capability of controlling the speed of an induction motor. This project is good but it has some disadvantages. The disadvantage is related to when the control is set by the power supply, many problems can occur at high temperatures. This can happen when a small change in engine speed occurs causing an increase in the power of the engine resulting in an overheat in the induction motors.

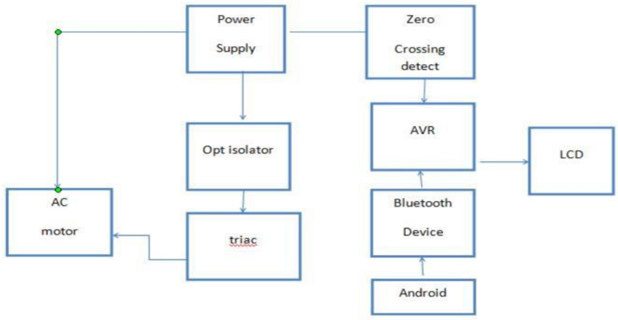

Fig 2.6. Block Diagram of the Speed Control of Induction Motor Using Universal Controller

[5] Presented a study on temperature-controlled DC fans. The study uses Internet of Things technology (IoT). The study aims to design a temperature-controlled fan utilizing analog components, as well as to determine the temperature at which the fan operates. An alarm circuit is attached to the system to indicate when the fan is on. The temperature-controlled dc fan is designed to turn off and turn on according to the temperature of the surrounding.

[7] presented a study about the speed control single-phase induction motor using android mobile, intending to control the speed direction of induction motor using android mobile by helps of Bluetooth device, which use resistance control technologies to control the speed of AC motor. It also uses the feedback network to detect the over-temperature high voltage and low voltage. The main issue with this study is that it is rigid since the Bluetooth wireless technology support only limited distance with low interfacing resistance.

[8] works on the Automatic Temperature Controlled Fan Using Thermistor for sensing the temperature It is also described how the speed of a fan can be
controlled, based on the temperature sensor which the sensor is a type of transducer. In a broader sense, a transducer is sometimes defined as any device that converts energy from one form to another.

III. SYSTEM DESIGN AND SPECIFICATION

The system design for this project is depicted in the block diagram in figure 3.1, it illustrates the stepwise connections involved in the actualization of the temperature-controlled DC fan using an ATMega328P microcontroller. The cycle starts by checking the room temperature via the temperature sensor (DS18B20). If the room temperature is high, the DC fan switches to high speed through the NPN transistor (TIP41C) which is connected to one of the pulse widths modulated pins of the ATMega328P microcontroller. Also, if the room temperature is at a medium level, the fan will switch to a medium speed and if the room temperature is low, the DC fan will switch to a low speed. The value of the room temperature is then monitored through the Liquid Crystal Display (LCD).

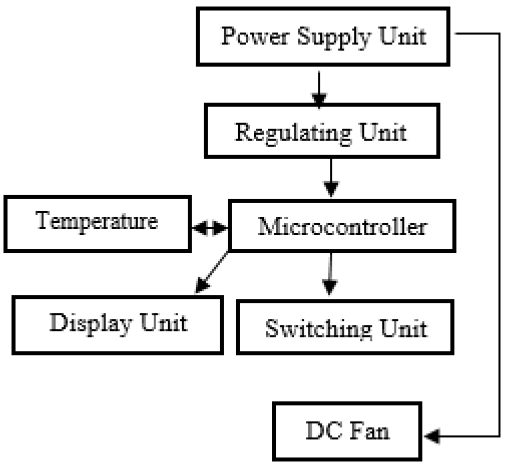

Fig 3.1. Block diagram of the System.

3.2 Hardware Requirements

3.2.1 Power Supply Unit

This unit was designed to supply DC voltage and current to the whole constructed circuit. In the construction of this power supply, a step-down transformer was used to step down the input voltage of 220V AC to 12V AC, a full-wave bridge rectifier was used for rectification of the voltage, which converts the 12V AC to 12 V DC, and the capacitor was then used to filters out the pulsating AC voltage that is not fully converted. The rectified DC is connected to the voltage regulator which regulates the voltage to the level required by the DC fan. However, this is done to prevent damage to the DC fan and other components used from excess supplied voltage.

