Design and Implementation of DC Motor Speed Control Based on TMS Microcontroller

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ABSTRACT

In today's modern factory use of DC motor increased day by day. Controlling of DC motors can be done through electrically or mechanically. There is need of intelligent devices for controlling DC motor. The system proposed in this paper is speed control of DC motor based on TMS microcontroller using PWM technique.PWM signal is generated from analog circuit , digital IC , microcomputer and microcontroller .Usually PWM signal is generated from microcontroller (TMS 320 F 28027) because PWM obtained from digital IC, analog or microcomputer contains harmonics. For speed control of DC motor flux and armature control method cannot provide required range of speed. The motor is operated in four quadrants; clockwise, counter clock wise, increasing and decreasing speed.PWM signal generated at 4 duty cycle with value 25%, 50%, 75%, 100% which in turn adjust directly the motor speed.

Keywords: *Speed control, PWM, TMS, Microcontroller*

1. INTRODUCTION

In the era of automation necessity of intelligent devices capable for driving and controlling electrical and electromechanical devices is increased. Fast progress in microcontroller has made it possible .In many modern factories all types of electromechanical devices are used and controlled by PWM signal generated from microcontroller. Mainly there are two ways of controlling speed of DC motor; mechanically and electrically. Mechanical method requires large hardware and more cost. But electrical method is small sized. Therefore in this work speed control of DC motor achieved by using electrical method. For increase the productivity of material it is necessary to increase the speed of DC motor .The application of this is used in domestic as well as industrial purpose .To reduce the steady-state error of the rotational speed of motor and to improve the performance of speed regulation of motor. The use of 8-bit microcontroller requires more and complex hardware where as 16/32 bit microcontroller contains some additional processing functions and advanced PWM techniques therefore use of this microcontroller is smart choice In this project we have control the actual speed of DC motor as per our requirement by using TMS (320 F 28027).The main objective of this work is to become familiar with the design and implementation of both software and hardware of microcontroller based speed control of DC motor. The speed of DC motor changed by changing voltage of motor. Firstly by giving supply to TMS .TMS generates pulses, generated pulses are nothing but PWM signal which is given to driver circuit. The main function of driver circuit is to generate 12 V DC pulse. Thus speed of DC motor is controlled by PWM signal. We can control speed of motor in its running condition. The rest of paper is organized as follows-Section 2 gives Literature Review. Section 3 gives System Architecture, section 4 gives Working Methodology and section 5 concludes the paper.

2. LITERATURE REVIEW

During the study of IEEE paper, we know that DC motor control has been used for mainly two parts: for variable speed and position applications. First choice for speed control requires controllable torque, simplicity and reliability.

Most important thing is that speed of DC motor is inversely proportional to armature voltage drop, inversely proportional to flux due to field winding and directly proportional to supply voltage. Speed of DC motor can be controlled by armature control method. In this method, the speed of DC motor can be controlled by controlling armature resistance to control the voltage drop across armature. In Flux control method for varying the speed of motor it is necessary to vary the magnetic flux due to field winding. But magnetic flux depends on current flowing through the field winding therefore it can be varied by varying the current through the field winding this can be achieved by using a variable resistor in series with the field winding resistor. In voltage control method, armature receives a variable voltage and field winding receives a fixed voltage .There are many technique of voltage control method :use of a switch gear mechanism to provide a variable voltage to the armature and other one uses an AC motor driven generator to provide variable voltage to armature. But the most useful technique is the use of pulse width modulation (PWM) to speed of DC motor .PWM signals are widely generated from microcontroller. By studying paper, firstly they are giving the supply to microcontroller. Then controller generates the pulse of 5 volts DC, the generated pulse is nothing but PWM signal.

