DEPARTMENT OF ELECTRICAL ENGINEERING

SECOND YEAR MINI PROJECT (EE2291)

TEMPERATURE BASED AUTOMATIC FAN SPEED CONTROL

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CONTENT

ABSTRACT

This project is an automatic fan speed controller that controls the speed of an electric fan according to the room temperature. Use of embedded technology makes this closed loop feedback control system efficient and reliable. Liquid crystal display (LCD) makes the system user-friendly. The sensed temperature and fan speed level values are simultaneously displayed on the LCD panel. It is very compact using few components and can be implemented for several applications including air-conditioners, water-heaters, snow-melting, ovens, heat-exchangers, mixers, furnaces, incubators, thermal baths and veterinary operating tables. Micro controller is the brain of the circuit as it controls all the functions. The temperature sensor (LM35) senses the temperature and converts it into an electrical (analog) signal, which is applied to the microcontroller. The sensed and set values of the temperature are displayed on the 16x2-line LCD. The micro controller drives Transistor to control the fan speed. This project uses regulated 12V, 2A power supply. This project is useful in process industries for maintenance and controlling of Boilers Temperature.

INTRODUCTION

With the advancement in technology, intelligent systems are introduced every day. Everything is getting more sophisticated and intelligible. Microcontrollers play a very important role in the development of the smart systems as brain is given to the system. Microcontrollers have become the heart of the new technologies that are being introduced daily.

A microcontroller is mainly a single chip microprocessor suited for control and automation of machines and processes. Today, microcontrollers are used in many aspects of life for carrying out automated tasks with higher accuracy. Almost every modern-day device including air conditioners, power tools, toys, office machines employ microcontrollers for their operation. Microcontroller essentially consists of Central Processing Unit (CPU), timers and counters, interrupts, memory, input/output ports, analog to digital converters (ADC) on a single chip. This microcontroller has code written in it according to the job required. With this single chip integrated circuit design of the microcontroller the size of control board is reduced and power consumption is low.

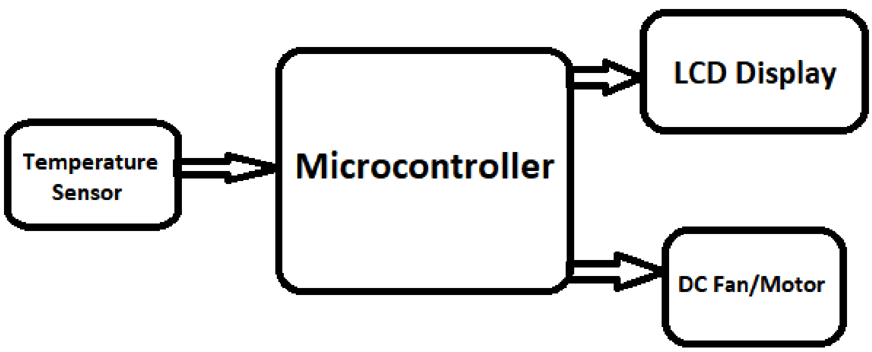
This project presents the design and simulation of the fan speed control system using Pulse Width Modulation (PWM) technique based on the room temperature. A temperature sensor has been used to measure the temperature of the room and the speed of the fan is varied according to the room temperature using PWM technique. The duty cycle is varied from 0 to 100 to control the fan speed depending upon the room temperature, which is displayed on LCD.

DESCRIPTION

The temperature-based fan speed control system can be done by using an electric circuit using a microcontroller. Here we have used Arduino board for the purpose. The proposed system is designed to detect the temperature of the room and send that information to the Arduino board. Then the Arduino board executes the contrast of current temperature and set temperature based on the inbuilt program of the Arduino.

The outcome obtained from the operation is given through the output port of an Arduino board to the LCD display of related data. The generated pulses from the board which is further fed to the driver circuit to get the preferred output to the fan.

