

Review Paper on Controlling the Speed of DC Motor with High Accuracy and Demerits of Other Speed Controlling Techniques

Mohit Yadav¹, Kartik Kanodia², Naresh Kumari³

^{1,2,3}Department of Electrical, Electronics & Communication Engineering, ITM University, Gurgaon, Haryana, India

Abstract: The presented paper is concerned with the speed controlling of dc motor by using embedded system, which is easy to use and provide us very high accuracy. Here we have compared the different type of techniques which are used to control the speed of DC motor. We have used CMOS 8-bit microcontroller with 8K bytes in system programmable flash AT89S2. The most important advantage of a DC motor is that we can vary the relationship of speed-torque as per our requirement & for that purpose we have use a simple technique which is known as Pulse Width Modulation, which is used to produce low and high pulses. The pulses produce is the cause of changing speed of motor. Therefore to achieve this we have use a microcontroller (AT89S2), which can be programmable to set the speed by changing the time period of duty cycle in the code.

Keywords: embedded, microcontroller, Pulse Width Modulation (PWM), speed-torque, CMOS.

1. INTRODUCTION

In this paper we present the controlling of speed of DC motor by using CMOS microcontroller AT805S2. The machine which is used to convert electrical energy into mechanical energy is known as motor and the motor which is excited by some dc source to produce mechanical energy is then known as DC motor. The advantages of using DC motors over AC motors are explained below.

- The efficiency of controlling the DC motor is very high.
- DC motors have approximate 95% efficiency.
- DC motors have better overload and peak voltage characteristics.
- The most important thing of using DC motor is that we can change its speed-torque relationship according to our requirement.

As it is having so many advantages, which results in use of DC motor in very wide range of applications, where fixed or constant speed is required at varying the load. Some of the applications of DC motor are mentioned here for example in sewing machines, lifts, mixing machines, cranes, elevator, conveyor (belt) chain, etc. The different types of DC motors are -:

- Series field wound type
- Compound field wound type
- Shunt field wound type

For all these types the speed control method is common.

1.1 Speed control methods in a DC motor

The DC motor can be controlled by controlling armature voltage and armature current. We know that speed control is possible by varying

- Flux per pole, (controlling of flux).
- Resistance R_a of armature
(By Rheostat Control).
- Applied voltage.

The above methods have some demerits like a large amount of power is dissipated in the controller resistance hence efficiency decreased. And also it requires very complicated and expensive arrangement for dissipations of heat produced in the controller resistance. It also gives very low speed below the normal speed. So by this we can conclude that these electrical and electromechanical methods are less economical, efficient and not of much use as these methods are having multiple drawbacks, so electronic methods and techniques are used for controlling of speed. These methods provide higher efficiency and feasibility, good reliability and quick response. One such very widely used technique is pulse width modulation (PWM). We apply this technique in our work to control the speed of DC motor.

1.2 Pulse width modulation (PMW)

Pulse width modulation is a technique which is used to generate binary signals having 2 sub signals one is high and the other one is low. Pulse width of each signal (pulse) is varies between 0 and the time (T). Our main objective is to control the power by changing the duty cycle, conduction time to the load is to be controlled. Let us assume that for the time t_1 , the input voltage appears across the load, which is in ON state and for the time t_2 the voltage appears on the load is zero.

- The average voltage at output is given by
$$V_s = 1/T \int V_o dt = t_1/T V_s = k V_s$$
- The average load current $I_a = V_a/r = k V_s/R$,
Where T is the total time period = t_1+t_2 ,
 $K=t_1/T$ is the duty cycle.
- The rms value of output voltage is $V_o = (1/T \int V_o^2 dt)^{1/2} = k V_s$
- The power at output is (P_o) =
$$1/T \int V_o i dt = 1/T \int V_o^2/R dt = k V_s^2/R$$
- And we can vary the duty cycle from 0 to 1 by changing t_1 , T or f. Therefore, it conclude that the the output voltage V_o can be change from 0 to V_s by controlling k, & hence the power flow can be easily controlled.
- As we can vary the time t, that changes the pulse width and this method of controlling is known as pulse width modulation.

2. EMBEDDED SYSTEM

Embedded system is an application specific computing system that is embedded in other applications to perform special information functionalities. Embedded system is composed of hardware part and software part both.