3. SYSTEM ARCHITECTURE

In industrial automation motion control is important. PWM is a method for binary signals generation that is high and low. PWM pulses reach the full supply voltage and will increase more torque in motor. The system hardware block diagram is shown in figure1.The system mainly includes TMS 320 F 28027 microcontroller, H-bridge driver, DC motor , and power supply.CCP (Capture/Compare/PWM) is inbuilt in TMS which can easily generate PWM signal. These PWM signal applied to enable pin of motor driver IC .The speed and direction of motor changed by DC driver. Two push buttons are used for variation of pulses that is for speed change and another two push buttons are used to control the direction. LED is used for visual indication

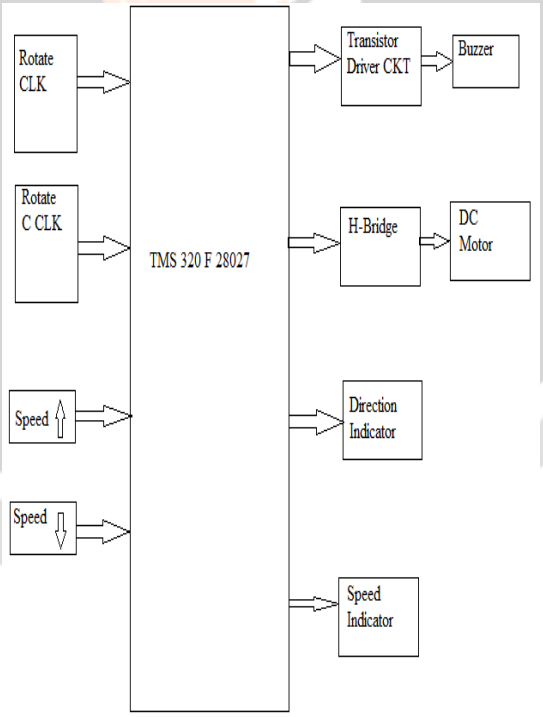

Figure1 .Block Diagram of Speed Control of DC Motor

3.1. Hardware Specification

3.1.1 TMS 320 F 28027

Here we have used TMS 320 F 28027 with Independent 16-Bit Timer in Each Enhanced Pulse Width Modulator (ePWM). The datasheet of micro controller TMS 320 F 28027 provided the working conditions, pin configuration of the microcontroller.TMS 320 F28027 is designed to work with Code Composer Studio.

- High Efficiency 32-Bit CPU
- Single 3.3-V Supply
- Low cost for both device and system
- Independent 16-Bit Timer in each Enhanced Pulse Width Modulation
- On chip memory
- Up to 22 pins are Individually Programmable
- Code security module
- 16 x 16 Dual MAC
- Three 32-Bit CPU Timer
- Small packaging
- Code-Efficient (in C/C++ and Assembly)

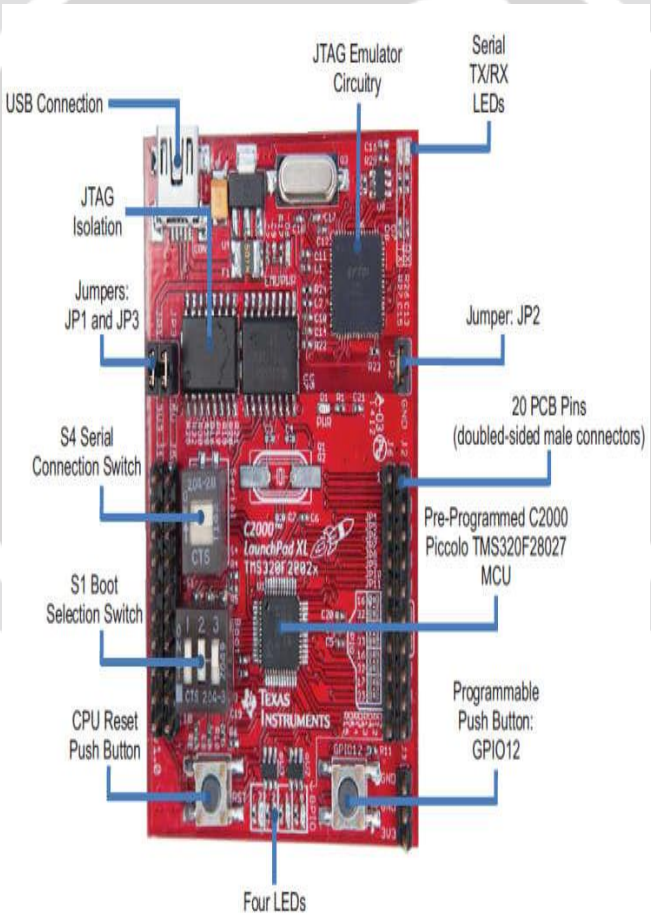

Figure 2 .TMS 320F28027 Board

3.1.2 H-Bridge Driver

H-Bridge designed to drive inductive loads such as a DC and switching power transistor. It has 600ma output current capability. Motor driver act as current amplifier. This amplifier current signal is used to drive motor. H-Bridge is an electronic circuit that enables a voltage to be applied across load in either direction .The L293 and L293D are quadruple high-current half-H drivers. It is used in robotics and other applications.

