SIMULATION OF PWM CONTROLLER BASED DC MOTOR

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Abstract— In this paper a control topology for DC motor is presented using PWM technique. PWM based control system design with H-bridge motor driver circuit. A design of DC motor driver, based on the H bridge using complementary IGBT type, is proposed in this paper. Differing from the conventional DC motor driver requiring dead time generation, the proposed driver does not has a dead time generator by using gate bias. Therefore, this proposed H-bridge driver without dead time generation can not only reduce its hardware complexity, but also increase the driving efficiency.

Index Terms — Pulse Width Modulation (PWM) technique, H-bridge converter, DC Motor, Matlab Simulation, Waveform.

I. INTRODUCTION

Electrical motors are extensively used in commercial and industrial applications. Electrical motors are an important part of any electrical system because they consume about 65% to 70% of all electricity generated. Earlier manually control used for control of dc motor. In manual control size of controller quite large because of the large size change over switch is used in case of high rating motor for industrial application, so cost of the control circuit increased. Manual (mechanical) control not preferred because it depends on mechanical time constant which is much higher than the electrical time constant. Earlier DC motor was controlled by conventional method.

H-Bridge converters are used for control DC motor. The bridge control is generally obtained by means of a pulse width modulation (PWM) technique. The most flexible control is obtained by means of a separately-excited DC motor, in which the armature and field circuits are provided with separate sources, The speed control in DC motor is widely applied , Methods of control in DC motors are in most cases simpler and less costly than those in AC motors, to obtain the same performance, The speed can be controlled either by the control of armature voltage, field voltage or both depending upon the desired performance characteristics of the drive. Recent developments in science and technology provide a wide scope of applications of high performance electric motor drives in areas involving mechatronics, such as robotics, rolling mills, machine tools, etc.

II. PULSE WIDTH MODULATION

PWM has been widely used in, power electronic applications, such as power converters and inverters, motor drive, and active power filters .There are many different ways to control the speed of motors but one very simple and easy way is to use Pulse Width Modulation**.** The power applied to the motor can be controlled by varying the width of these applied pulses and thereby varying the average DC voltage applied to the motors terminals. By changing or modulating the timing of these pulses the speed of the motor can be controlled, i.e. the longer the pulse is "ON", the faster the motor will rotate and likewise, the shorter the pulse is "ON" the slower the motor will rotate. In other words, the wider the pulse width, the more average voltage applied to the motor terminals, the stronger the magnetic flux inside the armature windings and the faster the motor will rotate and this is shown below. Fig. 1 shows the different ratio of duty cycle. The use of pulse width modulation to control a small motor has the advantage in that the power loss in the switching transistor is small because the transistor is either fully "ON" or fully "OFF". As a result the switching transistor has a much reduced power dissipation giving it a linear type of control which results in better speed stability.

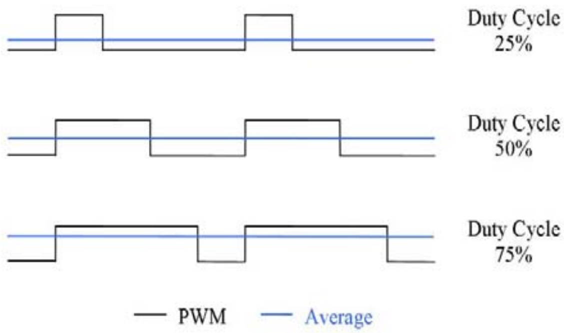

Fig. 1 Ratios of Duty cycle

A. Matlab Simulation of PWM

Fig. 2 show the simulation of PWM with 30% duty cycle.

