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AIR TEMPERATURE CONTROLLED MULTIFUNCTIONAL AUTOMATIC SWITCHING TECHNIQUE BY ELECTRONIC CONTROL SYSTEMS USING ATMEGA328P MICROCONTROLLER

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Abstract

The microcontroller based temperature controlled fan controls the temperature of any device according to its requirement for any industrial and home application. At the heart of the circuit is the ATMega328P microcontroller which controls all its functions. A temperature sensor LM35 is used for sensing the temperature of the environment and the system displays the temperature on an LCD in the range of –55°C to +150°C. This temperature is compared with the value stored by the user and if the temperature goes beyond the preset temperature then fan will switch on and if temperature goes below to preset value then fan will switch off.

Keywords: LCD, Transistor, Resistors, Brushless DC Motor, ATMega328P, LM 35.

I. Introduction

Temperature is one of the main parameter to control in most of the manufacturing industries like chemical, food processing, pharmaceutical etc. In these kinds of industries some product need the required temperature to be maintained at highest priority the product will fail. So the temperature controlled fan is most widely used in almost all the industries [1]. This project is microcontroller based temperature controlled fan. It has a sensor unit which senses the room temperature and converts room temperature into an equivalent voltage. This voltage is then feed to microcontroller input. If it exceeds the set value the fan is turned on. After then when temperature falls below the specified limit again fan is turned off. The goal of this project is to design an ambient temperature measurement and control circuit. The motivation for the project is the fact that temperature measurement has become an integral part of any control system operating in a temperature sensitive environment and the various learning outcomes associated during the implementation of the project. It is basically a close loop control system. There are two types: ON-OFF type or continuous type system [2]. ON-OFF type- Temperature is sensed displayed and it is compared with set value. If it is greater, then it switches on the fan and if it is less, then switches off the fan. Continuous type- Temperature is sensed displayed and it is compared with set value. The actual temperature is sensed by the temperature sensor. It is displayed on LCD with the set value. This project also applicable at home [3].

II. Hardware Description

2.1 Hardware Requirements

- Power supply
- LM 35 temperature sensor
- Microcontroller (ATMega328P)
- LCD (16x2)
- Transistor
- Resistors
- Brushless DC Motor

2.2 Power Supply

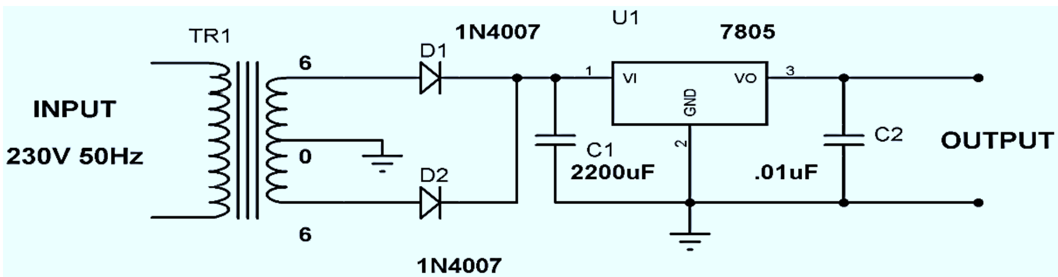


Figure-1: Block diagram of Regulated Supply

2.3 LM35 Temperature Sensor

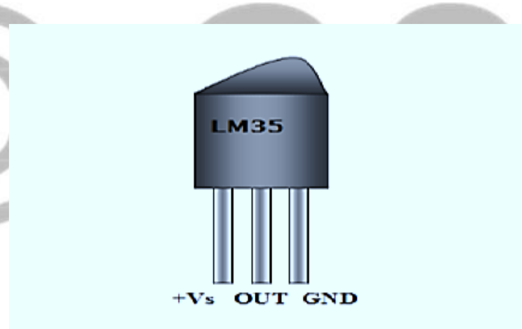


Figure-2: LM35 Pin Configuration

The +Vs can be from 4V to 20V as specified by the pin configuration. To use the sensor Vcc was connected to +5V, GND to ground and the OUT to one of the ADC (analog to digital converter channel). The output varies linearly with temperature. The output is 10 mill volts per degree centigrade [4].

