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A Review Article of Speed Control of Dc Motor Using Chopper

Manish Yadav Asst. Prof. Lavkesh Patidar
Student of M.Tech. Power Electronics[1], Asst. Prof. Dept. of Electrical & Electronics Engg[2]
Dept. of Electrical & Electronics Engg.
Jawaharlal Institute of Technology
Borawan, Khargone, MP , India

***Abstract* - This paper deal with various method of speed control of DC Motor and literature review on speed control of DC motor is presented. DC motors are widely used in industry applications, robotics and domestic appliances because of its low cost and less complex control structure and wide range of speed and torque. So wide range of position control is required. Proportional Integral Derivative (PID) controller is used in industries for wide number of applications .The tuning of PID controller parameters is very important for desired out response there is so many techniques for tuning of PID controller.**

***Keywords*- MATLAB, Speed, PI controller, Chopper, DC motor.**

I. INTRODUCTION

The brushed DC motor was invented in 1856 by Werner Von Siemens in Germany. Variable speed by armature voltage control was first used in the early 1930s using a system involving a constant speed AC motor driving a D.C. generator. The generator's DC output was varied using a rheostat to vary the field excitation and the resulting variable voltage DC was used to power the armature circuit of another DC machine used as a motor. This system was called a Ward-Leonard system after the two people credited with its development.

The Ward-Leonard technique for DC variable speed control continued until the late 1960s when Electric Regulator Company brought to promote a businesslike, all around helpful, static, solid state controller that changed over the AC line genuinely to redressed DC using SCR (thyristor) devices. That advancement was gotten by in every practical sense all producers and still is being utilized today. It is a fundamental power control thought and usages minimal number of parts possible to convey variable speed from an electric motor. Speed control infers intentional contrast in the drive speed to a value required for playing out the specific work process. Speed control is a substitute thought from speed rule where there is trademark change in speed due change in weight on the post. Speed control is either done physically by the head or by techniques for some modified control device.

1) Armature control strategy.
2) Field control method[1-7].

II. FOUR QUADRANT DC MOTOR

Four Quadrant DC engine are amazingly utilized in customizable speed drive and position control application. Their velocities beneath the base speed can be constrained by armature-voltage control. Speeds over the base speed are acquired by field-motion control. As speed control technique for DC engines are less complex and more affordable than those for the AC engines, DC engines are favored where wide speed range control is required. DC choppers likewise give variable dc yield voltage from a fixed dc input voltage. Chopper circuit are work in four quadrant ie. Forward Motoring, Forward Braking, and Reverse Motoring and Reverse braking. This sort of chopper is generally use in reversible engine drive.

Protected Gate Bipolar transistor is blend of Bipolar Junction Transistor (BJT's) and Metal Oxide Semiconductor Field Effect Transistor(MOSFET's). It carries positive attributes of BJT's and MOSFT's. Four Quadrant Chopper is used for conversion of fixed DC into variable DC. Operation of four quadrant chopper is shown in figure1. In the first quadrant operation power can be flow from source to load and hence, current and voltage in the first quadrant are assumed to be positive[8-9]. Similarly, in second quadrant operation voltage remain positive but change in direction of current ie. negative this condition happened when load is inductive such as a DC motor in third quadrant operation current and the voltage are both in negative but the power is positive. Similarly in four quadrant operation current is positive and voltage is negative and therefore power is negative which is shown.

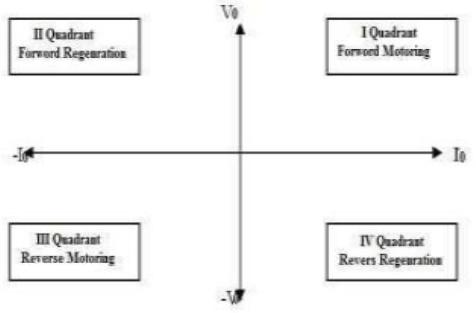

Fig.1 Basic operation of Four quadrant chopper.

At the first quadrant current and voltage are positive then the motor can rotate in the forward direction ie. Forward motoring. If the polarity of armature current and armature voltage changing then the motor can operated as reveres motoring ie. (III Quadrant) and when direction of energy is reveres in II and IV Quadrant the motor can operated as a generator braking. The chopper will give the facility of regenerative braking. The regenerative braking is Four quadrant chopper circuit Four quadrant operations can be carried out by the four switching devices with the diode connected in anti-parallel with switching diode, the motor is connected between the two arm A and B[10-12].

