INTERNATIONAL JOURNAL OF SCIENTIFIC PROGRESS AND RESEARCH (IJSPR) ISSN: 2349-4689
Volume-14, Number - 02, 2015

# Speed Control of DC Motor Using Dual Converter

Saniya Naseem Zunjani[1], Amit Shrivastava[2], Amol Barve[3]

*P.G. Student, Professor, Professor*

*Department of Electrical Engineering*

***Abstract - Dc motors are widely used in applications requiring adjustable speed, good speed regulation and frequent starting, braking and reversing. Important applications are rolling mills, paper mills, mine winders, hoists, machine tools, traction, textile mills etc. Today variable speed application are dominated by dc drives because of lower cost, reliability and simple controlled drives used in industries. For this purpose we are designing a model that can control the speed of a DC motor and to control its speed different techniques can be used. Here we are designing a dual converter using thyristors to control the speed of our DC motor by controlling its firing angle.***

***Keywords: DC Motor, Dual converter, Bluetooth.***

## I. INTRODUCTION

The versatile control characteristics of DC motor have contributed in the extensive use of DC motor in the industry. Today variable speed application are dominated by dc drives because of lower cost, reliability and simple controlled drives used in industries. Speed control means intentional change of the drive speed to a value required for performing the specific work process. DC motors feature a speed, which can be controlled smoothly down to zero immediately followed by acceleration in the opposite direction without power circuit switching and dc motors respond quickly to the changes in control signals due to the dc motor's high ratio of torque to inertia.

There are several methods by which the speed of a DC motor can be controlled and they are 1. Armature resistance control, 2. Armature voltage control and 3. Flux control. Here we are showing the 'armature voltage control' method as this method is very economical for controlling the speed as compare to others.

Different converters can be used for controlling the speed of DC motors such as half converters, full converters and dual converters. We are using a dual converter for our work. When two single phase converters are connected backto back and gives four quadrant operation then it is called dual converter. The dual converter we are using has a controlled firing angle done by the micro-controller and thus it has a control on its output voltage and this voltage is provided to our DC motor. Now we know that the speed of the DC motor depends on its voltage so thus the speed can be controlled.

We are also using an android system from which we will be able to control our model with a mobile application by connecting a Bluetooth on our model.

## II. SYSTEM MODEL

The permanent magnet (PM type) DC motor is used which consist of an armature winding as in case of an usual motor, but does not necessarily contains field windings. The construction of these types of motors are such that, the radially magnetized permanent magnets are mounted on the inner periphery of the stator core to produce the field flux. The rotor on the other hand has a conventional dc armature with commutator segments and brushes. The diagrammatic representation of PM type DC motor can be given as:

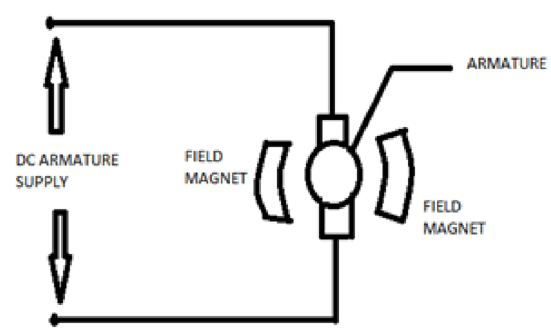


Fig. 2.1 Permanent Magnet DC Motor

The supply voltage to the armature will have armature resistance drop and rest of the supply voltage is encountered by back emf of the motor and is given by,

$$V = IR + E_b \quad \text{volts}$$

Where V is supply voltage, I is current, R is resistance and Eb is back emf.

Back emf can be given as,

$$E_b = \frac{\emptyset ZNP}{60A} \quad \text{volts}$$

And also the torque as,

$$T = K_e \phi I_a$$

Hence the speed can be given as,

$$\omega m = \frac{V}{Ke\emptyset} - \frac{R}{(Ke\emptyset)^2}$$

So we can say that, $\omega_m \alpha V$

By the above equation we can see that speed depends on the voltage and by varying the armature voltage speed can be varied.