2.4 ATMega328P

ATMega328P is an 8-bit high performance microcontroller. It is a less power consuming evince. The Atmel's AT-mega series of microcontrollers are very popular due to the large number of peripherals built in them. They have features such as 10-bit A/D converters, UART/USART, and much more and due to that reason they become useful for a large number of applications and external hardware is reduced as these are built-in [5].

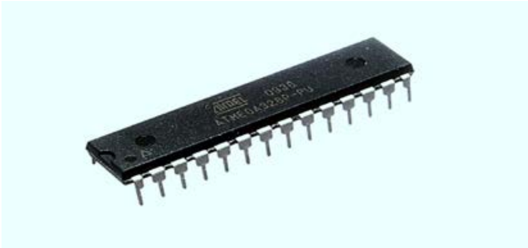


Figure-3: ATmega328P

2.5 Liquid Crystal Display (LCD)

LCD (Liquid Crystal Display) is an electronic display system [5]. A 16x2 LCD display is a very basic system and commonly used in various devices and circuits. LCD's are preferred over seven segments and other multi segment LEDs.

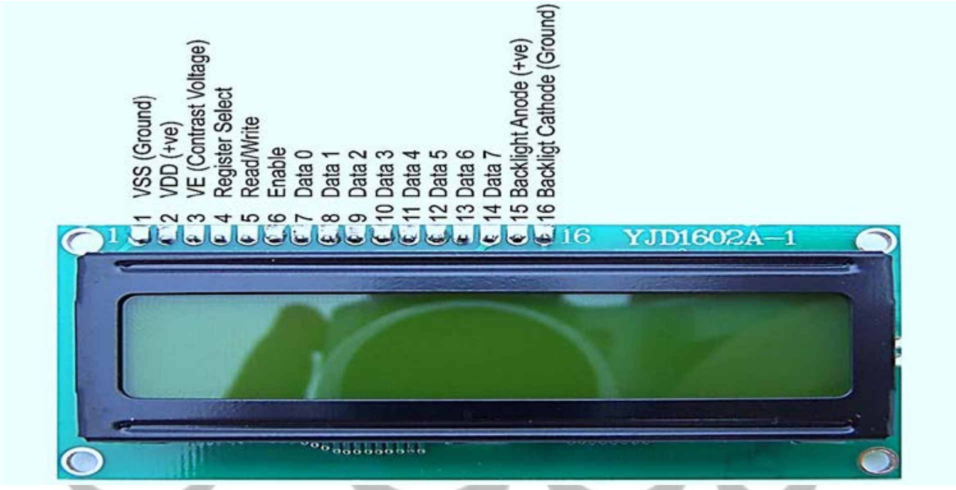


Figure-4: 2×16 LCD Display

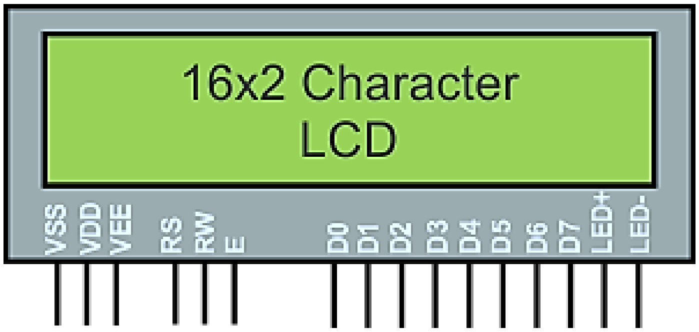


Figure-5: LCD Pin Diagram

2.6 Transistor (BC 547)

2.6.1 Technical Specifications

The BC547 transistor is an NPN Transistor. The BC547 transistor is a general-purpose transistor. It is used in general-purpose switching and amplification.