BLOCK DIAGRAM



CIRCUIT COMPONENTS

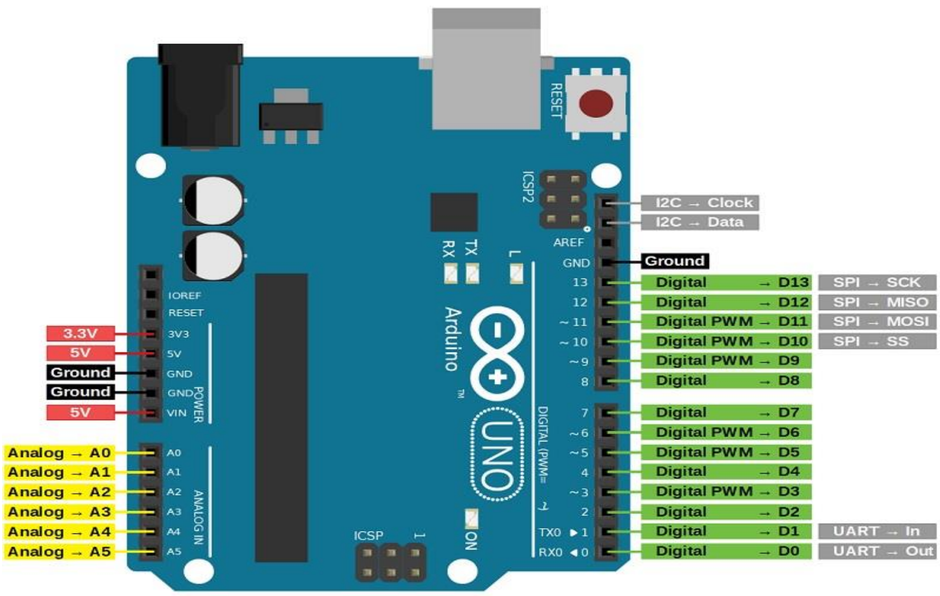
• Arduino Uno(R3):

Arduino Uno is an ATmega328P based microcontroller board. It comprises 14 digital I/O pins of which 6 pins can be utilized as PWM outputs, 6 analog inputs, a power jack, a USB connection, a 16 MHz ceramic resonator, an ICSP header, and a reset (RST) button. By a USB cable or by an external 9-volt battery, it can be powered. The voltage range that it accepts is between 7 and 20 volts.

Arduino Uno R3 Specifications

The **Arduino Uno R3 board** has the following features: -

- It is a microcontroller board based on the ATmega328P
- The operating voltage of the Arduino is 5V
- The preferred input voltage is in the range of 7V to 12V
- The input/output voltage limit is 6V to 20V
- Digital input & output pins are 14
- Digital input/output pins (PWM) are 6
- Analog input & output pins are 6
- DC Current used for each input/output Pin is 20 mA
- DC Current for 3.3V Pin is 50 mA
- Flash Memory -32 KB and 0.5 KB memory is used by the boot loader
- SRAM is 2 KB
- EEPROM is 1 KB
- CLK has a speed of 16 MHz
- It has an inbuilt LED
- The length and width of the Arduino are 68.6 mm and 53.4 mm respectively
- Arduino board's weight is 25 g



Pin Functions

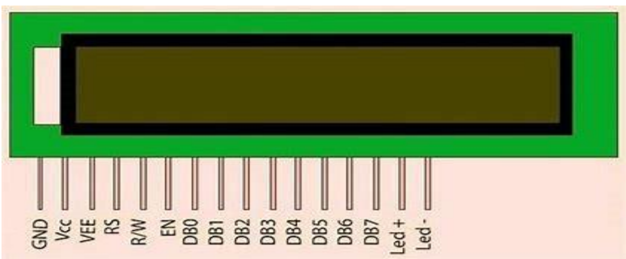
- **Power:**
  - **LED:** There is a built-in LED driven by digital pin 13. When the pin is high value, the LED is on, when the pin is low, it is off.
  - **VIN:** The input voltage to the Arduino board when it is using an external power source (as opposed to 5 volts from the USB connection or other regulated power source). We can supply voltage through this pin, or, if supplying voltage via the power jack, access it through this pin.
  - **5V:** This pin outputs a regulated 5V from the regulator on the board. The board can be supplied with power either from the DC power jack (7 - 20V), the USB connector (5V), or the VIN pin of the board (7-20V). Supplying voltage via the 5V or 3.3V pins bypasses the regulator, and can damage the board.
  - **3V3:** A 3.3-volt supply generated by the on-board regulator. The maximum current draw is 50 mA.
  - **GND:** Ground pins.
- **Analog Pins:** A0 – A5. These pins are used to provide analog input in the range of 0-5V.
- **Input/Output Pins:** Digital Pins 0- 13. These pins can be used as an input or output pins.
- **IOREF:** This pin on the Arduino board provides the voltage reference with which the microcontroller operates. A properly configured shield can read the IOREF pin voltage and select the appropriate power source, or enable voltage translators on the outputs to work with the 5V or 3.3V.
- **Reset (RST):** Typically used to add a reset button to shields that block the one on the board.
- **Serial/UART:** pins 0 (RX) and 1 (TX). Used to receive (RX) and transmit (TX) TTL serial data. These pins are connected to the corresponding pins of the ATmega8U2 USB-to-TTL serial chip.
- **External interrupts:** pins 2 and 3. These pins can be configured to trigger an interrupt on a low value, a rising or falling edge, or a change in value.
- **PWM** (pulse-width modulation): pins 3, 5, 6, 9, 10, and 11. Can provide 8-bit PWM output with the analogWrite() function.
- **SPI** (Serial Peripheral Interface): pins 10 (SS), 11 (MOSI), 12 (MISO), and 13 (SCK). These pins support SPI communication using the SPI library.
- **TWI** (two-wire interface): pin SDA (A4) and pin SCL (A5). Support TWI communication using the Wire library.
- **AREF:** Reference voltage for the analog inputs.