We are designing a dual converter using thyristors to control the speed of our DC motor. A single phase dual converter is shown:-

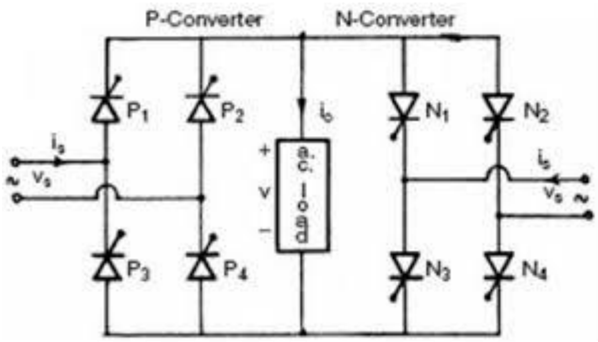


Fig 2.2 Single Phase Dual Converter

As we can see that there are two converters, operates in rectifying mode and second operates in conversion mode hence there output voltages will be equal and opposite.

Suppose the two converters having the output voltages as $V_1$ and $V_2$ (which are equal and opposite) and there firing angles are $\alpha_1$ and $\alpha_2$ respectively, then the equations will be,

$$\{(2Vm)/\pi\} \cos\alpha_1 = - \{(2Vm)/\pi\} \cos\alpha_2$$

$$\cos\alpha_1 = - \cos\alpha_2$$

$$\alpha_2 = \pi - \alpha_1$$

$$\alpha_1 + \alpha_2 = \pi$$

In this way our dual converters gives the four quadrant operation in which the first converter triggers when firing angle is less than 90° and the second will trigger when it is more than 90°.

## III. PREVIOUS WORK

Speed Control of DC Motor Using Thyristor Dual Converter The microcomputer is used to control the speed of a dc motor. The control algorithm are stored and implemented by the microprocessor of the microcomputer. The system employs the use of thyristor, which is controlled using the software implemented on the microcomputer. [1]

Krishnan T.; Kerala State Electronics Development Corporation Ltd. Trivandrum, India and Ramaswami B. showed "Speed control of DC motor using thyristor Dual Converter". The paper describes the design, construction and testing of a closed loop system for speed control of separately excited DC motor fed from a dual converter. The dual converter makes possible regenerative braking and reversal of direction of rotation. There is only one firing unit and the firing pulses are diverted to the appropriate converter by a master controller. There are three control loops: one for armature current control, one for adjusting the firing angle of the oncoming converter, and for speed control. [8]

## IV. PROPOSED METHODOLOGY

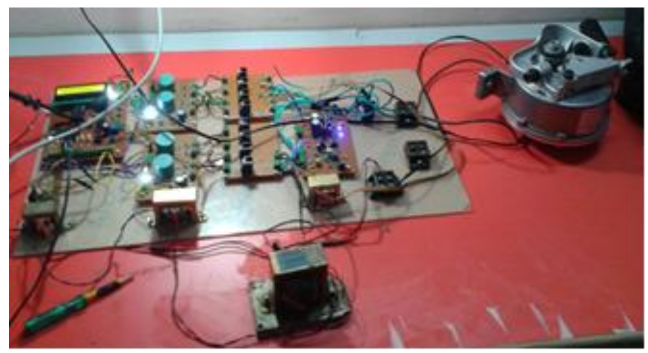

Fig 4.1 Hardware Model

The hardware model for controlling the speed of DC motor is shown in above figure.

Starting from the left our first PCB consists of micro controller (PIC16F877X), it has 40 pins DIP (dual in package). A LCD is connected with this microcontroller which shows the firing angle at which the system is working and also shows that our model is on Bluetooth mode or not. A Bluetooth is also connected here, with the help of this we can operate our model by an android application using our mobile. Four switches are present there Start, Stop, Forward and Reverse. A potentiometer is connected to our circuit which changes the firing angle when our model is not on Bluetooth mode. Opto couplers are connected in this circuit which provides synchronization and isolation to the circuit.

Power is supplied in the form of sine waves, which is converted into square waves by opto coupler so that it can be provided to the next circuit that is Pulse Transformer. Pulse transformer having the windings ratio 1:1:1 gives the voltage spikes or we can say that it provides the gate current with which the SCR turns ON.