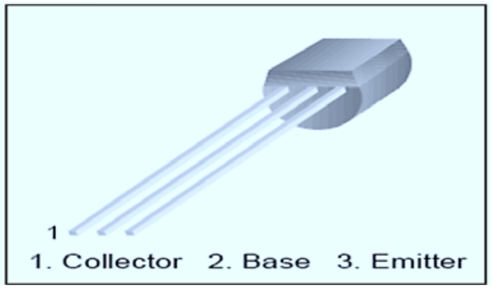


Figure-6: BC 547 Transistor Pin Configuration

2.6.2 Brief Description of Transistor Acting as Switch

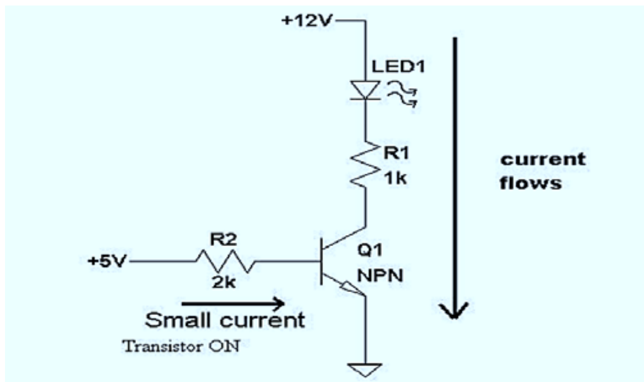


Figure-7: Transistor as a switch

2.7 Crystal Oscillator (16 MHz)

A crystal oscillator is an electronic oscillator circuit that uses the mechanical response of a vibrating crystal of piezoelectric material to create an electrical signal with a precise frequency. This frequency is commonly used to keep track of time, as to provide a stable clock signal for digital integrated circuits, and to stabilize frequencies for radio transmitters and receivers. The most common type of piezoelectric resonator used is the quartz crystal, so oscillator circuits incorporating them became known as crystal oscillators but other piezoelectric materials including polycrystalline ceramics are used in similar circuits [6]. Most are used for consumer devices such as wristwatches, clocks, radios, computers and cell phones etc. Quartz crystals are also found inside test and measurement equipment, such as counters, signal generators and oscilloscopes.

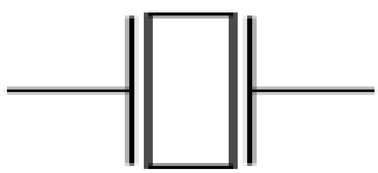
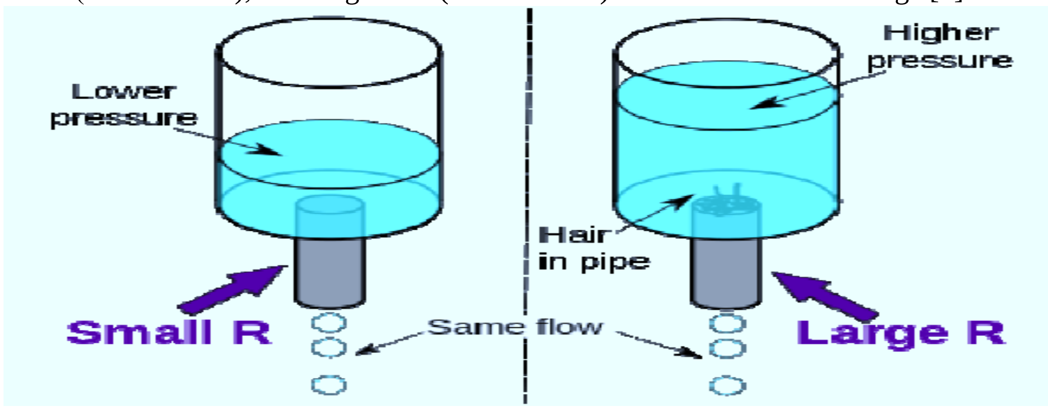


