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Analysis of Boost Converter fed DC Motor

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Abstract: This paper explains the simulation of boost converter fed DC motor. The output voltage of the boost converter is maintained constant regardless of slight change in input voltage. Using PID controller output voltage of the boost converter is kept constant. The output voltage of boost converter is fed to the DC motor. Hence speed of DC motor is controlled and kept constant for various applications.

Keywords: Boost converter, DC motor, PID controller.

I. INTRODUCTION

DC motors are used in Industrial applications where wide range of speed control is required. The main advantages of DC motor is it presents the wide range of speed control both above and below the rated speed. DC series motors are used in electrical traction applications. These motors have high starting torque. There for used in electrical trains and cranes.
In order to maintain constant speed of dc motor the armature voltage is kept constant. For this DC-DC converter is used. The armature voltage is kept constant by using PID controller. In olden days PID controller is demonstrated by using op-amps. The proportional (K_p), integral (K_i),and derivative(K_d) are set by choosing appropriate capacitor and resistors. These are now replaced by controllers such as 8051,PIC etc. All circuits and constant parameters are written in program .The simulation is done by MATLAB and K_p, K_i, K_d values are turned by trial and error method[1].

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II. PRINCIPLE OF OPERATION

Figure 1 shows the block diagram of DC motor fed from boost converter. The armature voltage of DC motor kept constant by using DC-DC converter [1]-[3]. Here PID controller is used to maintain the voltage constant. The output voltage of converter is given as feedback to the controller. The controller gives the pulse to the gate of the switch and by tuning K_p, K_i, K_d to the appropriate value voltage maintained constant[7].

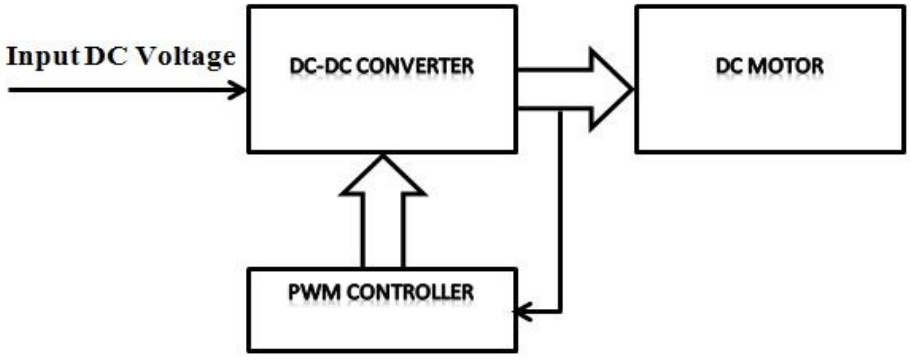

Fig 1.Block diagram of DC motor fed by Boost converter

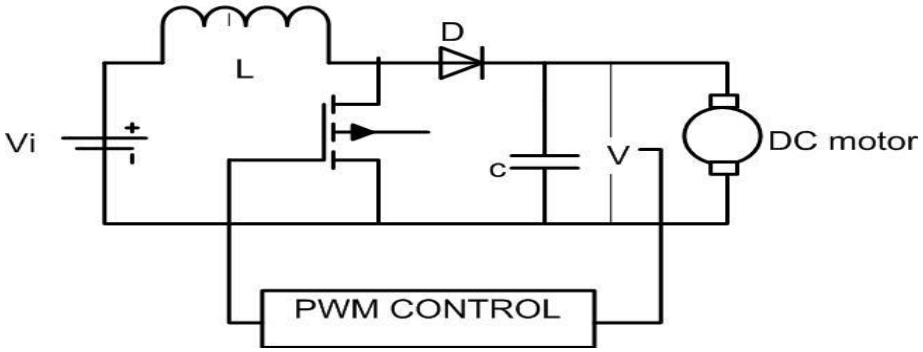

Fig 2 Proposed circuit Diagram

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III. PID CONTROLLER

PID controller keep on calculates an error value as the difference between a measured process and a desired set point.K_p denotes the present value of the error.If error is more and positive, then control variable is high value and negative.K_i denotes the past values of error. K_d accounts for possible future values of error. If u(t) is controller output then

PID formulae is $u(t) = K_p e(t) + K_i \int_0^t e(\mathcal{I})\, d\mathcal{I} + K_d \frac{de(t)}{dt}$

Where:K_p: Proportional gain, a tuning parameter

K_i: Integral gain, a tuning parameter

K_d: Derivative gain, a tuning parameter

e =Error = set point- Process variable

t: Time or instantaneous time (the present)

$\mathcal{I}$: Variable of integration; takes on values from time 0 to the present t

The parameters K_p, K_i and K_d can be designed by bode controller design method if transfer function of the system is known. Experimental method if the model of plant is not known[3]-[6].