- ## **Liquid Crystal Display (LCD):**

The **LCD** is a dot-matrix liquid crystal display that displays alphanumeric characters and symbols. 16X2 LCD digital display has been used in the system to show the room temperature. Liquid Crystal Display screen is an electronic display module and has a wide range of applications. A 16x2 LCD display is a very basic module, which is very commonly used in various devices and circuits. These modules are preferred over seven segments and other multi segment LEDs. The reasons for this: LCDs are economical; easily programmable; have no limitation of displaying special & even custom characters (unlike in seven segments), animations, and so on. A 16x2 LCD means it can display 16 characters per line and there are 2 such lines. In this LCD each character is displayed in a 5x7 pixel matrix. This LCD has two registers, namely, Command and Data. The command register stores the command instructions given to the LCD. A command is an instruction given to the LCD to do a predefined task like initializing it, clearing its screen, setting the cursor position, controlling the display, etc. The data register stores the data to be displayed on the LCD. The data is the ASCII value of the character to be displayed on the LCD.

- **16×2 LCD Specifications**
  - Operating Voltage is 4.7V to 5.3V
  - Consumption of current is 1mA without backlight
  - Alphanumeric LCD display module, meaning can display both alphabets and numbers
  - Consists of two rows and each row can print 16 characters.
  - Each character is built by a 5×8-pixel box
  - Can work on both 8-bit and 4-bit mode
  - It can also display any custom generated characters
  - Available in both Green and Blue Backlight

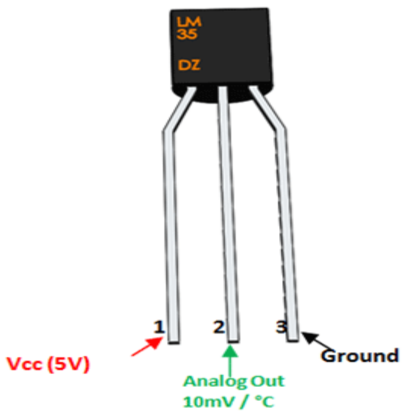
- **Pin description:**



Pin No.	Function	Name
1	Ground (0V)	Ground
2	Supply voltage; 5V (4.7V – 5.3V)	Vcc
3	Contrast adjustment; through a variable resistor	VEE
4	Selects command register when low; and data register when high	Register Select
5	Low to write to the register; High to read from the register	Read/Write
6	Sends data to data pins when a high to low pulse is given	Enable
7	Data pin 0 to 7 forms a 8-bit data line. They can be connected to microcontroller to send 8-bit data. These LCD's can also operate on 4-bit mode in such case Data pin 4,5,6 and 7 will be left free.	DB0
8		DB1
9		DB2
10		DB3
11		DB4
12		DB5
13		DB6
14		DB7
15	Backlight VCC (5V)	Led+
16	Backlight Ground (0V)	Led-

- **LM35 Temperature sensor:**

LM35 is a temperature sensor that outputs an analog signal which is proportional to the instantaneous temperature. The output voltage can easily be interpreted to obtain a temperature reading in Celsius. The advantage of LM35 over thermistor is it does not require any external calibration. The coating also protects it from self-heating. LM35 can measure from -55 degrees centigrade to 150-degree centigrade. The accuracy level is very high if operated at optimal temperature and humidity levels. The conversion of the output voltage to centigrade is also easy and straight forward. The input voltage to LM35 can be from +4 volts to 30 volts. It consumes about 60 microamperes of current.



- **LM35 Temperature sensor specifications**

➢ Minimum and Maximum Input Voltage is 35V and -2V respectively. Typically, 5V.

➢ Can measure temperature ranging from -55°C to 150°C

➢ Output voltage is directly proportional (Linear) to temperature (i.e.) there will be a rise of 10mV (0.01V) for every 1°C rise in temperature.