Figure-8: Electronic Symbols and Picture

2.8 Resistor

The behavior of an ideal resistor is dictated by the relationship specified by Ohm's law: V = I.R. Ohm's law states that the voltage (V) across a resistor is proportional to the current (I), where the constant of proportionality is the resistance (R). For example, if a 300 ohm resistor is attached across the terminals of a 12 volt battery, then a current of 12 / 300 = 0.04 amperes flows through that resistor. Practical resistors also have some inductance and capacitance which will also affect the relation between voltage and current in alternating current circuits. The ohm (symbol: Ω) is the SI unit of electrical resistance, named after Georg Simon Ohm. An ohm is equivalent to a volt per ampere. Since resistors are specified and manufactured over a very large range of values, the derived units of milliohm ($1m\Omega=10^{-3}\Omega$), kilo ohm ($1\ k\Omega = 10^{3}\Omega$), and mega ohm ($1\ m\Omega = 10^{6}\Omega$) are also in common usage [6].



2.9 Brushless DC Motor

A brushless DC motor is essentially a dc motor without the mechanical commutation of the brushed dc motor. BLDC motors are powered by direct current and have electronic commutation systems instead of the mechanical brushes and commentators used in brushed dc motors [6].

Figure-9: Brushless DC Motor

Figure-10: Laminated Steel Stampings - Stator

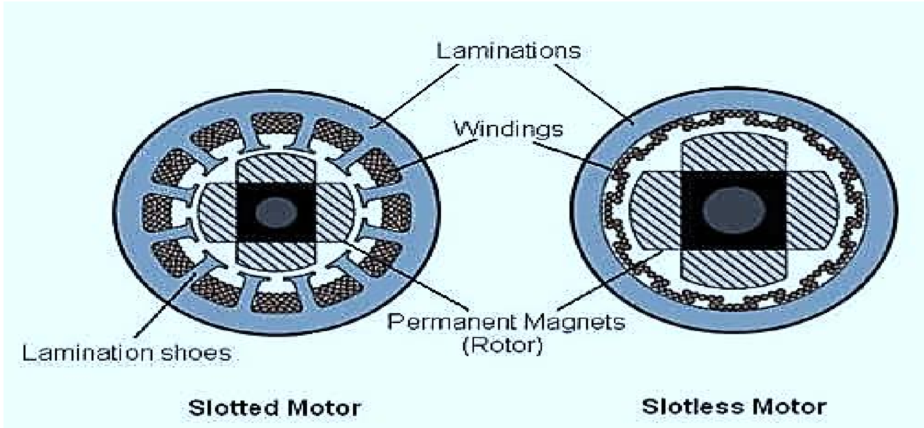


Figure-11: Slotted and Slotless Motor

Proper selection of the laminated steel and windings for the construction of stator are crucial to motor performance. An improper selection may lead to multiple problems during production, resulting in market delays and increased design costs [7].

2.9.1 Rotor

The rotor of a typical BLDC motor is made out of permanent magnets. Depending upon the application requirements, the number of poles in the rotor may vary.

Figure-12: Permanent Magnet Rotor

2.9.2 Working Principles and Operation

The underlying principles for the working of a BLDC motor are the same as for a brushed DC motor; i.e., internal shaft position feedback. In case of a brushed DC motor, feedback is implemented using a mechanical commutator and brushes. With an in BLDC motor, it is achieved using multiple feedback sensors. The most commonly used sensors are hall sensors and optical encoders. In figure (A), the Green winding labeled “001” is energized as the North Pole and the Blue winding labeled as “010” is energized as the South Pole. Because of this excitation, the South Pole of the rotor aligns with the Green winding and the North Pole aligns with the Red winding labeled “100”. In order to move the rotor, the “Red” and “Blue” windings are energized in the direction shown in figure (B). This causes the Red winding to become the North Pole and the Blue winding to become the South Pole [7, 8]. This shifting of the magnetic field in the stator produces torque because of the development of repulsion (Red winding – North-North alignment) and attraction forces (Blue winding – North-South alignment), which moves the rotor in the clockwise direction.

