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ARDUINO BASED SPEED CONTROL OF DC FAN

By Garvit Kumar, Yashwant Kumar, Nodeep, Vijendra Pal Singh, Vivek Kumar
Student in Department of Electrical Engineering, Rajkiya Engineering College, Bijnor.

Under the supervision of **MOHMMAD AHMAD**
Assistant Professor in Department of Electrical Engineering, Rajkiya Engineering College, Bijnor

ABSTRACT

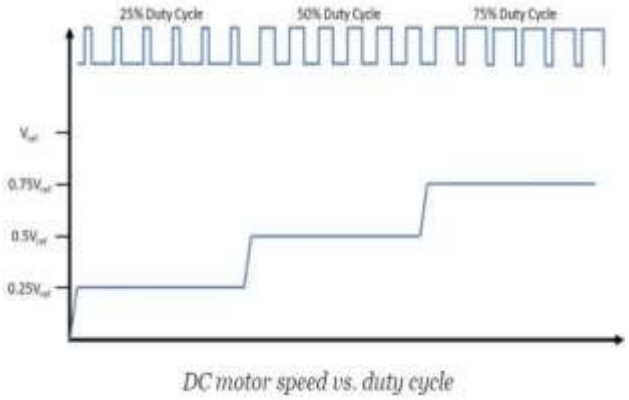
In present scenario, availability of electricity is found to reach crucial stage. To protect and safeguard one's future we need to save the energy. As a slogan suggest "One unit saved is one unit generated". The project is a standalone automatic fan speed controller that controls the speed of an electric fan according to our requirement. Use of embedded technology makes this closed loop feedback control system efficient and reliable. Arduino microcontroller allows dynamic and faster control. 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 as it is constructed by using few components and can be interfaced for several applications including air- conditioners, water-heaters, snow-melters, ovens, heat-exchangers, mixers, furnaces, incubators, thermal baths and veterinary operating tables. Arduino micro controller is the heart of the circuit as it controls all the functions. The temperature sensor LM35 senses the temperature and converts it into an electrical signal, which is forwarded to the microcontroller. The sensed and set values of the temperature are displayed on the 16x2-line LCD. The microcontroller 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.

1. INTRODUCTION

With the advancement in technology, intelligent systems are introduced every day. Everything is getting more sophisticated and intelligible.There is an increase in the demand of cutting edge technology and smart electronic systems. 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 disciplines of life for carrying out automated tasks in a more accurate manner. 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. 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 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 Liquid Crystal Display.



DC motor speed vs. duty cycle

Fig. 1 Graph

2. METHODOLOGY

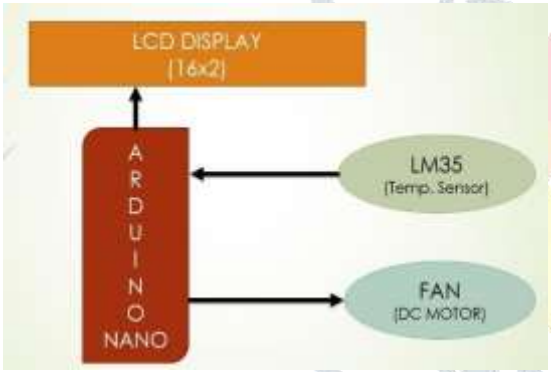


Fig. 2 Block diagram of the proposed concept

The above block diagram gives the basic idea about how Arduino NANO control the speed of DC Fan by using the output of LM35 Temperature sensor and side by side LCD gives reading of temperature and speed also.Here in this project speed can be control by using PWM technique and this PWM waveform is generated by the ARDUINO.
Speed of motor will be varied by varying the duty cycle of PWM waveform and this can be done by changing the temperature surrounding LM35.

In short we can say if temperature increase then duty cycle will also increase with some factor which is responsible to increasing the speed of motor.If the temperature is below the 35 degrees Celsius then the speed of motor is 0 percent and speed will increase if temperature will rise up.

Speed of motor will 100 percent if temperature reaches to 50 degrees Celsius and speed of motor remain constant above 50 degrees Celsius because at 50-degree motor will run at maximum speed.

Variation and relation in between Duty cycle, temperature, and speed of motor can be clearly seen in the result which is derived by number of operation of project on MATLAB Software

Circuit Explanation:

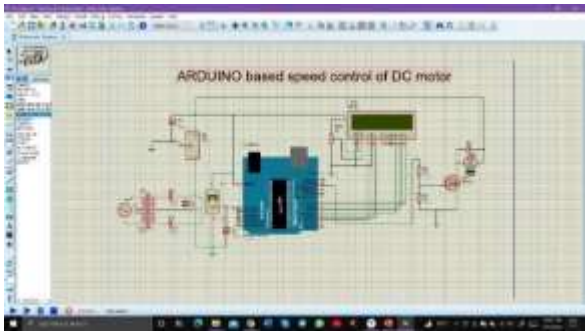


Fig. 3 Circuit Diagram

Basically, we work on 5v DC to supply the all components of this project because 5v is common voltage which is suitable for all components.
First, we step down the 220v AC supply to 9v AC with the help of 9-0-9 center taped transformer and also connect IN4007 diode with phase wire of transformer to make DC supply. After that we connect a 7805 IC with 47 micro farad capacitors to make constant 5v DC supply for circuit.