➢ ±0.5°C Accuracy

➢ Drain current is less than 60uA

➢ Low-cost temperature sensor

➢ Small and hence suitable for remote applications

➢ Low impedance output, 0.1 ohm for 1mA load

- **Pin description**

Pin Number	Pin Name	Description
1	Vcc	Input voltage is +5V for typical applications
2	Analog Out	There will be increase in 10mV for raise of every 1°C. Can range from -1V(-55°C) to 6V(150°C)
3	Ground	Connected to ground of circuit

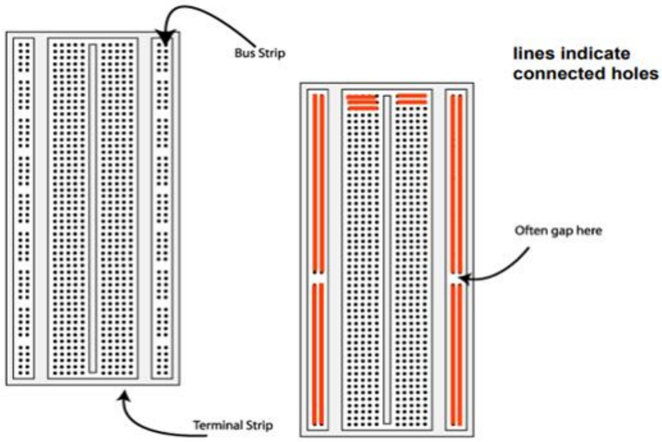
• Breadboard:

It is a simple tool which is used to easily connect electrical components and wires together. Components and wires are attached to the breadboard by simply pressing into the holes of the breadboard. It is used for creating temporary prototypes and experimenting with circuit design.

- **Description**

The **Breadboard** consists of two terminal strips and two bus strips (often broken in the center). Each bus strip has two rows of contacts. Each of the two rows of contacts are a node. That is, each contact along a row on a bus strip is connected together (inside the breadboard). Bus strips are used primarily for power supply connections, but are also used for any node requiring a large number of connections. Each terminal strip has 60 rows and 5 columns of contacts on each side of the center gap. Each row of 5 contacts is a node.

A bus strip usually contains two columns: one for ground and one for a supply voltage Typically the row intended for a supply voltage is marked in red, while the row for ground is marked in blue or black.



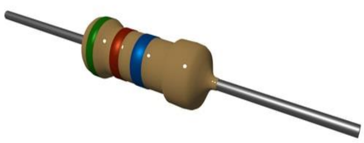
- **Typical specifications**

A modern solderless breadboard socket consists of a perforated block of plastic with numerous tin-plated phosphor bronze or nickel silver alloy spring clips under the perforations. The spacing between the clips (lead pitch) is typically 0.1 inches (2.54 mm). Integrated circuits (ICs) in dual in-line packages (DIPs) can be inserted to straddle the centerline of the block. Interconnecting wires and the leads of discrete components (such as capacitors, resistors, and inductors) can be inserted into the remaining free holes to complete the circuit. Where ICs are not used, discrete components and connecting wires may use any of the holes. Typically, the spring clips are rated for 1 ampere at 5 volts and 0.333 amperes at 15 volts (5 watts). The edge of the board has male and female dovetail notches so boards can be clipped together to form a large breadboard.

- **Limitations:**
  - It cannot handle frequencies greater than 10MHz.
  - Spacing between clips is usually 0.1 inches(2.54mm)
  - It has current limit of 1A.

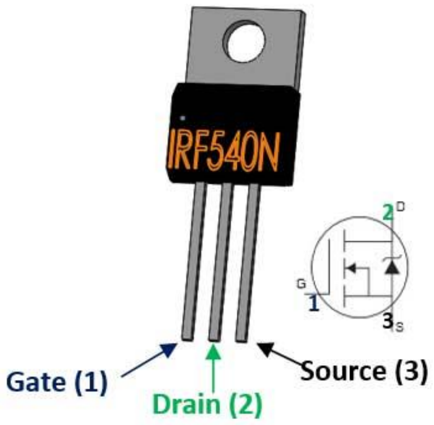
• Resistor:

A **resistor** is a passive two-terminal electrical component that implements electrical resistance as a circuit element. In electronic circuits, resistors are used to reduce current flow, adjust signal levels, to divide voltages, bias active elements, and terminate transmission lines, among other uses.