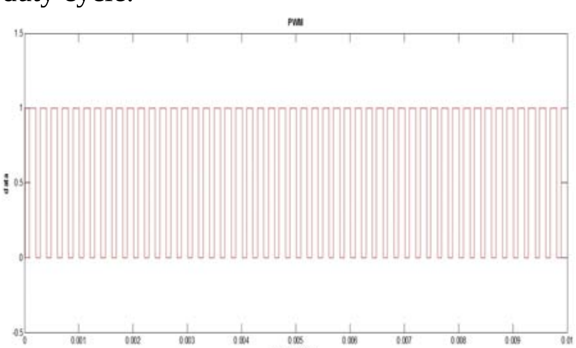

Fig. 2 Simulation Result of PWM with 30% duty cycle

III. H-BRIDGE

An H-Bridge is an electronic power circuit that allows motor speed and direction to be controlled. Most DC Motors can rotate in two directions depending on how the battery is connected to the motor. Both the DC motor and the battery are two terminal devices that have positive and negative terminals. In order run the motor in the forward direction, connect the positive motor wire to the positive battery wire and negative to negative. However, to run the motor in reverse just switch the connections; connect the positive battery wire to the negative motor wire, and the negative battery wire to the positive motor wire.

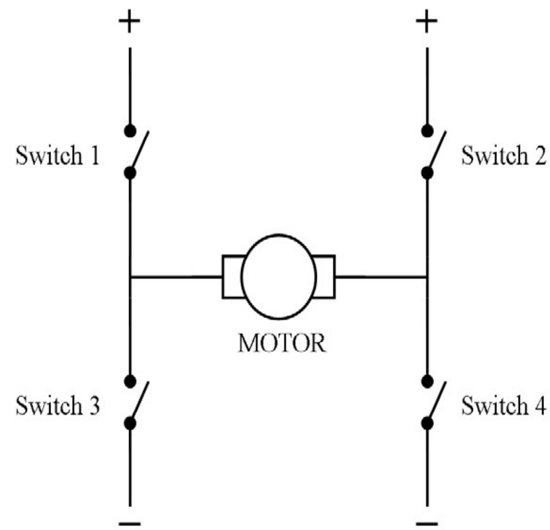

Fig. 3 Basic H-Bridge

An H-Bridge circuit allows a large DC motor to be run in both directions with a low level logic input signal. As shown in fig. 3 the IGBTs switches are used for switching. If it is desired to turn the motor on in the forward direction, switches 1 and 4 must be closed to power the motor. Fig. 4 below is the H-Bridge driving the motor in the forward direction.

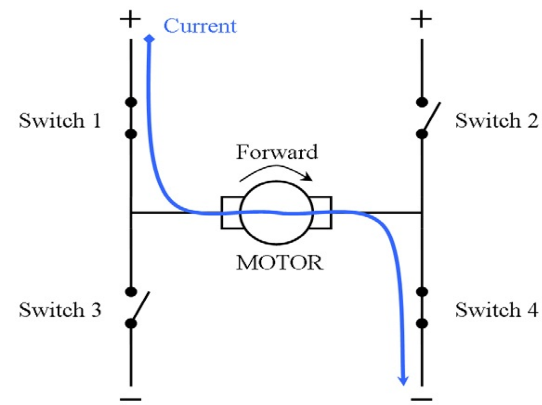

Fig. 4 Forward Motoring

If it is desired to turn the motor on in the reverse direction, switches 2 and 3 must be closed to power the motor. Fig. 5 below is the H-Bridge driving the motor in the reverse direction.

