Automatic Control of The Speed of A Fan Motor Based On Ambient Temperature Using PIC 16F877A

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Abstract— In this paper, the design and simulation of an automatic system control a specific device based on analog parameter. This Embedded system works in a similar concept where we are about to control the speed of a DC motor using based on the external temperature. The rise in temperature will result in increase in speed of the motor and vice versa. These type of temperature controlled fan systems can generally be used to maintain temperature of a room or object automatically. An important feature of this automation process is to reduce or eliminate the possibility of relying on the human factor operator onboard the ship. The use of automatic fan speed control systems can be used in different places onboard the vessel like Galley, EDG room, various stores in deck etc. The system in this paper used the microcontroller PIC16F887A as the central control unit, LM35 temperature sensor as a temperature source,16x2 liquid crystal display (LCD). Several temperature ranges was set in the code to vary the motor speed based on the level of temperature sensed. The speed of the motor is controlled by using PWM. The motor is driven using a driver IC L293D. The implementation and simulation of the system work has been achieved by using proteus professional software v7.0 and PIC C COMPILER software to write the equivalent program and generate .hex file for system working.

I. Introduction

ELECTRIC fan is one of the most popular electrical devices due to its cost effectiveness and low power consumption advantages. It is a common circuit and widely used in many applications. It is also one of the most sensible solutions to offer a comfortable and energy efficient. In fact, the fan has been long used and still available in the market.

Nowadays, the demand for accurate temperature control and air freshening control has conquered many of industrial domains such as process heat, automotive, industrial places or office buildings where the air is cooled in order to maintain a comfortable environment for its occupants. One of the most important concerns involved in heat area consist in the desired temperature achievement and consumption optimization [1].

Fan can be controlled manually by pressing on the switch button. where in this method, any change in the temperature will not give any change in the fan speed. except the usage change the speed of the fan which is manually. So, an automatic temperature control system technology is needed for the controlling purpose in the fan speed according to the temperature changes.

Many researches focusing on automatic temperature control system application in different fields will gain the benefits. For examples, an automatic temperature controller for multi element array hyperthermia systems [2], multi-loop automatic temperature control system design for fluid dynamics [3], design of automatic temperature- control circuit module in tunnel microwave heating system [4], the automatic temperature system with Fuzzy self-adaptive Proportional-Integral-Derivative (PID) control in semiconductor laser [5].

This paper will show how PIC16F877A microcontrollers can be used and applied in a real-world application. One practical use is to integrate a microcontroller in a temperature control system that can be used for automatically controlling a room temperature onboard the vessel.

II. Fan Speed Control System Components

The microcontroller PIC16F877A, is the heart of the system. It accepts inputs from the temperature sensor, LM35 which allows for the measurement of the current room temperature, then the controller will give the action to maintain the required fan speed. LCD is used to display the fan speed and room temperature. All of these can be summarized in a diagram as shown in Fig. 1.

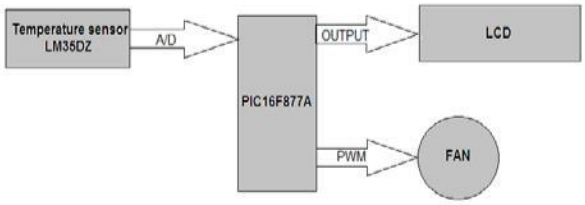

Fig. 1 Block diagram of fan speed control system

A. PIC16F877A Microcontroller

A microcontroller is a computer control system on a single chip. It has many electronic circuits built into it, which can decode written instructions and convert them to electrical signals. The microcontroller will then step through these instructions and execute them one by one. As an example of this a microcontroller could be used to control the fan speed according to the temperature of the room. Microcontrollers are now changing electronic designs. Instead of hard wiring a number of logic gates together to perform some function we now use instructions to wire the gates electronically. The list of these instructions given to the microcontroller is called a program. There are different types of microcontroller, this research focus only on the PIC16F877A Microcontroller

where it's pins as shown in Fig.2 [6] .

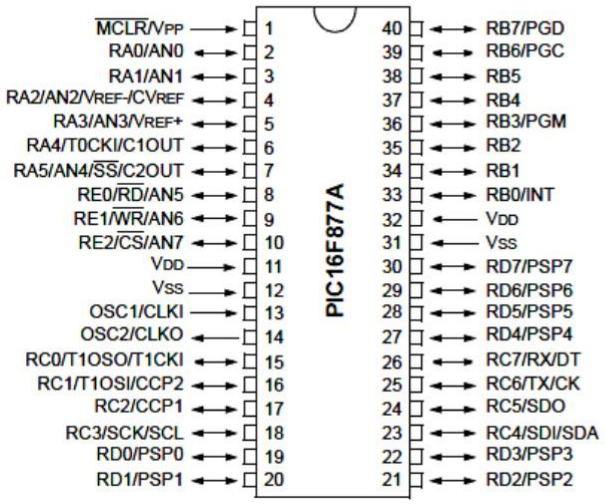

Fig. 2 Pin diagram of PIC16F877A

B. Regulated Power Supply

Usually, we start with an unregulated power supply ranging from 9volt to 12volt DC. To make a 5volt power supply, simply connect the positive lead form unregulated DC power supply (anything from 9VDC to 24VDC) to the input pin, connect the negative lead to the common pin and then turn on the power, a 5 volt supply from the output pin will be gotten to run the microcontroller.