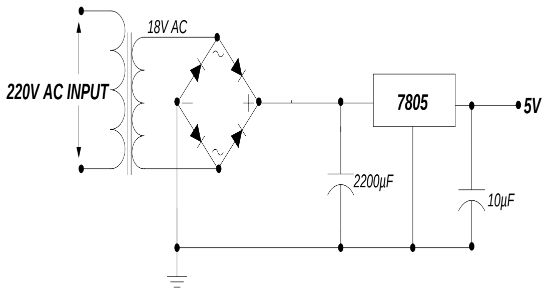

Fig 3.2. Circuit diagram of the Power Supply Unit

3.2.2 Regulating Unit (LM7805)

Voltage sources in a circuit may fluctuate, resulting in voltage outputs that are not constant. A voltage regulator IC maintains the output voltage at a constant value. 7805 Voltage Regulator, a member of the 78xx series of fixed linear voltage regulators used to maintain such fluctuations, is popular integrated circuit (IC).

The LM7805 IC converts the output voltage from the power supply to 5V which is the required voltage for the ATMega328p microcontroller. The input of the voltage regulator is connected to the output of the power supply, the ground of the voltage regulator is connected to the ground of the microcontroller, and the negative voltage of the power supply while the output of the voltage regulator is connected to the 5V pin of the ATMega328p microcontroller.

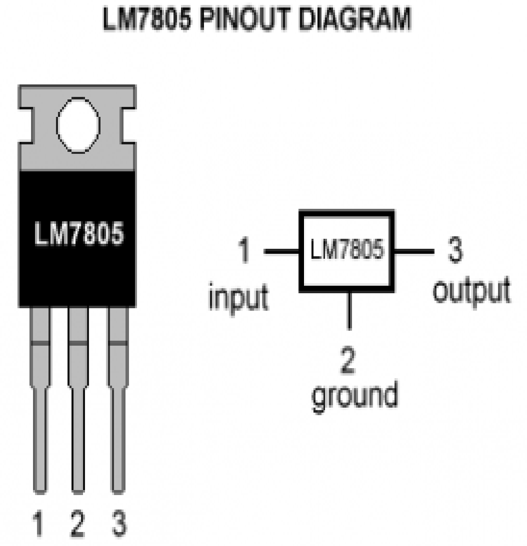

Fig 3.3. Diagram of the Voltage Regulator (LM7805)

3.2.3 Microcontroller Unit (ATMega328p)

ATmega-328 is an Advanced Virtual RISC (AVR) micro-controller. It can handle data of up to eight (8) bits. ATmega-328 has 32KB of internal built-in memory. There are a number of other features on this microcontroller. 1KB Electrically Erasable Programmable Read-Only Memory on the ATmega-328 (EEPROM). This attribute indicates that even if the microcontroller's electric source is withdrawn, it can still store data and produce results after being reconnected to the power supply. Furthermore, the ATmega-328 contains a 2KB Static Random Access Memory (SRAM) (SRAM). Other traits will be discussed at a later time. The ATmega-328 has a variety of capabilities that make it the most popular gadget on the market today. These features consist of advanced RISC architecture, good performance, low power consumption, real timer counter having a separate oscillator, 6 PWM pins, programmable Serial USART, programming lock for software security, throughput up to 20 MIPS, etc.

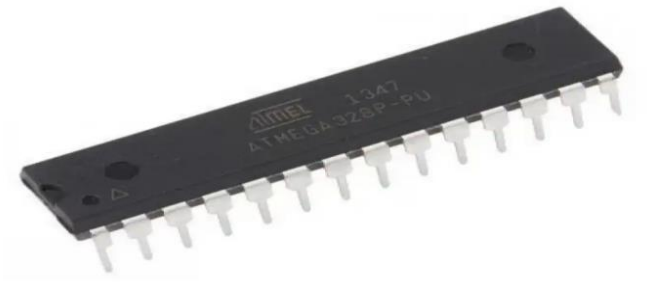

Fig 3.4: Diagram of the ATMega328p Microcontroller

3.2.4 Temperature Sensor (DS18B20)

DS18B20 is a 1-Wire interface Temperature sensor manufactured by Dallas Semiconductor Corp. The unique 1-Wire® Interface requires only one digital pin for two-way communication with a microcontroller. The sensor is normally available in two different configurations. One that comes in the TO-92 package looks exactly like an ordinary transistor. Another one is in a waterproof probe style which can be more useful when you need to measure something far away, underwater, or under the ground. The DS18B20 temperature sensor is fairly precise and needs no external components to work. It can measure temperatures from **-55°C to +125°C** with ±0.5°C Accuracy. The temperature sensor's resolution can be set to 9, 10, 11, or 12 bits by the user. However, the default resolution at power-up is 12-bit (i.e. 0.0625°C precision). The sensor requires only 1mA during active temperature conversions and can be supplied from a 3V to 5.5V power supply