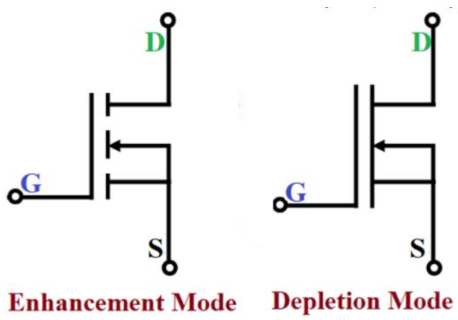


• N-channel MOSFET:

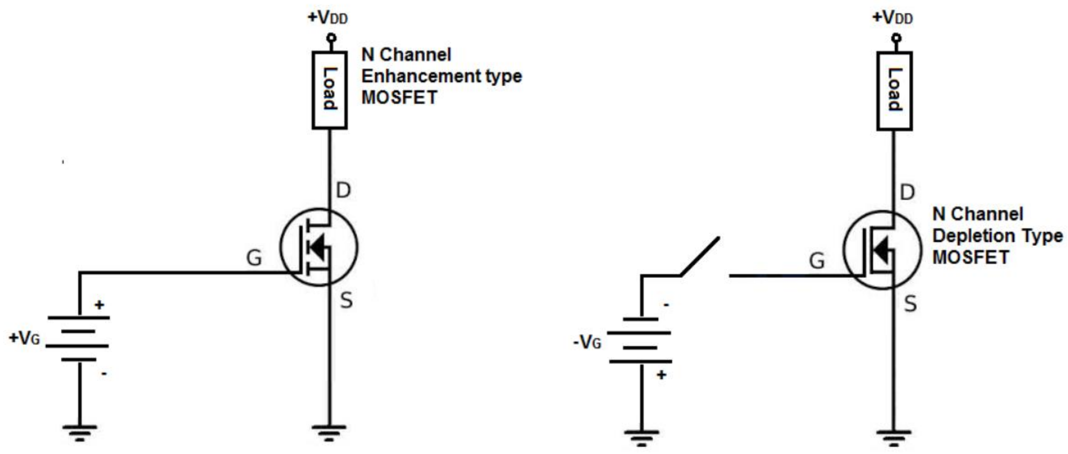
A N-Channel MOSFET is a type of MOSFET in which the channel of the MOSFET is composed of a majority of electrons as current carriers. When the MOSFET is activated and is on, the majority of the current flowing are electrons moving through the channel.



There are 2 types of N-Channel MOSFETs, enhancement-type MOSFETs and depletion-type MOSFETs.

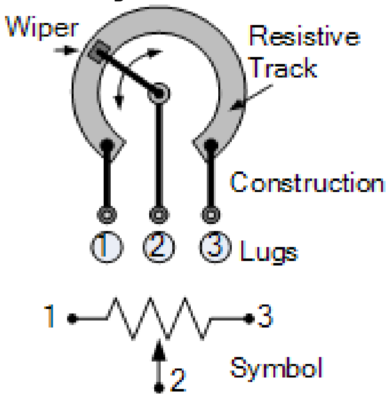


Circuit diagram of N-channel MOSFET:

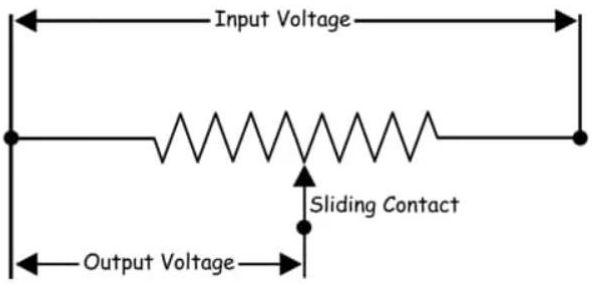


• Potentiometer:

A **potentiometer** (also known as a pot or potmeter) is defined as a 3 terminal variable resistor in which the resistance is manually varied to control the flow of electric current. A potentiometer acts as an adjustable voltage divider.



A potentiometer is a passive electronic component. Potentiometers work by varying the position of a sliding contact across a uniform resistance. In a potentiometer, the entire input voltage is applied across the whole length of the resistor, and the output voltage is the voltage drop between the fixed and sliding contact as shown below.



• DC motor:

A **DC motor** is a class of rotary electrical motors that converts direct current electrical energy into mechanical energy. A DC motor consists of two parts, a Stator which is the stationary part and a Rotor which is the rotating part. A DC motor's speed can be controlled over a wide range, using either a variable supply voltage or by changing the strength of current in its field windings.

Diode:

A **diode** is a semiconductor device that essentially acts as a one-way switch for current. It allows current to flow easily in one direction, but severely restricts current from flowing in the opposite direction. Diodes have polarity, determined by an anode (positive lead) and cathode (negative lead). When a diode allows current flow, it is forward-biased. When a diode is reverse-biased, it acts as an insulator and does not permit current to flow.