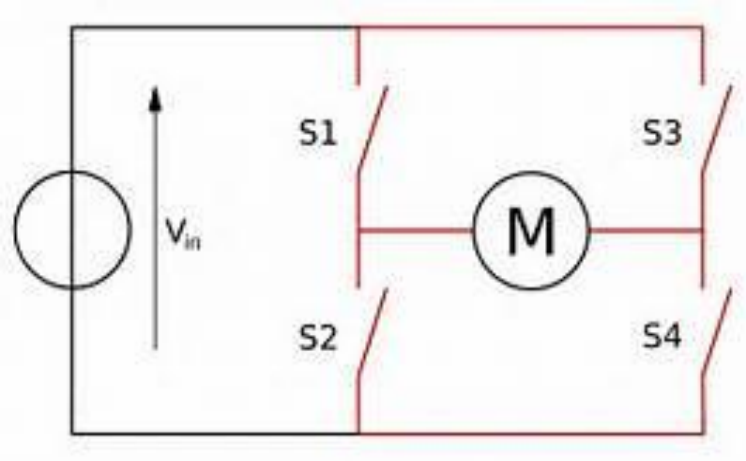

Figure3. H-Bridge Driver

Figure3 shows that H Bridge is built with four switches, when switches S1 and S4 are closed and switches S2 and S3 are open a positive voltage will be applied across the motor. By opening S1 and S4 switches and closing S2 and S3 switches, voltage is reversed, for reverse operation of the motor.

3.1.3 12 V DC Motor

12V DC Motor can be used in different types of robotics. DC motor is available with wide range of Torque and RPM. DC Motor used with following specification

- Shaft Diameter:6mm
- Length:80mm
- Weight:130 g
- Torque:1.5 kg.cm

3.2 Software Specification

The software development is implemented using code composer studio integrated development environment for programming the TMS 320F 28027.Code composer studio IDE gives a seamless and easy to use environment to write, build and debug C/C++ and assembler code. Code Composer Studio speeds the development process for programmer who creates and test real time applications. It extends the basic code generation tools with a set of debugging and real time analysis capabilities. Code Composer Studio supports all phases of the development cycle shown here:

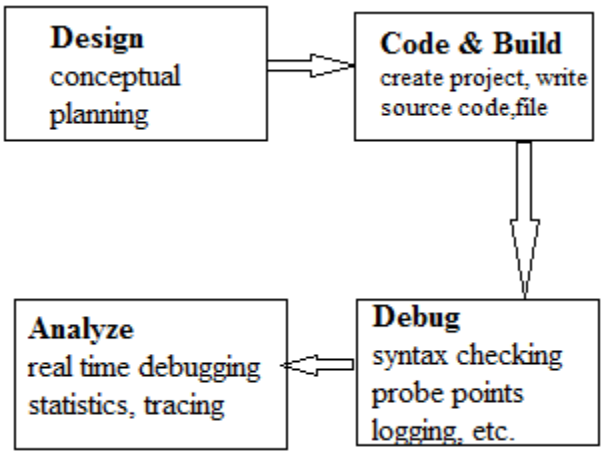

Figure 4. Development cycle

4. WORKING METHODOLOGY

For TMS 320F 28027 there is no need to modify the timer for generation of PWM signal TMS has inbuilt CCP (capture /compare/PWM) register which can be generates PWM signal .By using Code Composer Studio (CCS) operational algorithm can be implemented.TMS is code efficient (in C/C++ and Assembly) .The PWM duty cycle for clockwise direction is PWM Duty= (1875*2*App Duty Cycle), The PWM Duty Cycle for anticlockwise direction is PWM Duty=15000-(1875*2*App Duty Cycle). By using App Duty Cycle, initial Duty Cycle can be incremented or decremented .Four switches are used; two for speed & two for direction. Two speed switches are used for incrementing or decrementing of Applied Duty cycle and by using direction switches the direction of device can be changed. These four switches are connected to GPIO pins which are programmable speed of DC motor is complete depends on PWM Duty Cycle. We are using 12 V DC Motor and average DC value delivered to motor can be varied by varying the duty cycle ratio of PWM .The average DC voltage of 0% duty cycle is 0 V,25% duty cycle is 3 V, 50% duty cycle is 6V,75% duty cycle is 9V,and for 100% duty cycle 12V.