Now this thyristor circuit gives an output voltage which goes to our DC motor. The firing angle for this thyristor circuit is done by the micro controller that's why its output voltage is controllable and so is the input voltage of our DC motor. As we know that the speed of the DC motor depends on the voltage hence by this the speed of our DC motor can be controlled.

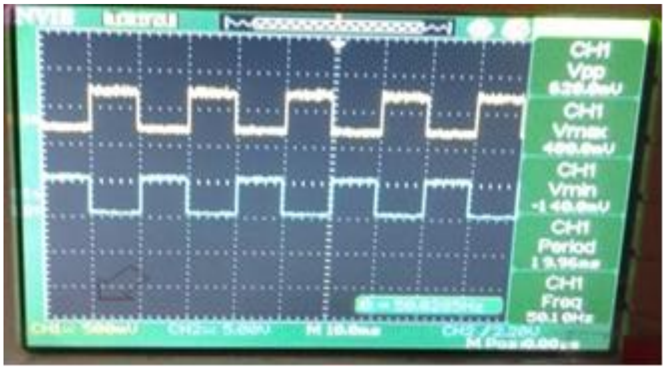


Fig 4.2 Synchronizing Waveforms

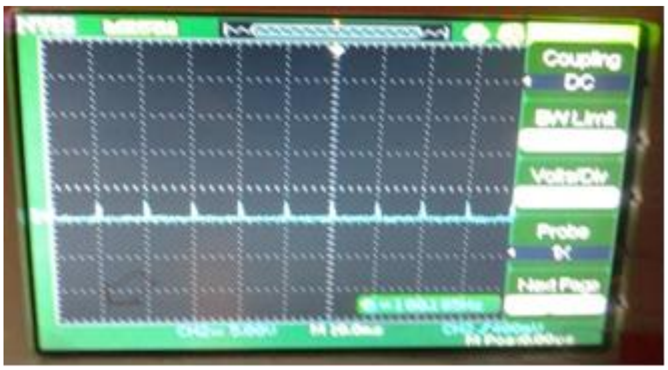


Fig 4.3 Firing angle at $0^0$ in forward direction

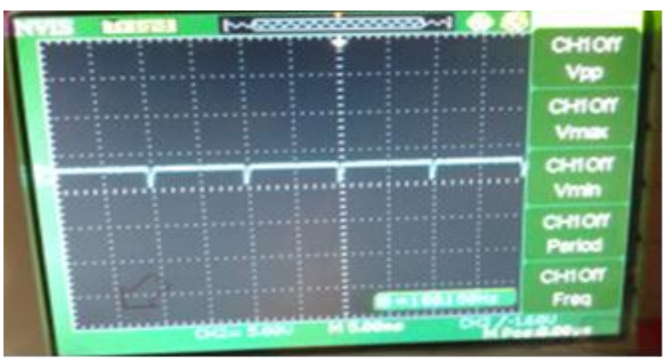


Fig 4.4 Firing angle at $0^0$ in reverse direction

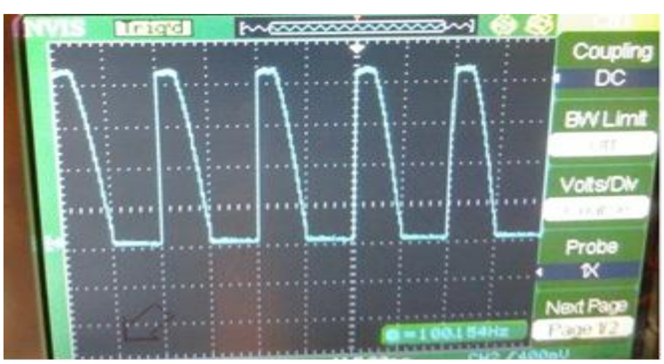


Fig 4.5 Firing angle at $90^0$ forward direction

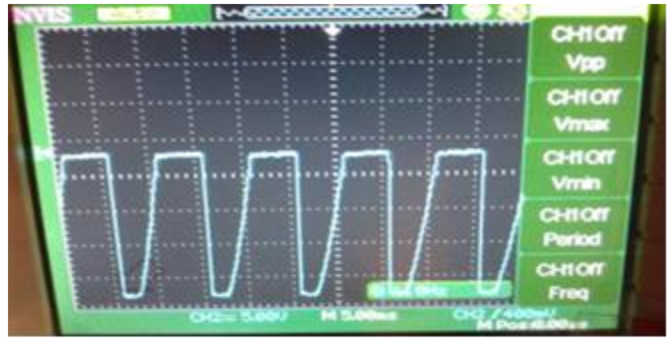


Fig 4.6 Firing angle at $90^0$ in reverse direction

ALGORITHM:-

1). Clearing of RAM and SFR.