1. First Quadrant- When the supply is given to the circuit the T1 and T4 is ON, current flowing through the path,(Vdc+) -T1 – Load (A-B) -T4 –(Vdc-).hence both current and voltage are positive. During this condition the inductance get charge by positive polarity. The first quadrant operation can be achieved

2. Second Quadrant- During third quadrant operation inductor get fully charge it find path to get discharge during discharge the energy can dissipated through Load(B) –D1 – (Vdc+) –(Vdc-) –D4 –Load(A) since the voltage is positive and current is negative and second quadrant operation can be achieved.

3. Third Quadrant - When T2 and T3 are turned-on current start to flow through path (Vdc+) –T3 –Load (B-A) –T2 –(Vdc-),the current and voltage are negative. the second quadrant operation can be achieved. the inductor get charge again with the same polarity.

4. Fourth Quadrant- During first quadrant operation inductor get fully changed it will find the path to discharge for that inductor change the polarity and get discharge through path Load(B) -D3 –(Vdc+) –(Vdc -) – D2 – Load(A) in that case voltage negative and current is positive the fourth quadrant operation can be achieved. If we consider the power in the electrical system is given below Po= Vo * Io (1) Where, Po=Output power in the circuit Vo=Output voltage Io= Output current This gives the result that the system can allow the power flow in both direction while reversing the current and changing the polarity of the voltage, that way motor operated in both direction.The switches in the four quadrant chopper can be switched in two different modes:

- The output voltage swings in both directions i.e. from +Vdc to -Vdc. This mode of switching is referred to as PWM with bipolar voltage switching.
- The output voltage swings either from zero to +Vdc or zero to -Vdc. This mode of switching is referred to as PWM with unipolar voltage switching.

III. LITERATURE REVIEW

1.Prof. Monalishapattnaik - The speed control of independently energized dc engine is completed by fluctuating the armature voltage for beneath evaluated speed and by shifting field transition to accomplish speed over the appraised speed. This postulation exhibits the speed control system by changing armature voltage utilizing chopper by giving control sign to the switches. speed can be controlled from beneath and up to appraised speed .the terminating circuit of chopper gets signal from controller and variable voltage is given to the armature of dc engine as per the ideal speed .there are two controllers we are utilizing here one is speed controller and other is present controller. the two controllers are of corresponding - vital sort .the purpose for utilizing pi type controller is it evacuates the deferral and give quick control. presently the recreation of model is done and dissected in matlab (simulink) under fluctuating rate and torque condition.

2.Nazanin Afrasiabi - in this paper dependent on shut circle framework model and utilizing chopper as a converter and relative indispensable sort speed and current controller the speed of a dc engine has been controlled. at first for controlling pace of dc engine an improved shut circle is used and necessity of current controller is contemplated. after that dc engine is demonstrated all the more totally and a full design of dc drive framework is accomplished. a current and speed controller is planned. the speed control circle is streamlined through modulus embracing approach. a dc engine detail is taken and comparing parameters are driven from inferred configuration approach. at long last reproduction is performed for model with and without channel utilized after reference speed the reaction of the two techniques are contrasted and one another. an examination is additionally performed on the recreation results acquired under various reference speed and various burdens. the model shows great outcomes under all conditions utilized during reproduction.

3.Prof. Samadhan patil - the four quadrant chopper circuit is structure and executed in which the speed and course of the dc engine is control. igbt is give the smoother control as contrast with the scr henceforth, the controlling task of engine is smoother by changing the pwm beats the engine speed will be control effectively and engine will finish their activity in every one of the four quadrant along these lines the four quadrant speed control activity should be possible. this framework gives high unwavering quality. development of entire circuit is straightforward and strong in nature. this kind of activity for the most part reversible drive application for bi-course task of the engine.

4. Rishabh Abhinav- the speed of independently energized dc engine can be controlled from underneath and up to appraised speed utilizing chopper as a converter. the chopper terminating circuit gets signal from controller and after that chopper gives variable voltage to the armature of the engine for accomplishing wanted

speed. there are two control circles, one for controlling present and another for speed. the controller utilized is relative basic sort which evacuates the postponement and gives quick control. demonstrating of independently energized dc engine is finished. the total design of dc drive instrument is acquired. the structuring of current and speed controller is completed. the improvement of speed controller is finished utilizing modul ushugging approach, in order to get stable and fast control of dc motor. after obtaining the complete model of dc drive system, the model is simulated using matlab(simulink).the simulation of dc motor drive is done and analyzed under varying speed and varying load torque conditions like rated speed and load torque, half the rated load torque and speed, step speed and load torque and stair case load torque and speed.