C. Temperature Sensor (LM35)

The temperature sensor chosen for the design is the popular LM35 IC temperature sensor as shown in Fig. 3. LM35 is a three terminal integrated circuit temperature sensor giving a linear voltage output of 10mv per degree Celsius. Available in two versions one operating from 0°c to 100°c (DZ version), the other is from -40°c to +110°c (CZ version). These devices are housed in TO-92 plastic packages and provide a low cost solution to temperature measurement. The function is that it gives an analog voltage output per degree change in temperature [8].

LM35 temperature sensor output voltage has linear relationship between the Celsius temperature，scale0° C, output is 0V, for every 1°C increases in output voltage of 10mV.

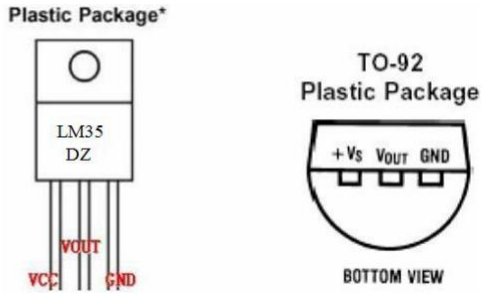

Fig. 3 Temperature sensor LM35

D. Brushless DC Motor

Brushless DC Motors are commutated electronically, they do not use brushes so called brushless DC motor. These motors provide better speed versus torque characteristics, noiseless operation and high efficiency over brushed DC motors. Magnetic field generated by stator and rotor have same frequency, so BLDC motors are synchronous motors. Fig. 4 shows transverse section of BLDC motor.

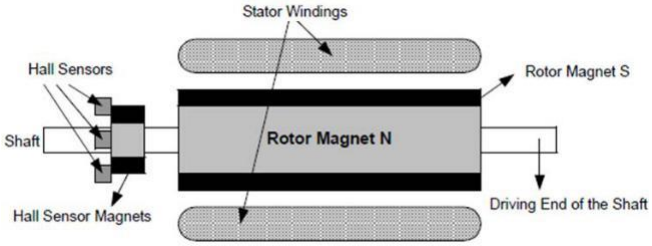

Fig. 4 Transverse section of BLDC motor.

BLDC motors have mainly two parts, stator and rotor. Some of the motors consist of hall sensors. BLDC fans do not have problems related to sparking, wearing of brushes or electromagnetic interference (EMI), as they use electrical commutation [9]. Fig. 5 presents BLDC fan used for this research.

Fig. 5 BLDC Motor

Rotor is the part of motor that rotates. Rotor is made of permanent magnet with alternate North (N) and South (S) poles over the circular core. BLDC fan use permanent magnets, so it has lighter rotor than the conventional DC fan that makes them suitable for the cooling fan application in laptop and desktop computers. Hall sensors detect the rotor position by south and north poles and based on their position, exact commutation sequence is determined. This commutation sequence is important in rotating BLDC motors as they use electronically controlled commutation [10].

E. Liquid Crystal Display (LCD)

This component is specifically manufactured to be used with microcontrollers, which means that it cannot be activated by standard IC circuits. It is used for displaying different messages on a miniature liquid crystal display. it can display messages in two lines with 16 characters each. Also it can display all the letters of alphabet, Greek letters, punctuation marks, mathematical symbols etc. Fig. 6 illustrates LCD (2 x 16 characters) and its connection [11].

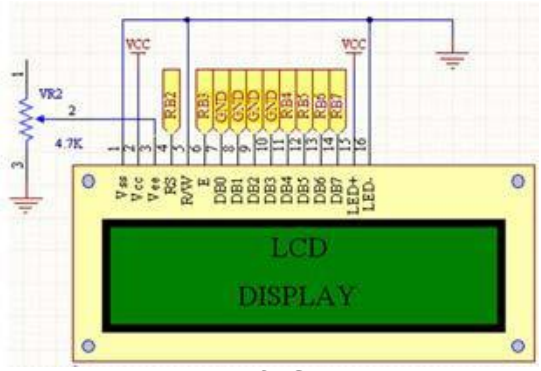

Fig. 6 LCD

III. Fan Speed Control System Circuit Design

This section describes how the speed of fan is controlled by PWM output from microcontroller, with the change in room temperature. The schematic circuit diagram of fan speed control system shown in Fig. 7