Capacitor:

A **capacitor** in an electrical circuit behaves as a charge storage device. It holds the electric charge when we apply a voltage across it, and it gives up the stored charge to the circuit as when required. The most basic construction of a capacitor consists of two parallel conductors (usually metallic plates) separated by a dielectric material. When we connect a voltage source across the capacitor, the conductor attached to the positive terminal of the source becomes positively charged, and the conductor connected to the negative terminal of the source becomes negatively charged.

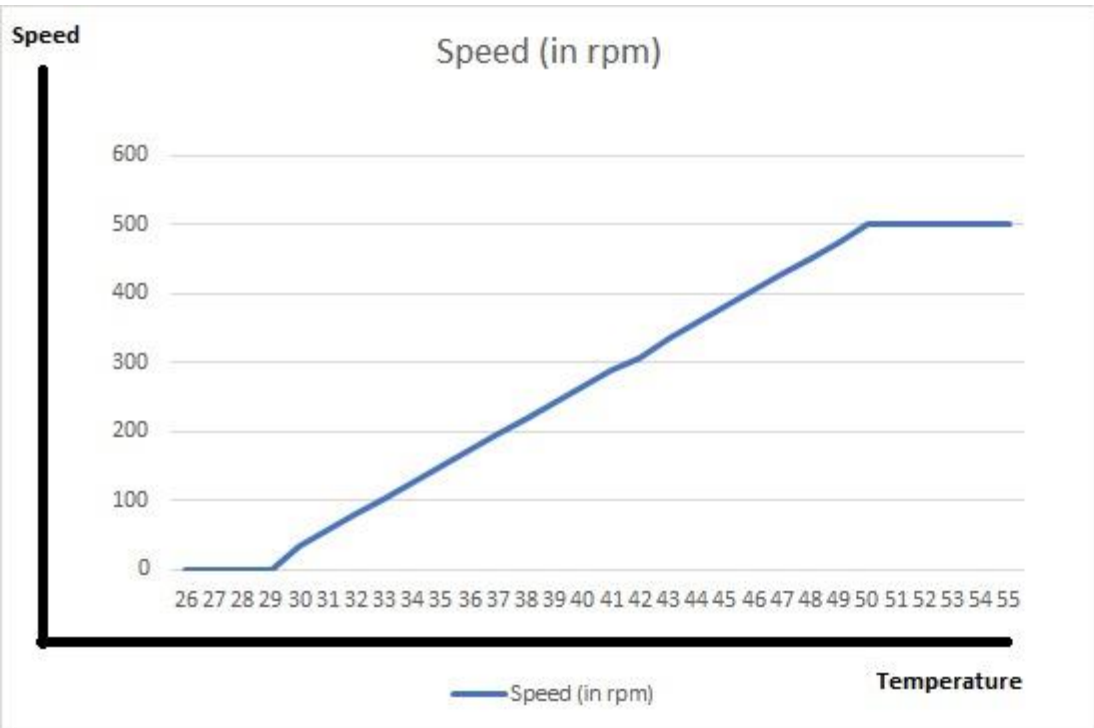
Battery/Power Supply:

A **battery** converts chemical energy into electrical energy by a chemical reaction. It is used in a circuit to power other components. A battery produces direct current (DC)electricity. A battery can be one cell or many cells. Each cell has an anode, cathode and electrolyte (the main material inside the battery). AA, AAA, C and D cells, including alkaline batteries, are of standard sizes and shapes, and have about 1.5 volts. The voltage cell depends on the chemicals used.