Now output of IC is given to LM35 sensor so that it will give output to ARDUINO with A0 pin and one output from IC is also given to ARDUINO at 5v pin to supply Arduino.

Connection of Arduino with LCD is similarly as given in circuit, we use D (2,3,4,5,6,7) for connection with LCD. And at last, D11 pin of Arduino is use to supply PWM wave to gate terminal of IRFZ44N MOSFET with one 100-ohm resistance for protection purpose.

Here we use this MOSFET to supply the pulsating input to DC motor by connecting drain terminal to one terminal of motor so that we can control the speed of motor.

We also connect one diode parallelly with motor to stop the fan below a certain cut-off level. And on pull down resistor also connected with MOSFET to overcome the floating voltage which can be caused by electric field present surrounding of gate terminal of MOSFET.

3. HARDWARE IMPLEMENTATION

A. Arduino NANO

Arduino Nano is designed by Arduino.cc which is one type of microcontroller board. Atmega328 microcontroller is used to built this type of Arduino. This microcontroller is also used in Arduino UNO. It is a small size board and also flexible with a wide variety of applications. Other Arduino boards mainly include Arduino Mega, Arduino Pro Mini, Arduino UNO, Arduino YUN, Arduino Lilypad, Arduino Leonardo, and Arduino Due. And other development boards are AVR Development Board, PIC Development Board, Raspberry Pi, Intel Edison, MSP430 Launchpad, and ESP32 board.
This board has many functions and features like an Arduino Duemilanove board. However, this Nano board is different in packaging. It doesn't have any DC jack so that the power supply can be given using a small USB port otherwise straightly connected to the pins like VCC & GND. This board can be supplied with 6 to 20volts using a mini USB port on the board.

Basic Features:

- ATmega328P Microcontroller is from 8-bit AVR family
- Operating voltage is 5V
- Input voltage (Vin) is 7V to 12V

- Input/Output Pins are 22
- Analog i/p pins are 6 from A0 to A5
- Digital pins are 14
- Power consumption is 19 mA
- I/O pins DC Current is 40 mA
- Flash memory is 32 KB
- SRAM is 2 KB
- EEPROM is 1 KB
- CLK speed is 16 MHz
- Weight-7g
- Size of the printed circuit board is 18 X 45mm
- Supports three communications like SPI, IIC, & USART

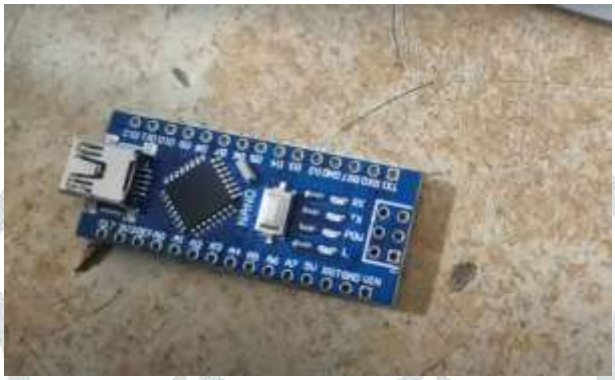


Fig. 4 ARDUINO NANO

B. Arduino IDE.

The open-source Arduino Software (IDE) makes it easy to write code and upload it to the board. It runs on Windows, Mac OS X, and Linux. The environment is written in Java and based on Processing and other open-source software. This software can be used with any Arduino board. The Arduino development environment contains a text editor for writing code, a message area, a text console, a toolbar with buttons for common functions, and a series of menus. It connects to the Arduino hardware to upload programs and communicate with them.

Software written using Arduino are called sketches. These sketches are written in the text editor. Sketches are saved with the file extension. It has features for cutting/pasting and for searching/replacing text. The message area gives feedback while saving and exporting and also displays errors. The console displays text output by the Arduino environment including complete error messages and other information. The bottom right-hand corner of the window displays the current board and serial port. The toolbar buttons allow you to verify and upload programs, create, open, and save sketches, and open the serial monitor.

C.Liquid Crystal Display (LCD)

LCD (Liquid Crystal Display) screen is an electronic display module and find a wide range of applications. A 16x2 LCD display is very basic module and is very commonly used in various devices and circuits. These modules are preferred over seven segments and other multi segment LEDs. The reasons being: 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 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 LCD to do a predefined task like initializing it, clearing its screen, setting the cursor position, controlling 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.