The VDD is connected to the 5V out pin on the ATMega328p microcontroller and the GND is connected to the ground of the microcontroller. Next, the remaining digital signal pin DQ is connected to the digital pin 2 on the ATMega32p microcontroller**.** A 4.7k pull-up resistor is then added between the signal pin and the power pin to keep the data transfer stable.

The DS18B20 temperature sensor measures the room temperature and sends it to the BC547 transistor to regulate the DC fan speed through the microcontroller.

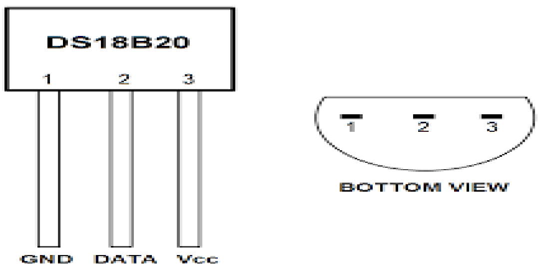

Fig 3.5: Diagram of the Temperature Sensor (DS18B20)

3.2.5 *Switching Unit (TIP41C)*

TIP41C is an NPN Bipolar Junction Transistor. And like all other transistors, it has three pins called the emitter, collector, and base respectively. TIP41C transistor acts as a switch between the collector and emitter. This switch closes when enough current is applied to the transistor's base, and current flows from the collector to the emitter. As a result, a small current applied to the transistor's base pin transfers the huge current between the collector and emitter.

The base of the transistor is connected to one of the pulse width modulated (PWM) digital pins of the microcontroller through a 10k biasing resistor, the collector is connected to the load (DC fan) and a diode which are then tied to the power supply while the collector is connected to the base through a 1micro-farad capacitor and also connected to the ground.

The TIP41C transistor receives an input signal from the microcontroller and regulates the speed of the DC fan according to the received signal.

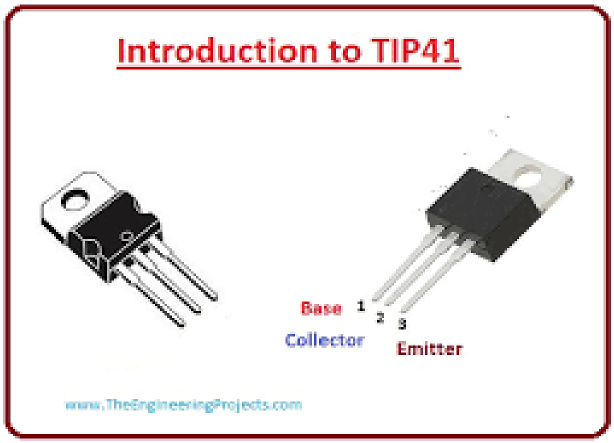

Fig 3.6. Diagram of the Transistor (TIP41)

3.2.6 Display Unit (16x2 LCD)

The term LCD stands for liquid crystal display. It's a form of electronic display module that's found in a variety of circuits and devices, including phones, calculators, computers, and television sets. The most typical uses for these displays are multi-segment light-emitting diodes and seven segments. The major advantages of utilizing this module are its low cost, ease of programming, animations, and the fact that there are no restrictions on displaying unique characters, special and even animations, and so on.

The 16×2 LCD display is a very basic module commonly used in most circuits. The 16×2 translates to a display of 16 characters per line in 2 such lines. On this LCD, each character is displayed in a 5x7 pixel matrix. The LCD as regards this project is used to output the value of the room temperature measured by the DS18B20 temperature sensor.