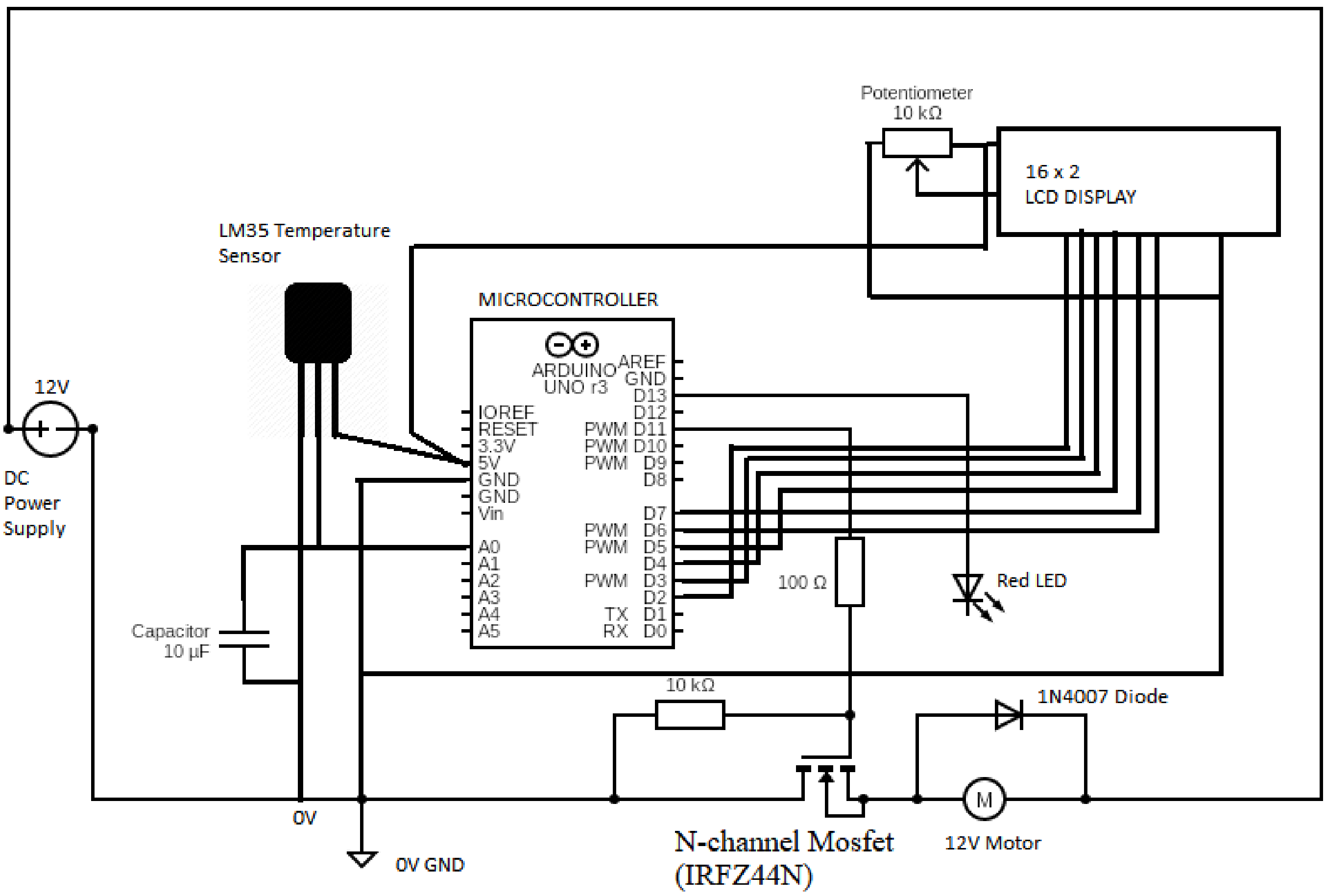
- **LED:**

A **light-emitting diode** (**LED**) is a semiconductor light source that emits light when current flows through it. Electrons in the semiconductor recombine with electron holes, releasing energy in the form of photons. The color of the light (corresponding to the energy of the photons) is determined by the energy required for electrons to cross the band gap of the semiconductor. White light is obtained by using multiple semiconductors or a layer of light-emitting phosphor on the semiconductor device.

Plot for Speed v/s Temperature for the DC Motor



CIRCUIT DIAGRAM



THE FINAL PROJECT BUDGET

COMPONENTS	UNIT	UNIT RATE	COST
Arduino Uno (R3)	1	Rs 621	Rs 621
16x2 LCD display	1	Rs 227	Rs 227
LM35 Temperature Sensor	1	Rs 250	Rs 250
Breadboard + Jumper wires	1	Rs 222	Rs 222
Resistor (10kΩ)	1	Rs 1.21	Rs 1.21
Resistor (1kΩ)	3	Rs 1.13	Rs 3.39
Potentiometer (10kΩ)	1	Rs 34.5	Rs 34.5
N-channel Mosfet (IRFZ44N)	1	Rs25	Rs25
DC Motor (12V-24V, 2.6A, 7K RPM)	1	Rs 299	Rs 299
Diode (1N4007)	1	Rs 4	Rs 4
Capacitor (10µF)	1	Rs 4	Rs 4
Rechargeable battery (12V DC, 1-3A)	1	Rs 1890	Rs 1890
TOTAL PRICE			Rs 3581.1