2.1 MICROCONTROLLER

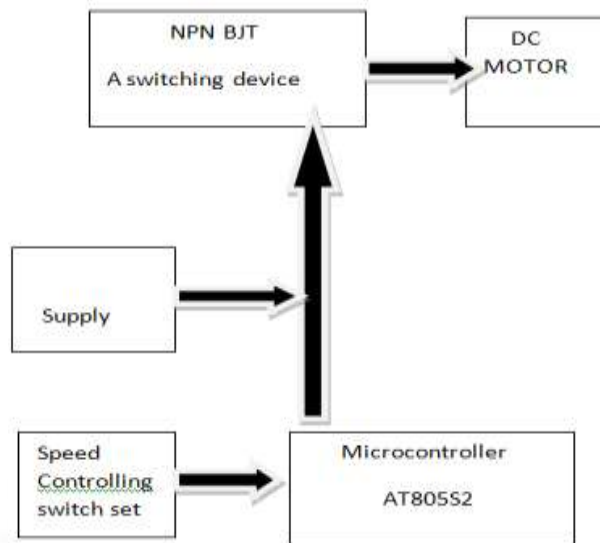
The microcontroller used is AT805S2 which is of CMOS 8 bit microcontroller with 8 bytes of in-system programmable flash memory. The technology is more economical and efficient with low cost microcontroller. Microcontroller incorporate PWM control. We can easily change the duty cycle and frequency of PWM control signal is also used in communications to take advantage of the higher immunity to noise provided by digital signals. So by getting these pulses generated by a microcontroller we can increase the efficiency, accuracy & thus the reliability of the system. The most commonly used microcontroller is 8052 that has been used in this project for production of pulses.

2.2.1 ADVANTAGES OF MICROCONTROLLER

Various uses of microcontrollers are as follows:

- **DESIGN AND STIMULATION:** Since the programming is done using software, we can stimulate the details in advance so that the code is correct and the performance of the system is enhanced.
- **FLEXIBILITY:** Reprogramming can be done using FLASH, EEPROM OR EPROM. This allows direct changes in the control law used.
- **HIGH INTEGRATION:** microcontrollers are generally single chip computers which have on chip processing, memory and input.
- **COST EFFECTIVE:** cost saving is done because we have the flexibility of changing the code and also because a large number of components are included in one controller which occupies very less area.
- **USER FRIENDLY:** the programming can be done in simple C language unlike in the past when tedious assembly language was used. The power requirement too is low as they only need a single 5V supply.

3. BLOCK DIAGRAM



4. EMBEDDED C CODE OF CONTROLLING PWM

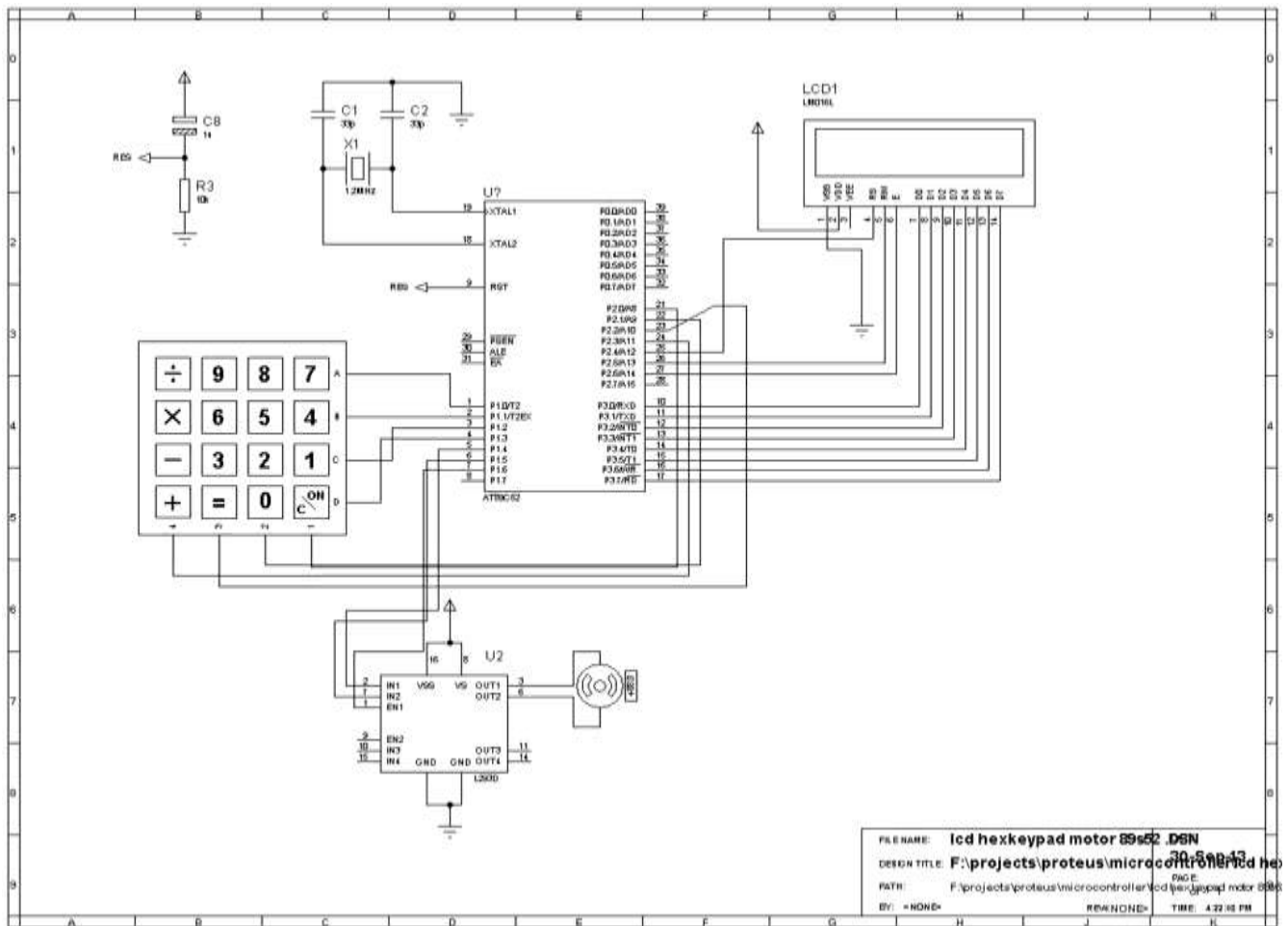
4.1 Timer setup for PWM in C Software used is KEIL

```
1. //Global variables and definition
2. #define PWMPIN P1_0
3.
4. unsigned char pwm_width;
5. bit pwm_flag = 0;
6.
7. void pwm_setup(){
8.     TMOD = 0;
9.     pwm_width = 160;
10.    EA = 1;
11.    ET0 = 1;
12.    TR0 = 1;}
```