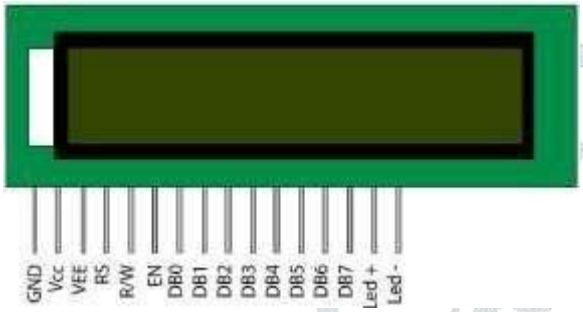


Fig. 5 Pin diagram of 16 x 2 LCD

D. LM35 Temperature Sensor

Temperature sensor senses the room temperature. This electronic device converts the data that sensed in the surrounding into the electronic data for recording purpose. There are many different types of temperature sensor. .Here in this project we are using LM 35 temperature sensor. The LM35 temperature sensor is graded to work from -55° Centigrade to 150° Centigrade with a udeviating scale factor of +10mv/° C.. It is a tiny and low cost IC which can be used to measure temperature anywhere in the surrounding between -55°C to 150°C.

Fig. 6 LM35

Properties:

- Measures directly in degree Celsius (centigrade)
- Linear +10.0 mV/ degree Celsius
- 0.5 degree Celsius accuracy (at +25degree Celsius)
- Rated between -55 to +150 degree Celsius range
- Suitable for remote applications
- Low cost due to wafer-level trimming
- Operates from 4 to 30 volts

- Less than 60 Micro ampere current drains
- Low self-heating, 0.08 degree Celsius and Nonlinearity only +/- 1/4 degree Celsius

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4. SOFTWARE IMPLIMENTATION

PROGRAM

```
#include <LiquidCrystal.h> LiquidCrystal lcd(2,3,4,5,6,7);
int tempPin = A8; // the output pin of LM35 int fan = 11; // the pin where fan is
int temp;
int tempMin = 35; // 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(tempPin, INPUT); lcd.begin(16,2); lcd.setCursor(0,0); lcd.print("Welcome Dc Motor ");
 lcd.setCursor(0,1);
 lcd.print(" Speed Control "); delay(2000);
 lcd.clear();
}
   }
   int readTemp() { // get the temperature and convert it to 5elsius
    temp = analogRead(tempPin); return temp * 0.48828125;
   }
```

5. RESULTS

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

  if(() && (temp <= )) { // 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);
  }

  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);
```

The following table 1 depicts the results obtained by operating the prototype model at various different temperatures. It defines the behavior of the embedded system about how it reacts to variation of temperature at real time.

Table 1 Results of embedded system designed

S. NO	Temperature in degree Celsius	Duty cycle in%	PWM Value	Fan Speed in RPM
1	Less than 35	0%	0	0
2	35	20%	0	0
3	40	60%	51	227
4	45	80%	153	654
5	50	100%	255	1000

The following represents graphical representation of tabulated data.

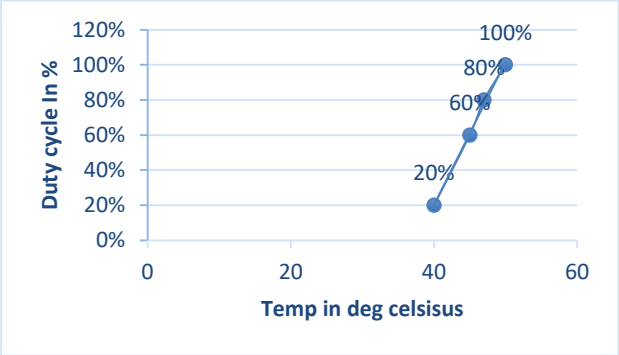

Fig. 6 Temp. Vs Duty Cycle

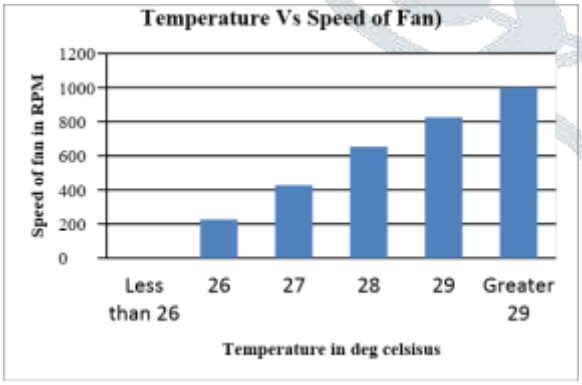

Fig. 7 Temp. Vs Fan Speed

6. CONCLUSION

Arduino based temperature controlled fan is implemented. Thus, here fan speed has been controlled by using Pulse Width Modulation and Arduino board according to the temperature sensed by the help of Temperature and Humidity Sensor (LM35). The idea of the project is to change the fan temperature automatically. PWM technique is found to be the best technique for controlling the fan speed using the sensed temperature. The system is working properly. The speed of fan depends on the temperature and there is no need for regulating the fan speed manually again and again.

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