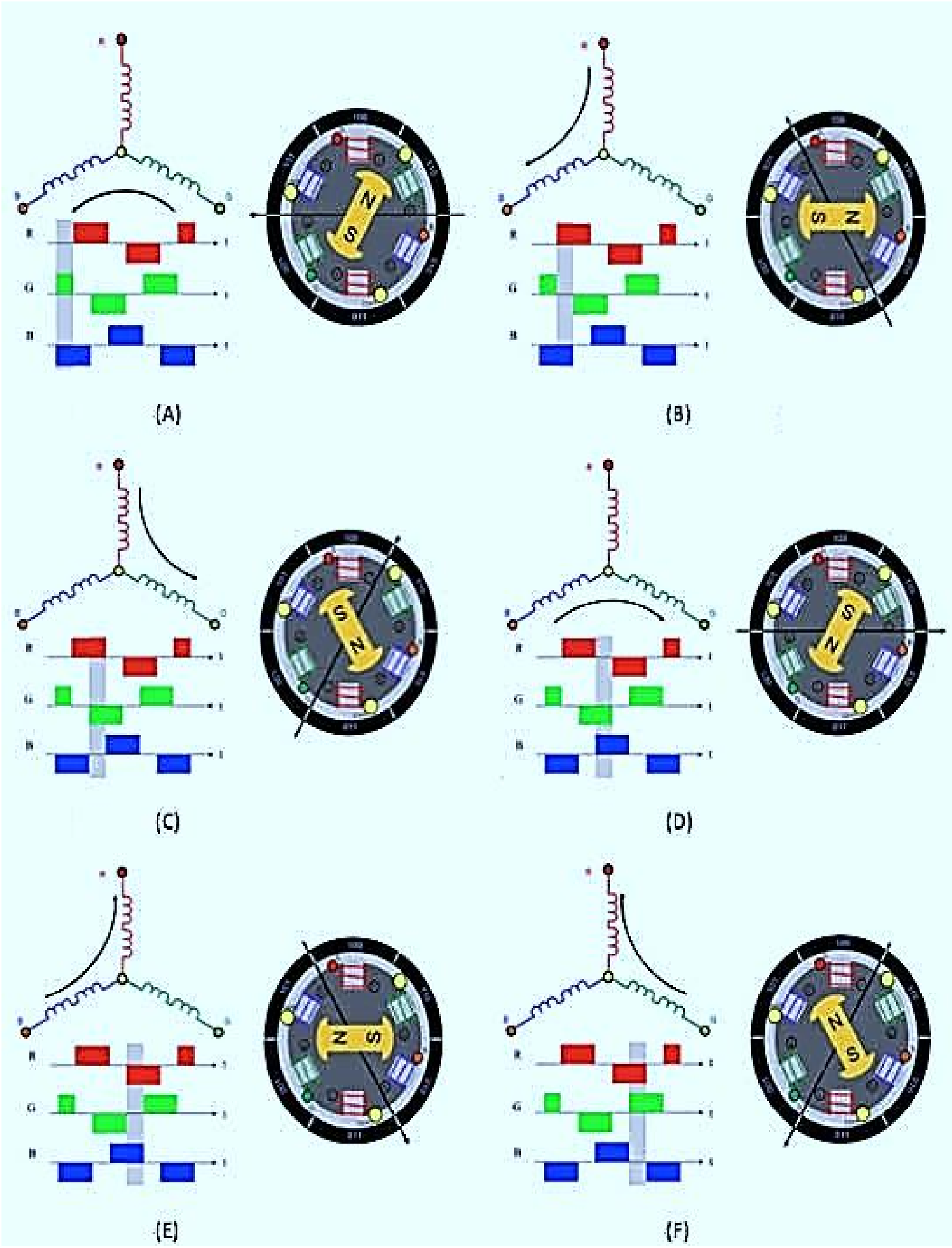


Figure-13: Winding

III. Methodology

The following software's were used for programming and feeding in ATMega328P microcontroller.