4.2 Interrupt Service Routine

```
1. void timer0() interrupt 1 {
2.     if(!pwm_flag) { //Start of High level
3.         pwm_flag = 1; //Set flag
4.         PWMPIN = 1; //Set PWM o/p pin
5.         TH0 = pwm_width; //Load timer
6.         TF0 = 0; //Clear interrupt flag
7.         return; //Return
8.     }
9.     else { //Start of Low level
10.        pwm_flag = 0; //Clear flag
11.        PWMPIN = 0; //Clear PWM o/p pin
12.        TH0 = 255 - pwm_width; //Load timer
13.        TF0 = 0; //Clear Interrupt flag
14.        return; //return
15.    }
16. }
```

5. CIRCUIT DIAGRAM: D.C Motor speed control with AT805S2 Microcontroller



6. DEMERITS OF DIFFERENT TYPES OF SPEED CONTROLLING METHODS

6.1 ARMATURE CONTROL METHOD:

- As the entire current passes through the external resistance, there are tremendous power losses. Hence the method is expensive, wasteful and less efficient.
- As armature current is more than field current, rheostat required is of large size and capacity.

6.2 FIELD CONTROL METHOD:

- Creeping speeds cannot be obtained.
- Top speeds only obtained at reduced torque.
- The speed is maximum at minimum value of flux, which is governed by the demagnetizing effect of armature reaction on the field.

6.3 FLUX CONTROL METHOD:

- The speed control below normal rated speed is not possible as flux can be increased only up to its rated value.
- As flux reduces, speed increases. But high speed affects the commutation making motor operation unstable. So there is limit to the maximum speed above normal, possible by this method.

6.4 VOLTAGE CONTROL METHOD:

- The system is very costly because two extra machines are required.
- Overall efficiency of the system is not sufficiently especially it is light loaded.

7. USES & ITS APPLICATIONS

Conveyor belts, elevators, cranes, ski lifts, extruders, mixers, sewing machines are a few examples of applications where DC motors are used at a constant speed. Hence the speed control of DC motor is a highly important area to work in.

CONCLUSION

The paper portrayed the control algorithms and methodology that we have utilized to control the speed of DC Motor using microcontroller AT805S2. This code & method is tested & were found to be enabling to control the speed of DC Motor by pulse width modulation. Through the experiments conducted we were able to determine the precision with which the speed of motor is controlled as per our requirement. This paper provides us reliable, accurate and efficient way of speed controlling of a DC motor. The project is feasible and efficient as per economy point of view, and has a great advantage of running DC motors of very higher rating.

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