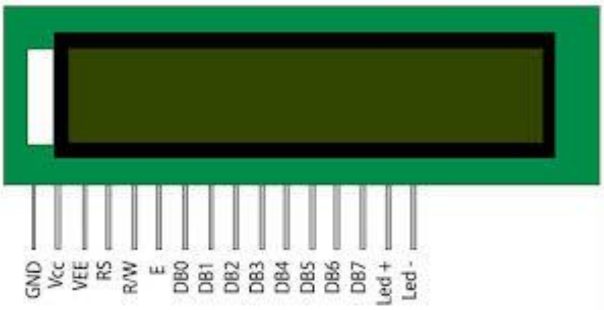

Fig 3.7: Diagram of the 16x2 LCD

4.0 SOFTWARE IMPLEMENTATION

After designing, assembling, and testing the circuit, we concluded that the circuit of the proposed automatic temperature-based fan speed controller is Working satisfactorily. The microcontroller was programmed in C and C# language according to the designed features and is loaded to the microcontroller in accordance with the specified features. The PWM signal is used to control the speed of the DC motor, which necessitates adjusting the pulse width. The system was designed with temperature sensor configuration in mind. The temperature sensor detects the temperature of a room and sends a signal to the microcontroller. If the room temperature is high, the fan speed will increase, if the room temperature is low, the fan speed will decrease.

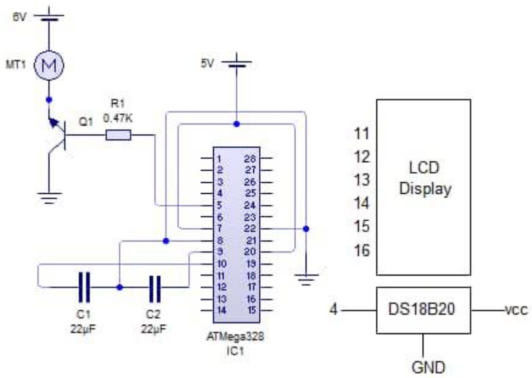

Fig 4.1. Overall Circuit Diagram of a Temperature Controlled DC Fan Using Microcontroller.

4.0 RESULT AND DISCUSSION

The power supply of the DC fan is used to power the DC Fan and also to charge the battery of the microcontroller. The DC battery was used to power the operation of the temperature-controlled DC fan, this is so that the power will not destroy the microcontroller.

Once the power is on, the temperature sensor senses the temperature of the room and sends it to the microcontroller, the Liquid Crystal Display connected to the microcontroller reads the temperature measured by the temperature sensor's value. The Transistor connected to the microcontroller switches the speed of the fan to its corresponding temperature range. It switches to either high, medium, or low depending on the temperature of the room.

As the room temperature increases in the room, the speed of the fan increases, that is, the speed 5 displayed on the Liquid Crystal Display denotes that the room temperature is cold, while the speed 1 (one) on the Liquid Crystal Display denotes that the room temperature is hot, therefore, the higher the temperature, the lower the speed reading on the fan.

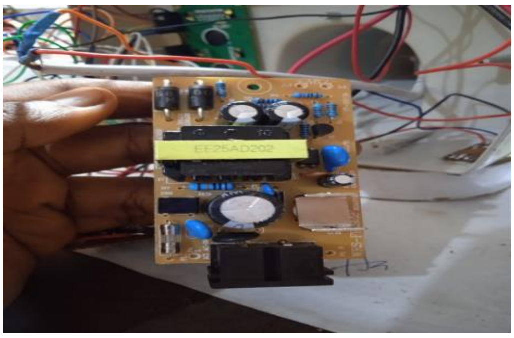

Fig 4.1 Rectifying Circuit of DC Fan

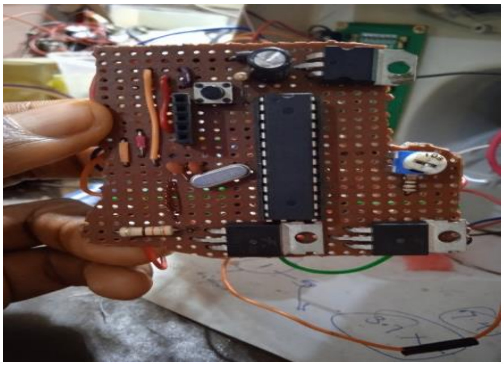

Fig 4.2 Microcontroller Circuit.

Fig. 4.3. Temperature Controlled DC Fan

CONCLUSIONS

The purpose of this work was to create a circuit that would automatically alter the speed of a fan in response to changes in ambient temperature. The circuit was built using a Vero board, and all of the other components were joined. It was put to the test as a DC fan. The results of the test revealed that our fan performed admirably at the specified speed.

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