IV. MOTOR MODELLING

Separately excited DC motor of 0.5HP is used.The parameters of motor is as shown in Table 1.

TABLE I Parameters of DC motor

Power(P)	0.5HP
Voltage(V)	220V
Current(I)	3A
Armature resistance (R_a)	11 Ω
Field resistance (R_f)	166 Ω
Armature inductance (L_a)	122.57mH
Field inductance (L_f)	4.6H
Inertia constant (J)	0.002215kgm^2

V. SIMULATION RESULT

The simulation is completed by MATLAB/Simulink and the armature voltage is constant regardless in slight variation of input voltage..The model of Boost converter including motor is as shown in fig 3.The parameters of converter is as shown in Table 2.The boost converter is designed in such a way that output voltage kept constant. A separately excited DC motor 0.5HP, 220V and 3A is used.The speed of dc motor is constant is as shown in fig 7.The output current waveform of motor is as shown in figure 8.

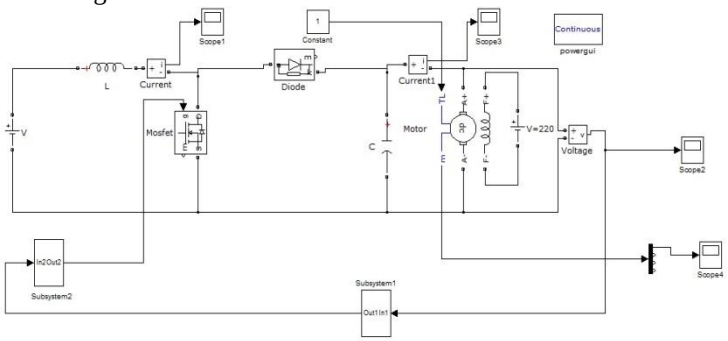

Fig 3 Simulation model

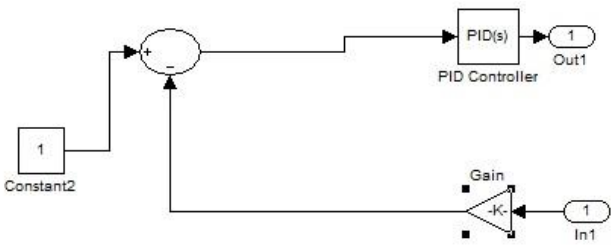

Fig 4. Subsystem1

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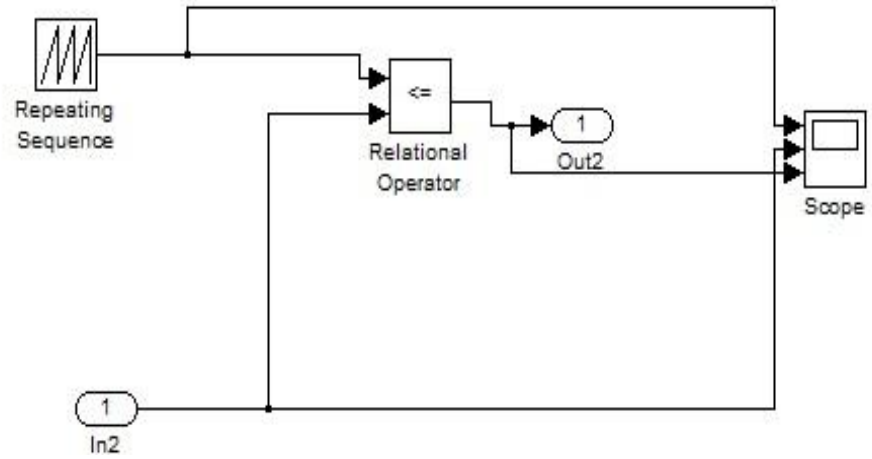

Fig 5. Subsystem2

TABLE II. Parameters of Boost converter

Range of Input Voltage	100-110V
Output Voltage(V)	220V
Capacitor(C)	37µF
Inductor(L)	230µH
Switching Frequency(KHz)	20KHz

