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Fan Speed Controller using PWM and LM35

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Abstract

This practical temperature controller controls temperature of any device according to its requirement for any industrial application. It also displays the temperature on an LCD display in the range of –55°C to +125°C. The heart of the circuit is an ARDUINO board which controls all its functions. An IC LM35 is used as temperature sensor. The LM35 temperature device is interfaced to the pin of the ARDUINO board, through its built-in ADC, which converts these reading and displays that on the LCD, to indicate temperature of the device. User defined temperature settings can be done using push buttons provided through ARDUINO board. Maximum and minimum settings are used for allowing any necessary hysteresis. Few push buttons are used to set the temperature by INC, for increase and DEC for decrease settings. As soon the max and min temperatures are set then the ARDUINO program generates PWM output on the corresponding digital output according to the measured temperature. This is fed to a DC fan through a motor driver IC. The fan speed is proportional to the temperature measured. Standard power supply of 12volt DC and 5volt through a regulator are made from a step-down transformer along with a bridge rectifier and filter capacitor.

Keywords*: ARDUINO board, LM-35 PWM modulation.*

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1. Introduction

In this modern era, technologies are growing better and faster. Everything is getting more sensible and automated. Microcontroller plays very important role in making this smarter. Microcontroller has become the smart developments. It is a single chip microprocessor which helps to control and automate machines and processes. The chip is used to execute the code on the given board. Microcontroller usually consist of Central Processing Unit (CPU), timers and counters, interrupts, memory, input/output ports, analog to digital converters (ADC) on a single chip. This project presents the output of the fan speed using the Pulse Width Modulation (PWM) on the input 16x2 LCD. A temperature sensor LM35 is used which senses the temperature change and the speed of the fan varies accordingly.

2. Pulse Width Modulation

Pulse Width Modulation (PWM) is a technique where the width of the periodic sequence pulses is varied in accordance with the baseband signal. The leading edge of the pulse is held constant

and the change in pulse width with signal is measured with respect. PWM is also known as Pulse Duration Modulation. The general purpose of Pulse Width Modulation is to control power delivery, especially to inertial electrical devices. The on-off behavior changes the average power of signal. Output signal alternates between on and off within a specified period. If signal toggles between on and off, quicker than the load, then the load is not affected by the toggling. A secondary use of PWM is to encode information for transmission. In PWM, the pulse width is proportional to the amplitude of the signal. By varying the duty cycle of the pulse, the speed of the fan can be controlled. Duty cycle may be defined as the amount of time in a particular period during which the pulse is active or high. The speed is made slow, medium, fast, very fast and zero by having different duty cycles. The Duty Cycle is a measure of the time the modulated signal is in its "high" state. It is generally recorded as the percentage of the signal period where the signal is considered on.

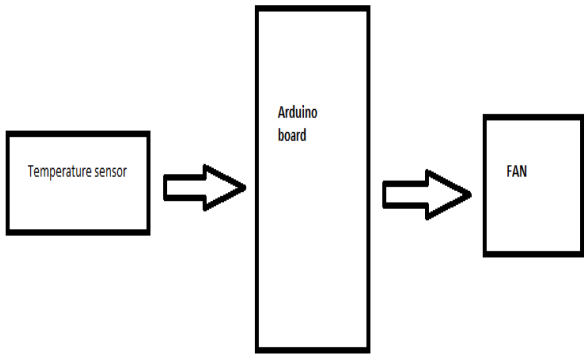
3. Block Diagram

The block diagram of the system has been shown in above figure which consists of the following:

Temperature sensor: The LM35 is a precision IC temperature sensor, whose output voltage is proportional to the temperature in Celsius. LM35 sensor is interfaced with the microcontroller to measure the temperature.

Arduino: Arduino is an open-source prototyping platform based on easy-to-use hardware and software. Arduino boards are able to read inputs - light on a sensor, a finger on a button, or a Twitter message and turn it into an output, active a motor, turning on an LED, publishing something online.

FAN: It is the output part of our project. The speed of the fan varies according to the change in temperature.



4. Power Supply

Five volts power supply with respect to ground is needed for the operation of the microcontroller and 12V power supply is needed to the fan. The power supply consists of a step down transformer which is used to convert 230V, 50Hz AC voltage to 12V AC, 50Hz. This 12V AC voltage is given to the bridge rectifier, which converts it into 12V DC. A voltage regulator 7805 is used to convert the 12V DC into 5V DC which is needed by the microcontroller. Capacitors are used for smoothening the output voltage. This five volts dc thus produced is given to the microcontroller for its operation. From the power supply two different voltages are generated from the voltage regulators. One is 12 volt generated by the 7812 voltage regulator. This supply goes to the fan. Another is 5 volts generated by the 7805 voltage regulator. This supply goes to the LCD and Arduino board.

5. Circuit Simulation

The simulation of the system has been done on Arduino Software v1.0.6. An Arduino board is used in this project. ATmega328P microcontroller is used in the Arduino board. Coding of the system has been done in Embedded C language. 16X2 LCD display has been used which is

connected to pins 2, 3, 4, 5, 9, 11 and 12 of the Arduino board. The temperature sensor LM-35 senses the room temperature and it is displayed on the LCD. The speed of the fan is controlled by using PWM technique according to the room temperature. The temperature sensor LM-35 interfaced to the A1 port of the Arduino board which acquires the room temperature. And the signal is converted into digital voltage signal.

The microcontroller used in this system has inbuilt PWM module which is used to control speed of the fan by varying the duty cycle. According to the readings from the temperature sensor fan speed is varied automatically. Table 1 shows the speed of the fan varying with the temperature.

Table 1: Temperature and Fan speed

SN.	Temperature (in ℃)	FAN Speed (in %)
1.	30℃	0%
2.	35℃	12%
3.	40℃	25%
4.	45℃	37%
5.	50℃	50%
6.	55℃	62%
7.	60℃	75%
8.	65℃	87%
9.	70℃	100%

We have set a range of 30℃ to 70℃ in the board so at the temperature below 30℃. The rise in temperature and the speed of the fan are directly proportional, as the temperature increases the fan speed also increases correspondingly. At 30℃ and below temperature, the fan speed is 0% and when the temperature increases from 30℃, the speed of the fan increase from 0%. The speed of the fan reaches 100% when the temperature reaches 70℃.

6. Results

The speed of the fan has been controlled using PWM technique according to the room temperature. The simulation of the system has been done on Arduino software v1.0.6 and it is running in good agreement. The logic used in the system is verified. The fan speed is varied according to room temperature. The design of the system presented in this paper is appropriate according to the modern technology.

7. Conclusion

A novel design of speed control of fan based on temperature using PWM technique is proposed. The simulation of the system is working properly and the design is appropriate according to the modern needs and technology. The speed of fan depends on the surrounding temperature and there is no need for regulating the speed manually. A table has been given to show the relationship between the change in temperature and the increasing in the speed of the fan. PWM technique is found to be appropriate for controlling fan speed according to change in surrounding temperature. This design can be further extended in terms of area and power at layout and characteristic level by using Advanced VLSI applications.

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