- Arduino-1.6.6-windows: Arduino-1.6.6-windows are the development platform. It is required to write the code and to compile the program.
- Sinaprog 2.0: It is used to burn the program and hex file is dumped into the microcontroller.

3.1 Burning the Code using Sinaprog Software

The hex file is generated with same name as program using Arduino-1.6.6. This program is transferred to flash memory of microcontroller. An USB ISB programmer can be used to burn the program. Through the sinaprog software the program is burnt into microcontroller [9]. The burner uses SPF port of microcontroller to load the program.

Steps:
- Hex file is generated.
- Connect the ATmega328p development board and PC through burner.
- Open sinaprog and select ATmega328p.
- Load the program and burn through sinaprog.
- Output is shown.

3.2 System Designing and Implementation

3.2.1 Hardware Block Diagram

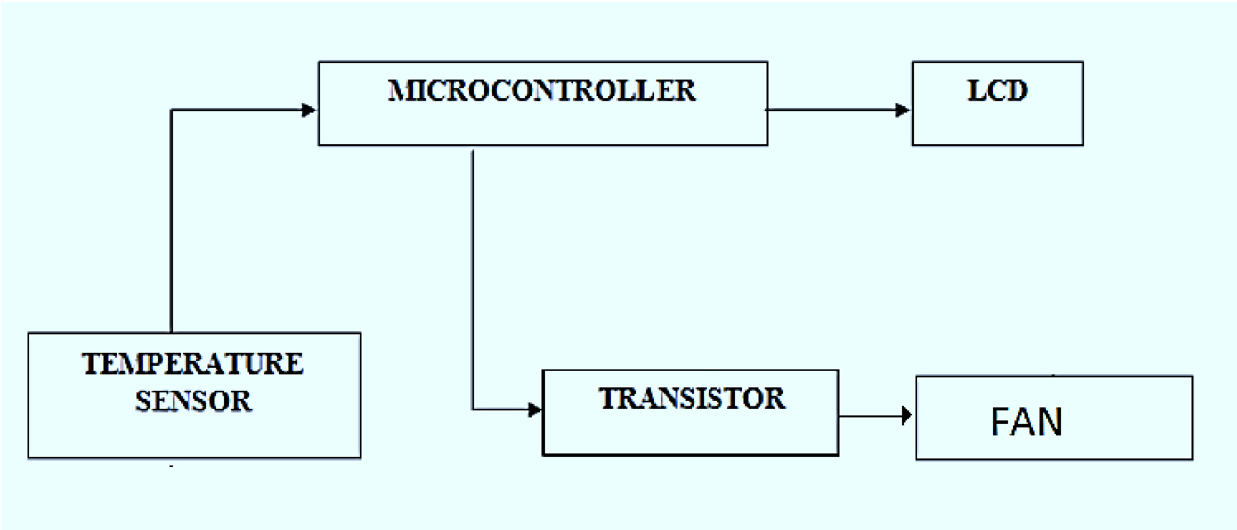


Figure-14: Hardware Block Diagram

3.3.2 Implementation

The pin 1 of LM35 temperature sensor was connected to the positive 5 volt supply and pin 3 was connected to the ground. The pin 2 or vout pin of LM35 temperature sensor was connected to one of the ADC input pin of Tmega328P microcontroller. The LM35 temperature sensor sense the temperature and output to the vout pin almost 1 millivolt per degree Celsius temperature. ADC was activated for interfacing the temperature sensor and a program ways written so that whatever temperature the sensor senses it can be displayed on LCD screen. ATmega328p microcontroller has 10 