# Speed Control of DC Shunt Motor using Arduino

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*Abstract*— DC motor are widely used for industrial applications because of easy speed control, high performance and reliability. The speed of DC motor can be controlled below and upward to the rated speed using boost chopper converter. By receiving the signals from the converter chopper firing circuit gives variable voltage to the armature of the motor for obtaining required speed. PWM technique is used for fulfil requirement of controlling the speed of DC motor using Arduino. A closed loop control system is used to control speed set by the user with respect to load. The controller used is Proportional-Integral type. It not only removes the delay but also provides fast control. Chopper drive consist of electronic components, microcontrollers, keyboard and LCD display etc. This drive is used for starting speed control and protection purpose. The model of complete DC drive system is simulated by using MATLAB SIMULINK. The simulation of DC motor drive is done and analysed under varying speed.

***Keywords:*** Arduino, MATLAB SIMULINK, LCD, DC Motor

## I. INTRODUCTION

Speed control of DC motor can be achieved by electrical and mechanical techniques but in conventional methods require large size of hardware implementation. Variable speed DC motor is used in various applications such as rolling mills, paper mills, traction, printing, textile mills etc. DC chopper drive has ability to supply continuous DC variable voltage which makes revolution in modern industrial equipment and drives. This results in controlling of a speed of DC motor by changing the voltage across the motor terminals. Following are the speed control techniques in separately excited dc motor:

- By varying the armature voltage for below rated speed.
- By varying field flux obtain speed above the rated speed.

A large amount of power is wasted in the resistance used in conventional methods. As speed variations depends upon the resistance and load current that causes problem to keep a constant speed at variable load. For dissipation of heat produced in the controller resistance it requires some arrangements which are more expensive. The speed above rated value cannot be control due to decrease in the armature voltage by controller resistance.

The purpose of this paper is to drive the motor at required speed according to the need of consumer. For large motors it is highly economical to use power electronics components in order to minimize power loss. Armature voltage is controlled by controlling the duty cycle of chopper which results in speed control of DC motor. Controlling duty cycle of pulse width modulation technique is done by Arduino.

## II. MATERIALS

### A. Arduino:

Arduino Uno is microcontroller board that has been used as a digital PI controller. This board issued to test the controller. Arduino has 14 digital input or output pins, out of them 6 can be used as a PWM output pins. It also has 6 analog inputs, 16MHz clock crystal, a USB connection that is used to connect it to the PC and it operates at 5 Volts. Various Arduino boards can be used instead of Arduino Uno

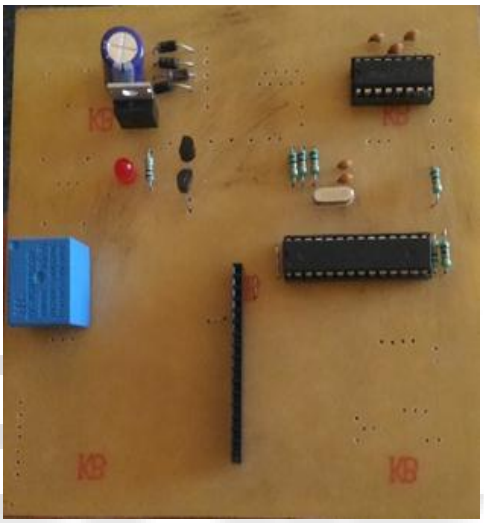


Fig. 1: Arduino Uno

### B. LCD Display:

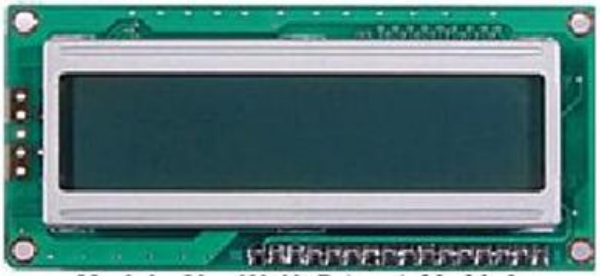


Fig. 2: LCD Display

This display contains two internal byte wise resisters, One for the commands (RS=0) and second for character to be displayed (RS=1). It also contains a user programmed RAM area (the character RAM) that can be programmed to generate any desired character that can form using a dot matrix. To distinguish between these two data areas, the hex command byte 80H will be used to signify that display RAM address 00H is chosen. Port 1 is used to furnish the command or data byte, and ports 3.2 to 3.4 furnish register select and read/write levels. For accomplishing the functions display takes varying amounts. To ensure the display is not overwritten the LCD bit 7 is monitored for logic high.