5.Ragini Sonbarse- this paper manages the speed of dc engine can be control by utilizing chopper is to structure the four quadrant speed control model. the speed control of dc engine give structured model to four quadrant both way for example clockwise heading, counter clockwise bearing alongside braking of the dc engine .this task won't unrivaled than air conditioning engine , contrast and dc engine in light of the fact that the air conditioner engine changing the revolution of engine is unmanageable and convoluted to configuration as contrasted and the dc engine. thusly for the smooth in activity we can utilized the protect door bipolar transistor (igbt). for speed control of dc engine both way the chopper circuit is structured by utilizing igbt. the beat width regulation (pwm) is utilized enemy exchanging activity of igbt. the pwm structured sign model can be created by utilizing ic lm324 (quart operation amp). to control the course and the speed of engine, the four quadrant speed control system is definitely not a confused.

6.Ankita Ringe-this paper introduces on matlab reproduction on speed control of four quadrant dc drive utilizing chopper. the matlab reenactment is utilized to look at the exhibition of chopper circuit. to structure and actualize speed and heading of four quadrant chopper circuit, dc engine can be control.

7.Ainee Ansaari-dc engines are utilized broadly in flexible speed drives and position control applications. this paper proposes a technique to control the speed and heading control of a dc engine by utilizing a four quadrant dc-dc chopper. the speed underneath the base speed can be constrained by armature voltage control technique. igbts are utilized for the exchanging activity of the chopper. the entryways of these igbts are given heartbeat width tweak which gives the four quadrant activity. this heartbeat width balance is produced by programming the computerized sign processor utilizing the code author programming. the above model is mimicked in matlab.

IV. PRINCIPLE OF CHOPPER OPERATION

The chopper is a convertor which is controlled recompense convertor. The chopper use is to furnish with quenching assistant circuit or totally controlled gadget in four engines. This gadget called as controlled replacement convertor in light of the any gadget control is much these gadget both time for example passage time and for hindering their conduction is accomplished uniquely at well-characterized point in time. In flexible speed drive and position control application for four quadrant DC engine are generally utilized. The speed of base speed of DC engine can be controlled their rates will be decline by armature voltage control.

The base speed of DC engine can be increment by field transition control. As speed control of AC engine is anything but a decent on account of are giggle and less exorbitant. For DC engine of speed control technique. The utilization of DC engine where more speed range control will be required. DC chopper likewise accommodated transformation variable DC yield voltage from fixed DC input voltage. The forward motoring, forward breaking, invert motoring and switch breaking this are four quadrant and this quadrant chopper circuit will be worked the utilization of this sort of chopper in reversible engine drive

Classification of Chopper may be classified as following

1. On basis of input and output voltage level: a) Step-down chopper

- Class A
- Class B
- Class C
- Class D
- Class E

2. Step-up chopper

- Class B 2. On basis of circuit operation:
- First quadrant
- Second quadrant
- Four quadrant 3. On basis of commutation method
- Voltage commutation
- Current commutation
- Load commutation
- Impulse commutation

A chopper is a static power electronic device which converts fixed dc input voltage to a variable dc output voltage. It can be step up or step down. It is also considered as a dc equivalent of an ac transformer since they behave in an identical manner. Due to its one stage conversion, choppers are more efficient and are now being used all over the world for rapid transit systems, in marine hoist, in trolley cars, in mine haulers and in forklift trucks etc.

The future electric automobiles are likely to use choppers for their speed control and braking. Chopper systems offer smooth control, high efficiency, faster response and regeneration facility. The power semiconductor devices used for a chopper circuit can be force commutated thruster, BJT, MOSFET, IGBT and GTO. Among above switches IGBT and GTO are widely used. These devices are generally represented by a switch. When the switch is OFF, no current will flow. Current flows through the load when switch is ON. The power semiconductor devices have on-state voltage drop of 0.5V to 2.5V across them. For the sake of simplicity, this voltage drop across these devices is generally neglected.

V. CONCLUSION

The speed of a dc motor has been successfully controlled by using Chopper as a converter and Proportional-Integral type Speed and Current controller based on the closed loop model of DC motor. Initially a simplified closed loop model for speed control of DC motor is considered and requirement of current controller is studied. Then a generalized modeling of dc motor is done. After that a complete layout of DC drive system is obtained. Then designing of current and speed controller is done. Now the simulation is done in MATLAB under varying load condition, varying reference speed condition and varying input voltage. The results are also studied and analyzed under above mentioned conditions. The model shows good results under all conditions employed during simulation. Since, the simulation of speed control of DC motor has been done. We can also implement it in hardware to observe actual feasibility. Here speed control of DC motor is done for rated and below rated speed. We can also control the speed of DC motor above rated speed and this can be done by field flux control.

VI. FUTURE SCOPE

The speed of the motor has been varied successfully in an open loop manner in accordance with the change in duty ratio. Future scope is to control the speed of the motor in a closed loop manner by taking a feedback from the taco generator and giving it as a feedback to the DSP. Where in the DSP, it compares the desired value and the actual value and gives an error voltage which is given to the motor through an interface circuit. In this manner, the speed of the motor can be controlled as per the user.

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