5. CONCLUSION

DC motor is controlled by using series architecture of variable resistor, but it has more power dissipation .DC motor is also controlled by flux and armature control method but it cannot provide required range .Therefore voltage control method is used in which microcontroller generate the PWM signal. PWM obtained from digital IC, analog or microcomputer contains harmonics. Microcontroller based PWM signal generation consumes less power .Due to flexibility of microcontroller all control algorithms can be implemented in software. Therefore control of DC motor based on TMS microcontroller having high accuracy.

REFERENCES

[1] Pratik J Patel, Hardeep J PATEL, Apeksha D Unadkat,Chintan U PATEL,Ass.Prof.Sanjay Bhanderi, "PWM Based Speed Control for a DC Motor" International Journal of Science, Engineering and Technology Research (IJSETR)Volume o6,issue 04 April 2017,ISSN 2278-7798

[2]Atul Kumar Dewangan, Nibbedita Chakraborty, Sashi Shukla, Vinod Yadu, "PWM Based Automatic Closed Loop Speed Control of DC Motor" International Journal of Engineering Trends and Technology, Volume- 3Issue 2-2012

[3] A.S.M.Bakibillah, Nazibur Rahman, Md.AnisUzZaman, "Microcontroller based closed loop speed control of DC motor using PWM technique", International journal of computer Applications (0975-8887), volume 108-No.14, Dec.2014

[4] Shrutishrivastava, Jagashwarrawat, Amit Agraval, "Controlling DC motor using microcontroller PIC16F72 with PWM", International journal of Engineering Research, Volume no.1, Issue no2, pp: 45-47, 01 Dec 2012

[5]Snehlata Sanjay Thakare, Prof. Santosh Kompelli, "Design and Implementation of DC Motor Speed Control Based on PIC Microcontroller" International Journal of Engineering And Computer Science, ISSN: 2319-7242 Volume -3, Issue-9 September, 2014 Page No.8075-8079

[6]Bogdancroitoru, Adrian tulbure, Mihaliabrudean, "Microcontroller Based Multiple platform PWM Signal Generation procedures for industrial use", IEEE International conference on Automation, Quality and Testing, Robotics, 2014

[7]ShindeKrishant,TarateAkshay,Taur Sandip, Prof. Jayashree Deka, "Speed control of DC motor using pic 16F877A microcontroller" Multidisciplinary journal of research in engineering and technology .ISSN:2348-6953.

[8]Mekala.N, Muniraj .C "Implementation of PI Controller for 4Φ SRM Drive Using TMS320F28335" PInternational Journal of Power Electronics and Drive System (IJPEDS) Vol.5, No.3, pp.283-292, ISSN: 2088-8694, February 2015

[9] Sandeep Kumar Singh, Harish Kumar Kamal Singh, Amit Patel "A Survey And Study Of Different Types Of PWM Technique Used In Induction Motor Drive" International Journal of Engineering Science & Advanced Technology ISSN: 2250-3676[IJESAT] Volume-4, Issue-1,018-122.Jan –Feb 2014.

[10]V Srikant, G Prasad, BC Chakrapani, Samule Jaswant, V Ravi Shankar, P Sridhar "Microcontroller Based Speed Control of a DC Motor Using PWM Technique" International Journal of Advanced Trends in Computer Science and Engineering, Vol.5,No1, Pages 124-127(2016)

[11] AyuAnnurFetrahBtYusoff, "Microcontroller Based Delta Modulation PWM for 3-Phase Inverter", Faculty of Electrical & Electronic Engineering University Malaysia Pahang, JUNE, 2012.

[12]Texas Instruments, L-293D quadruple half-h drivers datasheet, slrs008c, November 2004.