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Result Paper: (TMS320 F 28027)Microcontroller Based PWM Signal Generation for Speed Control of DC Motor

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***Abstract*—**Inany modern factory all types of electromechanical devices are used such as AC motors, DC motors, power amplifiers. Therefore there is serious need of intelligent devices capable of driving and controlling a wide range of electrical and electromechanical devices. For controlling the speed of DC motor series architecture of variable resistors is not good because it drops excess of energy and flux and armature control methods cannot provide speed control in the desirable range. Therefore DC motor is controlled by Voltage control method in which PWM signal is used to control electromechanical devices and this PWM signal is generated from analog, digital IC and microcontroller. PWM signal obtained from analog or digital IC contains harmonics, therefore mostly PWM signals are generated from (TMS 320 F 28027) Microcontroller. It reduces the hardware complexity and it consumes less power. PWM signal generated using modifying CCP register of microcontroller. DC motor is interfaced with TMS microcontroller through H-bridge driver L-293D. H-bridge control the motion of DC motor. PWM signal is generated at four duty cycles for increasing or decreasing the speed of motor.

Keywords-*DC motor controlling, TMS microcontroller , Motor Driver,Experimental result*

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I INTRODUCTION

Any modern factory or facility is full of all types of intelligent machines. These machines contain one or more microcontrollers/microprocessors capable of controlling them. The different types of AC motors, DC motors and power amplifiers use the PWM signal to be controlled. This PWM signal is usually generated by special microcontrollers.

In industries, there are some of control techniques that can be applied to solve the problems such as DC motor speed, water tank and others. In designing a control system, factors such as the nonlinearity systems, time response, cost and reliability have to be taken into account. Many controller have been proposed to control digital servo motors including Optimal Control, Sliding Mode Control, Adaptive Control, Neural Network, Fuzzy Logic etc., however, these controllers are complex hence difficult to implement.On the other hand, microcontroller is widely used in feedback control of industrial processes and is simple in both structure and principles[8].

There is many microcontroller are available with special feature such as PWM function. The user is able to use the characteristics of PWM signal by accessing the PWM register and by modifying the value of PWM register such as:

- Frequency of PWM signal
- Duty cycle
- Pre-scale factor
- Bit length of timers.

The main aim of this project is to implement microcontroller (TMS 320 F 28027) based PWM signal generation for speed control of DC motor. PWM signal will be generated at four duty cycles with values 25%, 50% ,75% and 100% using (TMS 320 F 28027) microcontroller. A motor driver used typically is a H-Bridge system.The rest of the paper is organized as follows-Section II describes Framework of proposed system. Section IIIdescribes the system performance and section IV concludes the paper.

II FRAMEWORK AND SYSTEM ARCHITECTURE

PWM is an effective method for adjusting the amount of power delivered to the load. PWM technique allows smooth speed variation without reducing the starting torque and eliminates harmonics.

The circuit diagram of propose system is shown in Figure1. This system comprises both hardware and software elements. Main system elements are (TMS 320 F 28027) microcontroller, DC motor, H-bridge driver and power supply.

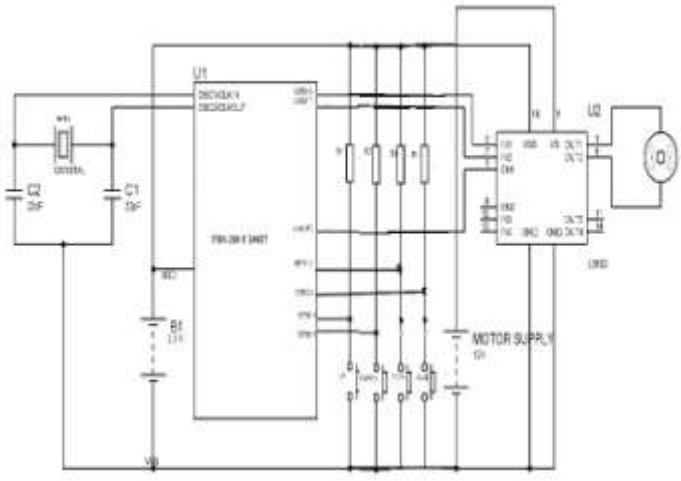

Figure 1: Circuit Diagram of Speed Control Of DC Motor

Fig.1 shows DC motor interfaced with microcontroller through H-bridge driver. TMS Microcontroller using L293D Motor Driver. Two Push Button switches are provided to control the speed of the motor and other switches are used to control the direction of motor. Here we are using 12V DC Motor and average DC value delivered to motor can be varied by varying the duty ratio of the PWM. The average

DC Voltage of 0% duty cycle is 0V, 25% duty cycle is 3V, 50% duty cycle is 6V, 75% duty cycle is 9V and for 100% duty cycle 12V.