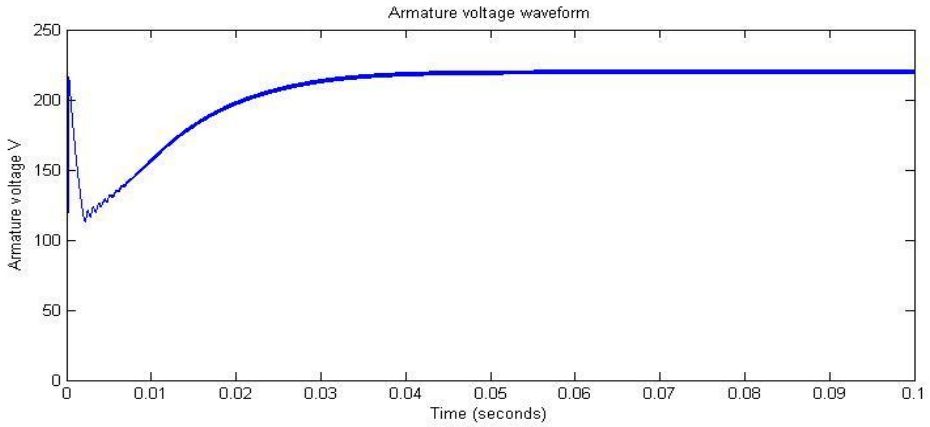

Fig 6. Armature voltage waveform

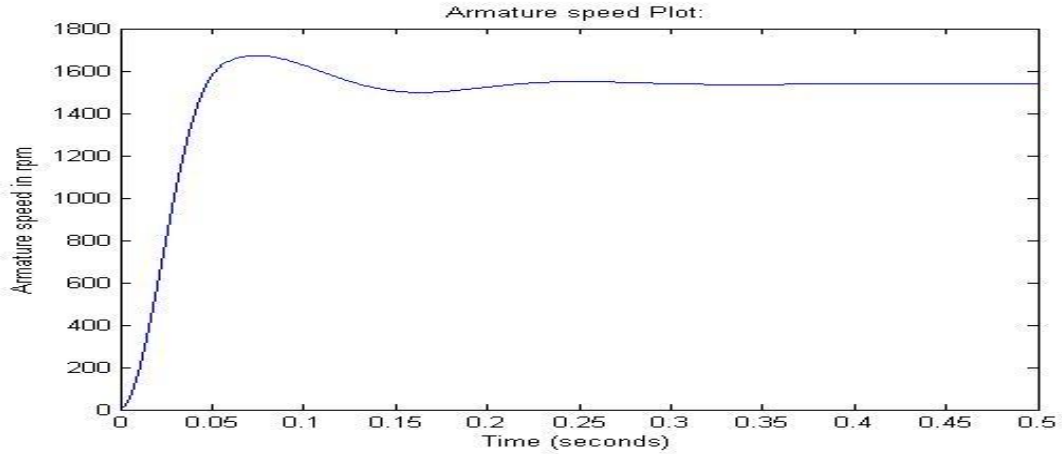

Fig 7. Speed of DC motor in RPM

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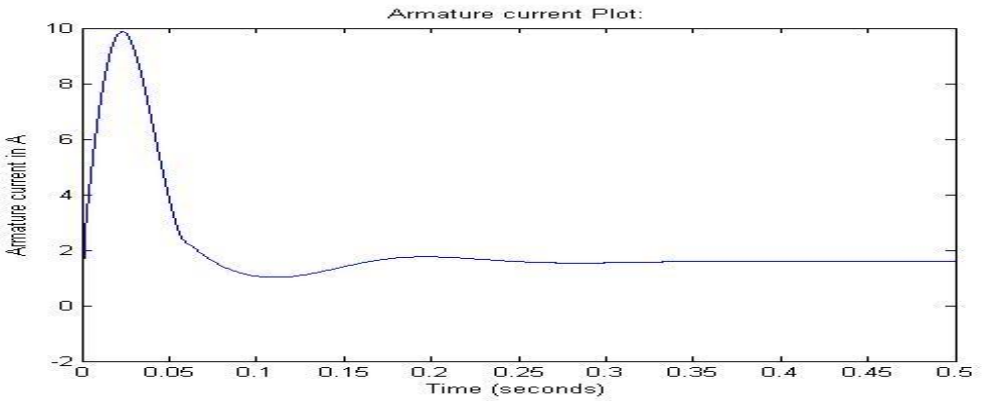

Fig 8. Armature current of motor

VI. CONCLUSION

The analysis of DC motoris completed. Motor is kept at a constant speed regardless of slight variation in input voltage .Using PID controller output voltage of the boost converter maintained constant.Hence speed of DC motor is controlled and kept constant for various applications.

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