bit analog to digital converter (ADC) which converts the LM35 output analog voltage into digital which is displayed on LCD screen [10-11]. LCD was set up for 4 bit mode to display current temperature. A transistor was interfaced to pin 13 of the ATmega328p. Transistor was acting as a switch to turn ON/OFF the motor. A brushless dc motor was interfaced with the microcontroller with the help of transistor. When pin 13 is logically high then transistor will be turn on and the motor start rotating. Code was written such that the microcontroller can switch ON/OFF motor with respect to set temperature [14].

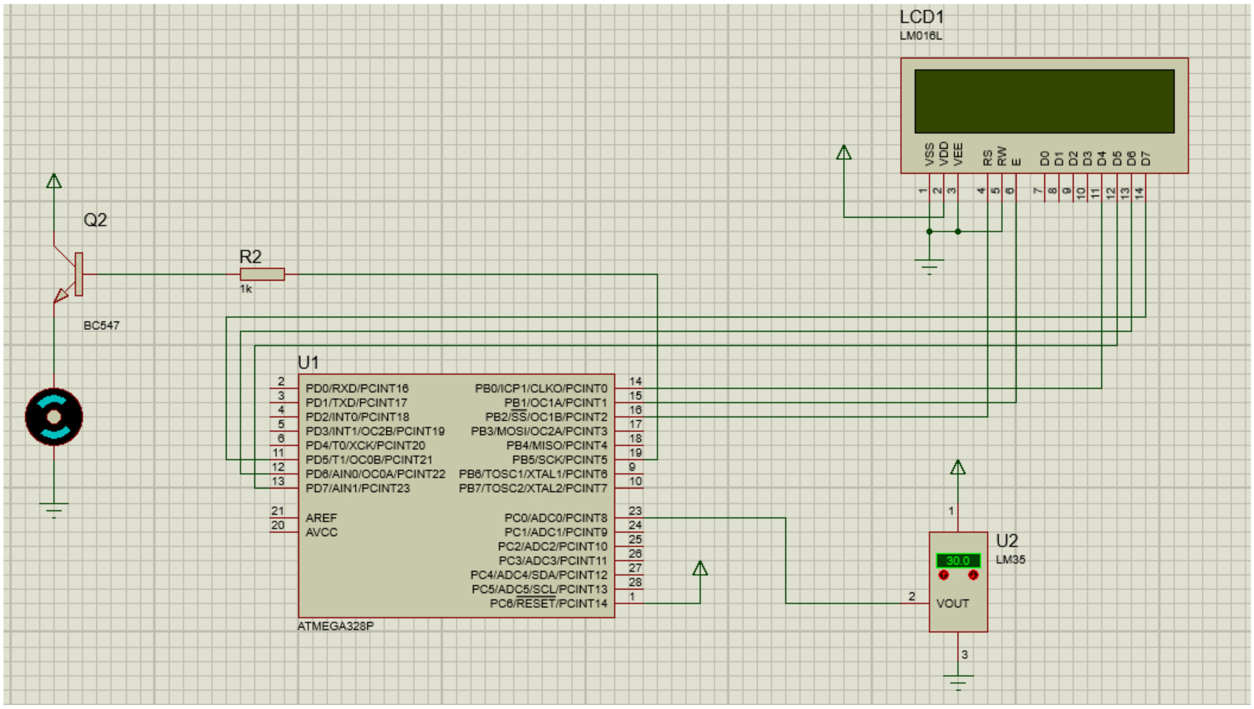


Figure-15: Schematic Diagram

IV. Results and Discussion

The project uses a precision centigrade temperature sensor LM35 which is capable of sensing the temperature. It gives the output in millivolts. This output is converted into corresponding digital data using inbuilt ADC of the ATmega328P microcontroller. LCD is interfaced with the microcontroller and the value of the actual temperature is displayed on the LCD. The LCD displays the present temperature. The temperature display in LCD in Celsius during two seconds and then in Fahrenheit during next two seconds and so on. The set value can be increased through switches attached to the microcontroller [12-13]. If the temperature crosses the maximum value the fan is switched on as indicated by cooling fan using a brushless dc motor connected through a transistor by the microcontroller. If the temperature goes below the set value the fan is off.