III SYSTEM PERFORMANCE

A. SETUP FOR PWM OPERATION

Step 1: open all the ports of TMS 320 F 28027 microcontroller for configuring the GPIO pins. There are 22 GPIO pins are user programmable out of which four GPIO pins (GPIO2/3/4/5) are configured as input pins and another four GPIO pins (GPIO1/6/7/12) are configured as output pins. GPIO 2 is configured as input switch for clockwise direction. GPIO 3 is configured as input switch for anticlockwise direction. GPIO 4 is configured as input switch for increasing speed of motor by increasing the PWM duty cycle. GPIO 5 is configured as input switch for decreasing speed of motor by decreasing the PWM duty cycle. GPIO 6/7 are configured as output and it will fed the generated PWM signal to motor driver L293D for enabling the motion of motor.

Step 2: configure the 16 bit timers of ePWM3 and ePWM4 module for external interrupt calling. PCLKCR0 is system control register if it is set to 0 then all the timer base clock is stop else if it is set to 1 then start all timers. By modifying Event trigger selection register (ETSEL) external interrupt is generated at every 1sec. Here we can generates two external interrupt for speed and direction control.

Step 3: Setup for PWM signal generation
The following steps should be taken when configuring ePWM module for the PWM operation:
1: Set the PWM period by writing to the TBPHS register.

2: Set the PWM duty cycle by writing to the counter compare register set CMPA of ePWM1 module.

3: Make the ePWM1 pin an output by clearing the 16 bit TBCTL (Timer Base Control Register).

4: Enable the 16 bit timers of ePWM3 and ePWM4 module for interrupt calling.

5: Configure the ePWM1 module for PWM operation.

In this system the PWM duty cycle is different for clockwise and anticlockwise direction. PWM duty cycle set using by configuring the CMPA register.

PWM duty cycle for clockwise direction is:

PWM Duty cycle = (1875*2* applied duty cycle)

PWM duty cycle for anticlockwise direction is:

PWM Duty cycle = 15000-(1875*2* applied duty cycle)

Applied duty cycle is depend on duty cycle counter. There are 5 duty cycle counter. The duty cycle counter 0 is set in such way that the PWM duty cycle is 100%. In the same way at duty cycle counter 1 ,2,3,4 the PWM duty cycle is 75%, 50%, 25%, 0% resply.

If GPIO 4 == 0 and duty cycle counter < 4 then by pressing speed up switch applied duty cycle is incrementing and leads increase the PWM duty cycle and hence the speed of DC motor is increases.

If GPIO 5 == 0 and duty cycle counter >0 then by pressing speed down switch applied duty cycle is decrementing and leads decrease the PWM duty cycle and hence the speed of DC motor is decreases.

If GPIO 2==0 then by pressing the directional switch DC motor can be rotates in clockwise direction.

If GPIO 3==0 then by pressing the directional switch DC motor can be rotates in anticlockwise direction.

Step 4: For display the events such as speed or direction change the external desktop can be used for that initialization of serial communication is necessary. By modifying the serial communication control register (SCICTL) TX and RX function are enabled. For that baud rate is set at 11500 by configuring the SCIBAUD register. For enable TX interrupt the bit TXINTENA of SCICTL is set to 1. For enable RX interrupt the bit RXBKINTENA of SCICTL is set to 1. GPIO 28 pin used for transmission and GPIO 29 pin used for reception.

B. CONTROL ALGORITHM

The TMS 320 F 28027 microcontroller (MCU) can control the speed of DC motor accurately with minimum hardware at low cost . The flow chart of the control algorithm is shown (Fig.2)below. The program is written in micro C.