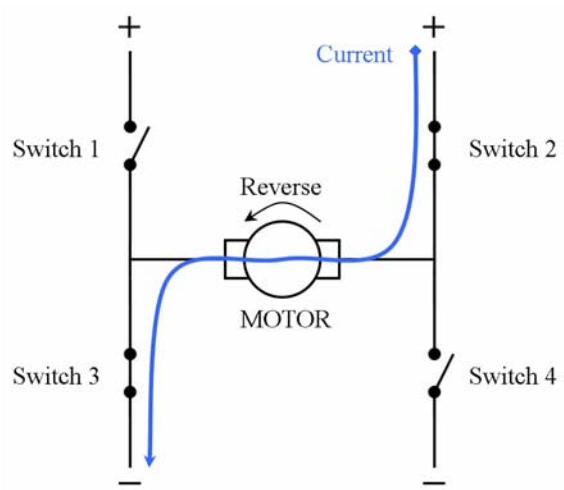

Fig. 5 Reverse Motoring

IV. SIMULATION FOR FORWARD MOTORING

This is the Simulation of Motoring Operation. In this simulation IGBT based H-Bridge is used. Arduno is used for logic signal. Fig.6 show the simulation of forward motoring and reverse motoring operation.

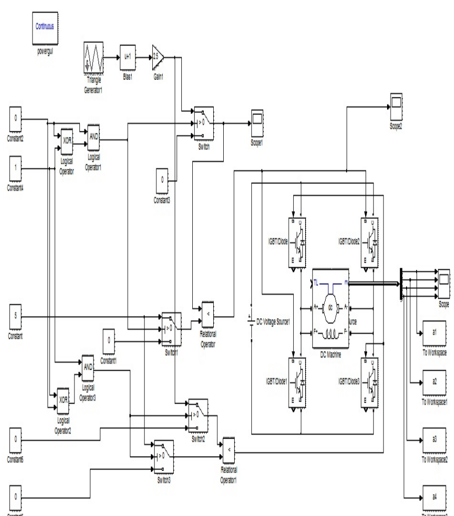

Fig. 6 Matlab Simulation

V. WAVEFORM IN FORWARD DIRECTION

Results of the given simulation is shown in below figures for forward motoring operation. Each waveform shows different parameters.