CODE

```
#include <LiquidCrystal.h>
LiquidCrystal lcd(2,3,4,5,6,7);
int tempPin = A0;   // the output pin of LM35
int fan = 11;       // the pin where fan is
int led = 13;     // led pin
int temp;
int tempMin = 30;   // the temperature to start the fan
int tempMax = 50;   // the maximum temperature when fan is at 100%
int fanSpeed;
int fanLCD;

void setup() {
  pinMode(fan, OUTPUT);
  pinMode(led, OUTPUT);
  pinMode(tempPin, INPUT);
  lcd.begin(16,2);
  lcd.setCursor(0,0);
```

```
  lcd.print(" Group no. 6 ");
  lcd.setCursor(0,1);
  lcd.print(" Mini Project ");
  delay(2000);
  lcd.clear();
}

void loop() {
   temp = readTemp();     // get the temperature

   if((temp >= tempMin) && (temp <= tempMax)) {  // if temperature is higher
than minimum temp
       fanSpeed = map(temp, tempMin, tempMax, 32, 255); // the actual speed of
fan
       fanLCD = map(temp, tempMin, tempMax, 0, 100);  // speed of fan to
display on LCD
       analogWrite(fan, fanSpeed);  // spin the fan at the fanSpeed speed
   }

   if(temp < tempMin) {   // if temp is lower than minimum temp
    fanSpeed = 0;      // fan is not spinning
    fanLCD = 0;
    digitalWrite(fan, LOW);
   }

   if(temp > tempMax) {        // if temp is higher than tempMax
    digitalWrite(fan, HIGH);
    digitalWrite(led, HIGH);  // turn on led
   } else {                    // else turn of led
     digitalWrite(led, LOW);
   }

   lcd.setCursor(0,0);
   lcd.print("Temperature:");
   lcd.print(temp); // display the temperature
   lcd.write(223);
   lcd.print("C  ");

   lcd.setCursor(0,1); // move cursor to next line
   lcd.print("Fan Speed:");
   lcd.print(fanLCD); // display the fan speed
   lcd.print("%   ");
   delay(200);
}

int readTemp() {  // get the temperature and convert it to celsius
  temp = analogRead(tempPin);
  return temp * 0.48828125;
}
```

WORKING

We used an LCD to display the current temperature and speed of the fan, but the circuit can be used without the LCD display. We also need to select the transistor by the type of fan that we use. In our case we used the well-known 2N2222 transistor and a 12V battery to provide power to the fan and transistor. The LM35 temperature sensor and red led are powered with 5V from the Arduino board. As can be seen in the sketch on the first line we included the Liquid Crystal library (header) that includes useful functions to use when an LCD is connected to the Arduino board. Then we set the pins for the sensor, led and fan. The most important part is to set the variables TMin and TMax with our desired values. TMin is the temperature at which the fan starts to spin and TMax is the temperature when the red led lights warning you that the maximum temp was reached. For example, if we set TMin at 30 and TMax at 35 then the fan will start spinning at 30°C and reach its maximum speed at 35°C. We store the temperature value in the temp variable and then use some if() functions to check if temp is lower than TMin and if so let the fan OFF (LOW). The next if() is to check if temperature is higher than the TMin and lower than the TMax and if so then use the map() function to re-map the temp value from one value to another. In our case Speed will have a value of 32 at TMin and 255 at TMax. These values are Temperature based fan speed controller 28 used to control the speed of the fan using PWM and the analog Write(). The fan LCD re-maps the temp to allow the display of Speed in a 0 to 100% range so we can say that the speed of the fan is directly dependent of the LM35's temperature. When the temperature reaches the value set in TMax the fan will be at its maximum spinning velocity and the LCD will display FANS: 100% even though the temperature might increase above TMax.

CONCLUSION

Thus, we got to know about the project and the components used in it. How the circuit is designed, how the microcontroller can be programmed and where these different components can be attached in the microcontroller. We have seen fans in our daily lives that runs when the current is supplied to the motor, but by this way, the fan's speed can be manipulated by the surrounding temperature.

In this process, we also came to know about the temperature sensor. Hence this reduces man power required and makes the system smoother and more automatic.

APPLICATION

Temperature based fan speed controller is useful for cooling the processor in the laptops and personal computers "more efficiently". Generally, fan in laptop comes with only two or three possible speeds. So, it results in more power consumption.

ADVANTAGES

1. This project can be used in Home appliances as well as Industries easily.
2. This will help in managing the energy / electricity and sabing human effort.
3. To monitor the environments that is not comfortable, or possible, for humans to monitor, especially for extended periods of time.

DISADVANTAGES

1. It can only be maintained by technical person. Thus, it becomes difficult to be maintained.
2. Due to temperature variation, after sometimes its efficiency may decrease.

FUTURE SCOPE

1. We can monitor more parameters like humidity, light and at the same time control them.
2. We can send this data to a remote location using mobile or internet.
3. We can draw graphs of variations in these parameters using computer.

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