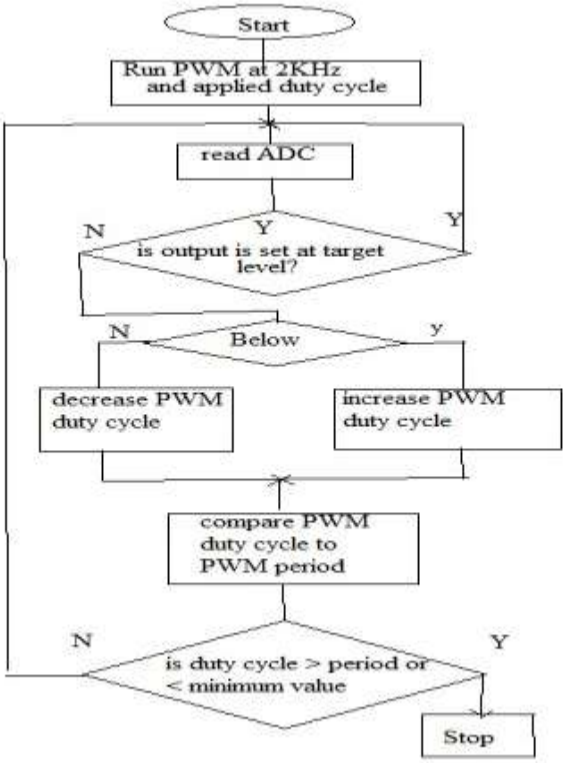

Fig.2 control algorithm

C. EXPERIMENTAL RESULT

In this experiment, the speed of the motor is observed at different duty cycles. Initially the duty cycle is set at 25% of the rated voltage and the speed is measured. Then duty cycle

is varied to observe the effect on motor speed. This system is able to maintain the desired speed at various loads.

Fig.3 shows the result at if PWM duty cycle is set to 25% and motor run in clockwise direction.

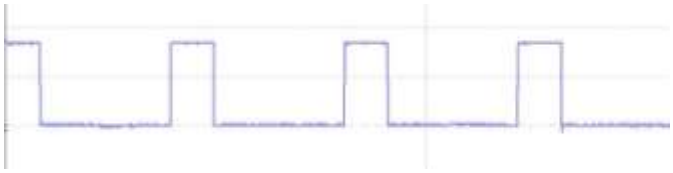

Fig.325% PWM duty cycle

Fig.4 shows the result at if PWM duty cycle is set to 50% and motor run in clockwise direction.

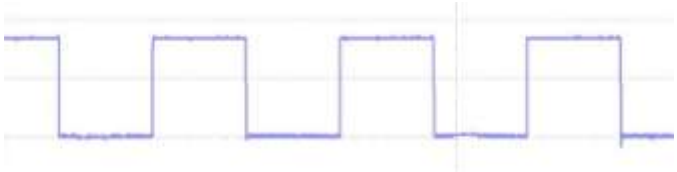

Fig.450% PWM duty cycle

Fig.5 shows the result at if PWM duty cycle is set to 75% and motor run in clockwise direction.

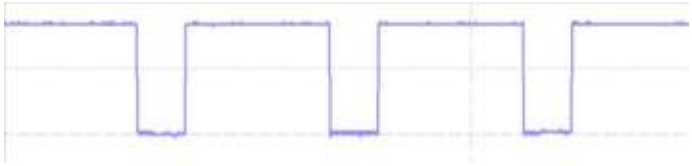

Fig.5 75% PWM duty cycle

Fig.6 shows the result at if PWM duty cycle is set to 100% and motor run in anticlockwise direction.

Fig.6 100% PWM duty cycle

Fig.7 shows the result at if PWM duty cycle is set to 75% and motor run in anticlockwise direction.

Fig.7 75%PWM duty cycle

IV CONCLUSION

We achieved DC motor speed control in desired range using TMS 320 F 28027 microcontroller. (TMS 320 F 28027) is DSP microcontroller therefore it eliminates need of 2nd controller in many complex operations. TMS 320 F 28027 is 32 MCU therefore it has wide bit range from 0 to2^{32}, it performing high numerical resolution problem and it gives faster response therefore it is more superior than 8/16 bit microcontrollers. PWM signals are generate by using TMS 320 F 28027 microcontroller it gives smooth speed variation without reducing starting torque and eliminates harmonics.It reduces the hardware complexity and it consumes less power.

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