A. Armature Current in Ampere

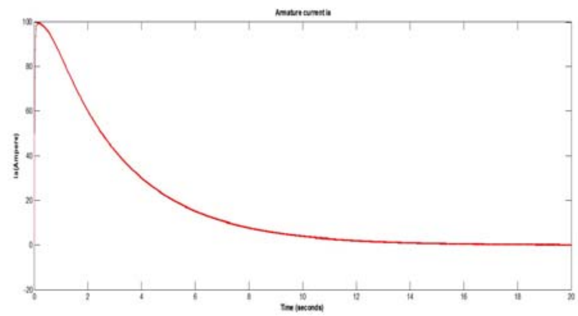

Fig. 7 Armature Current

B. Field Current in Ampere

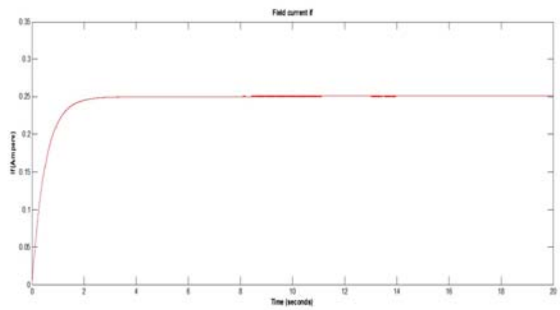

Fig. 8 Field Current

C. Speed in W_m

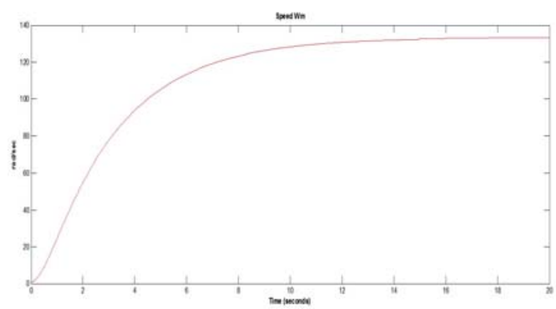

Fig. 9 Motor Speed

D. Electrical Torque in N.m

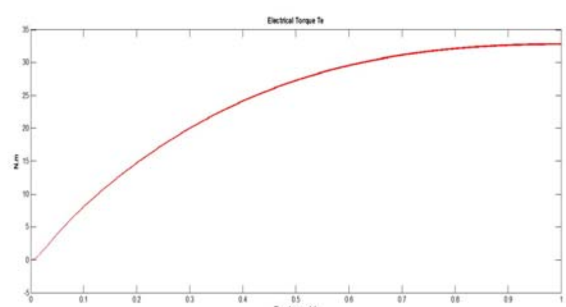

Fig. 10 Electrical Torque

VI. Waveform in Reverse Direction

Results of the given simulation is shown in below figures for reverse motoring operation. Each waveform shows different parameters.

A. Armature Current in Ampere

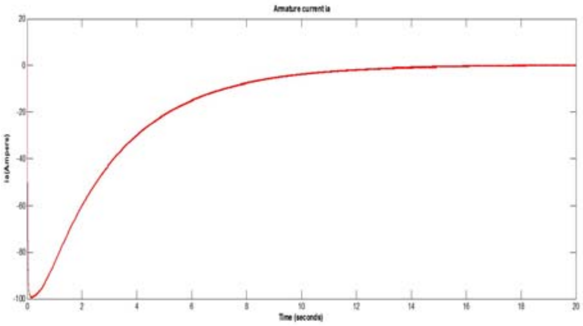

Fig. 11 Armature Current

B. Field Current in Ampere

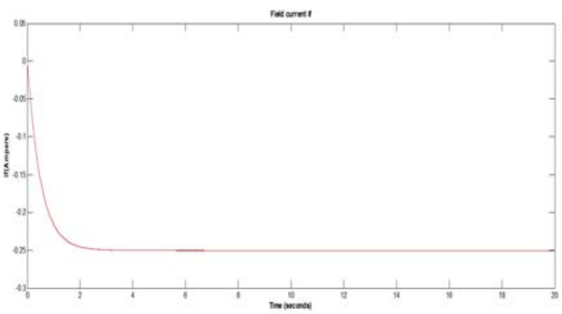

Fig. 12 Field Current

C. Speed in W_m

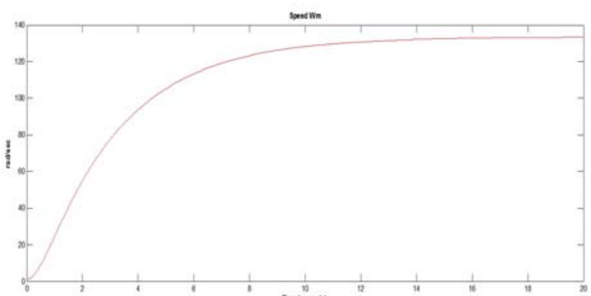

Fig. 13 Motor Speed

D. Electrical Torque in N.m

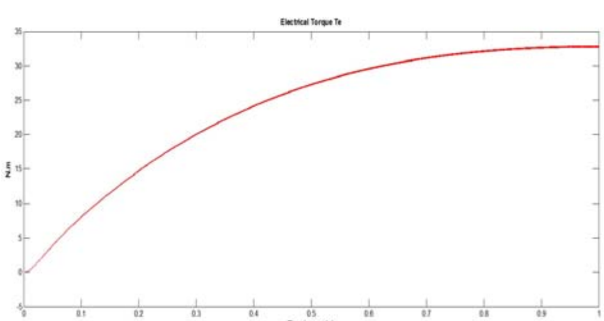

Fig. 14 Electrical Torque

VII. Conclusion

Speed control of DC motors is very simple and easy by using Pulse Width Modulation**.** The power applied to the motor can be controlled by varying the width of these applied pulses and thereby varying the average DC voltage applied to the motors terminals. So here PWM analysis carried out for speed control of DC Motor. The different Parameter like current of Motor are analyzed with help of Matlab. This simulation shows that by using PWM topology the motor can operate forward and reverse direction successfully.

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