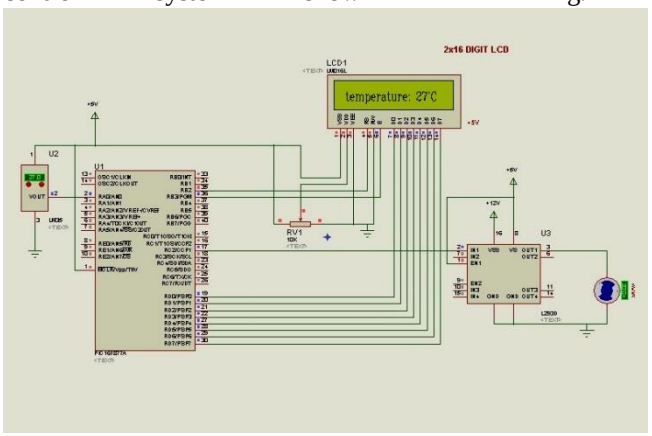

Fig. 7 Schematic circuit diagram of fan speed control system

In this circuit the microcontroller is used to control the fan according to the temperature variation. The voltage from the mains (220/240V AC) is stepped down by a transformer to 12V. Then the 12V DC passes through the voltage regulator to give a clean 5V DC. The LM35 functions to measure the changes of temperature surrounds the area. All the operations are controlled by the PIC16F877A to produce the output. The LCD, fans are the output where they are set with the pseudo code of PIC. The LCD is used to measure and show the changes of temperature value.

As working principle, the temperature sensor senses the room temperature and displayed it on the LCD. The speed of the fan is controlled by using PWM technique according to the room temperature change. For processing analog signals, microcontroller has analog to digital converter which converts analog signals to digital ones.

The LM35 gives 10mv for each 1°c change in the temperature; this value is analog value and should be converted to digital. Any change in the temperature will be send to the microcontroller via PORTA pin 2, which have been specified by us in the program using TRISA.

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, duty cycle is varied automatically thus controlling fan speed. The microcontroller will send the PWM signal via pin RC2 in port C to the transistor which working as switch to the fan.

Crystal oscillator is connected in between pin 13 (osc1) and pin 14 (osc2) of PIC16F877A, those are pins if we want to provide external clock to the microcontroller. 0.1 µF bypass capacitor used on the output pin +5 V of the voltage regulator to smooth out the supply voltage to microcontroller and LCD. V_{out} pin of temperature sensor LM35 is connected on pin RA2 which is ADC0 of all ADC input pins. Pin 3 of LCD is connected to ground via 1Kohm resistor to set the contrast of the LCD to display temperature on LCD. Pins from RB2 to RB7 are connected to remaining LCD pins used for data and control signals between LCD and microcontroller

PWM output is given to driver IC L293D from microcontroller. Driver IC L293D is high switching speed power switch. This switches on and off at PWM frequency and controls the voltage across motor. When L293D is on, the motor starts to gain speed and off then motor loses speed.

automatic fan control.c

```
#include <16F877A.h>
#device ADC=10                          //Setting ADC bits
#FUSES NOWDT
#FUSES NOBROWNOUT
#FUSES NOLVP
#use delay(crystal=20000000)
#byte lcd=0x08
#byte TRIS_lcd=0x88
#bit rs=0x06.2
#bit en=0x06.3
#bit TRIS_rs=0x86.2
#bit TRIS_en=0x86.3
long int adc_value,real_value;
int i;
char value[4];
unsigned char text[]="Temperature:";
void display(unsigned char a, int b);
void motor();
void main()
{
  TRIS_lcd=TRIS_rs=TRIS_en=0;
  display(0x38,0);
  display(0x01,0);
  display(0x0c,0);
    for(i=0;i<=12;i++)
    {
     display(text[i],1);
    }
  setup_timer_2(T2_DIV_BY_16,255,1);    //Setting timers for PWM
  SETUP_ADC_PORTS(AN0);                   //Setting ADC PORTS
  SET_ADC_CHANNEL(0);                     //Selecting Channel
  SETUP_ADC(ADC_CLOCK_INTERNAL);
     while(TRUE)
```

Fig. 8 Coding on CCS compiler

IV. Result And Discussion

The coding is done on CCS C compiler, the compiled. After on proteus run the project. When temperature sensor senses low temperature, fan is running slowly. When temperature increases the fan is running fast.

V. Conclusion

This paper elaborates the design and construction of fan speed control system to control the room temperature. The temperature sensor was carefully chosen to gauge the room temperature. Besides, the PIC microcontroller had been used to control the fan speed using the PWM, the fan speed in rpm and the room temperature was successfully programmed using C Language and their values displayed on LCD. Moreover, the fan speed will increase automatically if the temperature room is increased. As conclusion, the system which designed in this work was perform very well, for any temperature change and can be classified as automatic control.

References

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