2). Initialization of PORTS, PORT A, PORT B, PORT C.

3). Initialization of timer at 0.1 milli sec.

4). Press the switch 1 (start switch) LED glows, firing of thyristor takes place motor runs.

5). Press the switch 3 LED glows firing of thyristor takes place motor runs in forward direction.

6). Press the switch 2 (stop switch) LED glows motor stops.

7). Press the switch 1 (start switch) LED glows, firing of thyristor takes place motor runs.

8). Press the switch 4 LED glows firing of thyristor takes place motor runs in reverse direction.

9). Press the switch 2 (stop switch) LED glows motor stops.

## V. EXPERIMENTAL RESULTS

Speed control of DC Motor based on microcontroller done successfully under following condition:-

OPERATING SOURCE VOLTAGE = 230V AC

DC VOLTAGE = 230*1.414 DC

SOURCE CURRENT = 4 AMP (ARMATURE CURRENT) & 3.5 AMP (FIELD CURRENT)

FIRING ANGLE = 90 DEGREE

SPEED = 1500RPM

POWER = 1HP

| Firing Angle (In Degree) | DC Motor Speed (In rpm) |
|---|---|

| | |
|---|---|
| 0 | 1498 |
| 30 | 1249 |
| 45 | 1122 |
| 60 | 996 |
| 90 | 748 |
| 120 | 499 |
| 135 | 375 |
| 180 | 0 |

Table 5.1

NOTE: For both the directions (forward and reverse) of firing angle the speed will be same, but the direction of rotation will change. For forward firing angle the DC motor will rotate in clockwise direction and for reverse firing angle it will rotate anti-clockwise.

## VI. CONCLUSION

After collecting the required data for the project, data analysis is carried out. It was observed that previous scheme consumes less power but provides less torque thus not applicable in industries.

Following points are also under taken:

1). The speed of a dc motor has been successfully controlled by using SCR as a dual converter.

2). Under operating condition drive run successfully.

3). Microcontroller based design is done successfully.

4). Designing of firing angle with full speed is done. A 1 HP DC motor specification is taken and corresponding parameters are found out from derived design approach

5). Interfacing drive with computer.

## VII. FUTURE SCOPES

The drive is fully automatic and can be interfaced with PC. It is user friendly, low power drive with small size. Still following improvements can be done on the drive:-

1). Touch pad in place of keypad.

2). More user programmable settings can be embedded.

3). This drive work up to 2hp.

4). The microcontroller based design can be used in industrial automation.

5). This model also implement with DSP processor which help to make firing angle smoothens.

6). Microcontroller based design also implemented for computer software.

## REFERENCES

[1] Speed Control of DC Motor Using Thyristor Dual Converter," IEEE Trans, Vol, T-IECL, pp, 391-399, Nov. 1998.

[2] B.H. Khan, S.R. Doradla , and G.K. Dubey"A new simultaneous gating GTO dual converter-fed DC motor drive without circulating current" IEEE Transactions on Education.

[3] Gopal K.Dubey Fundamentals of Electricals Drives Narosa Publishing House, 2005.

[4] Muhammad H. Rashid, Power Electronics, Prentice Hall of India Pvt. Ltd.2012.

[5] P. S. Bhimbhra, Power Electronic, Khanna publishers, 2010.

[6] Sending and Receiving Data via Bluetooth with an Android Device by Brian Wirsing.

[7] Professor K. Eswaramma published a paper in Institution of Engineers (India) on 17 August 1982 titled "Speed Control of DC motor by Dual Converter".

[8] Krishnan T.; Kerala State Electronics Development Corporation Ltd. Trivandrum, India and Ramaswami B. "Speed control of DC motor using thyristor Dual Converter" Industrial Electronics and Control Instrumentation, IEEE Transaction on Nov. 1976.