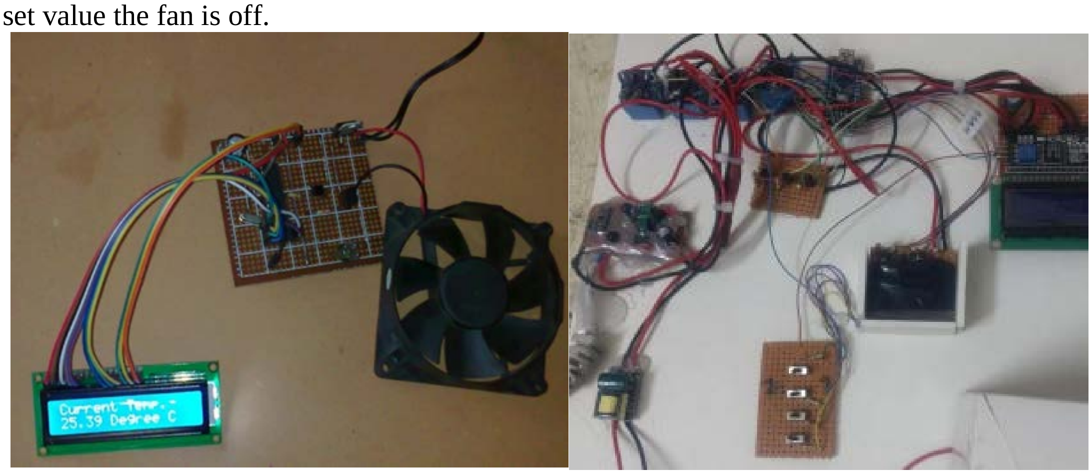


Figure-16: Setup of the project

V. Conclusions

There are three sections of this project such as temperature sensor section, control unit and motor driving section. I have assembled all the parts me self. I also had to learn ATMEL microcontroller programming language to complete software part by using Arduino-1.6.6-windows. Microcontroller based temperature controlled fan is a simple and useful circuit which can be used to control the temperature above a set value using LM35 temperature sensor. Initially, circuit was selected and components where purchased and the circuit was verified in bread board. Then we designed the PCB and the circuit was soldered onto the PCB. The actual temperature and set value of temperature were getting displayed on the LCD screen and the set temperature was found changing with the help of preset buttons. Output was verified by setting the temperature at different levels and it was found that the fan turn on and off when the device crosses the set value. The program written for this project is the result of my hard work. To complete my desired program I had to conduct many experiences. To rotate the brushless motor I had to conduct a lot of experiment. This is an interesting project. I have designed an ATMEL microcontroller based temperature controlled fan. Its temperature controlled can further be increased by proper redesign of both hardware and software.

VI. Future Scope and Enhancements

Microcontroller based temperature controlled fan is a simple whereas a useful circuit with which the temperature can be controlled with the aid of a LM 35 temperature sensor. As explained the circuit can be made useful in practical area where the circuit can be connected to a device whose temperature has to be controlled at a particular limit. Also this project can be used at home to control room temperature by turn on/off fan. In future the circuit can be enhanced by connecting a GSM Module to the circuit so that in industrial area when a machine crosses the set temperature, we can inform the control room by sending a message, or else a call to control room manager so that damages to the machine can be avoided by disconnecting the equipment with GSM technology.

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