*C. Power MOSFET:*

It is basically an N-Channel power Metal Oxide Silicon Field Effect Transistor (MOSFET) and operates in enhancement mode. MOSFET is a lot sensitive in comparison to an FET (Field Effect Transistor) due to its very high input impedance. Power MOSFET can perform very fast switching as compared to the normal transistor. It is based on HEXFET technology and operates on the temperature ranging from -55 degree Celsius to 175 degree Celsius. For performing any of amplification process we need switching applications. MOSFET IRF540 performs very fast switching as compared to the general transistors. It has applications in real life such as high power switching drivers, switching regulators, relay drivers, switching converters, motor drivers.

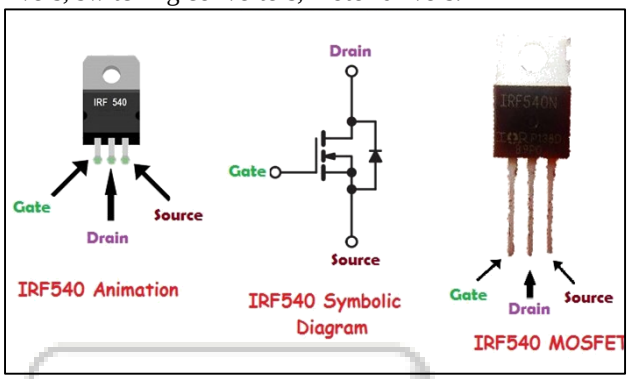



Fig. 3: IRF540 MOSFET

*D. Voltage Sensing unit:*

This Unit contains two parts such as Voltage divider bias and Optocoupler. Optocoupler isolates high voltage and low voltage circuits

## III. Block Diagram and Circuit Description:

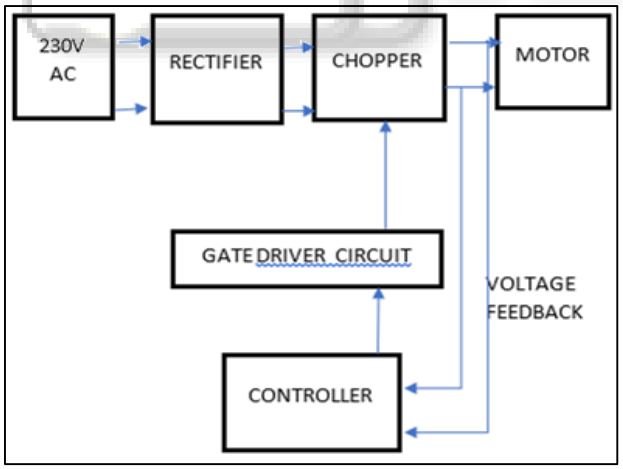



Fig. 4: Block Diagram

This Basic Block Diagram shows the overall process path for the project execution. First, we get the 230 V AC supply. Here we have to convert the AC to DC for this purpose we want to use Rectifier. After that fixed DC voltage is given to the Chopper circuit for getting variable DC voltage, which is then given to the Motor. The Speed of the motor is sensed by using Voltage sensor called as voltage feedback given to the controller circuit. Here the Reference parameter and actual parameter is compared and respective controlling actions are taken by using driver circuit proper gate pulse control of chopper is done.

*A. Rectifier*

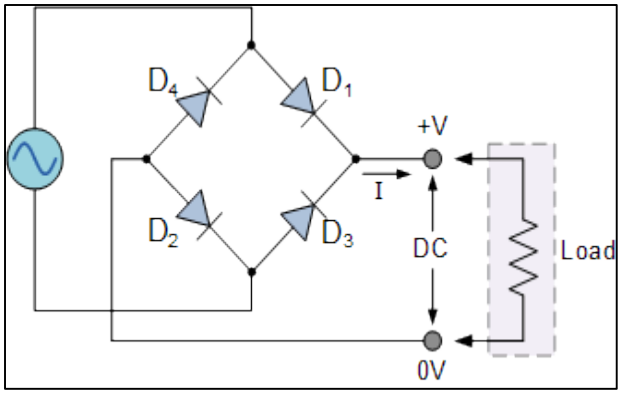



Fig. 5: Bridge Rectifier

Available 230V AC supply is converted into fixed DC. Supply. Single phase bridge converter is used since it has low ripple factor and high efficiency than single phase half wave rectifier and centre tapped full wave rectifier.

It converts the complete input waveform to one of constant polarity (positive or negative) at output of it. Mathematically, this corresponds to the absolute value function. Two diodes and a centre tapped transformer, or four diodes in a bridge configuration and any AC source (including a transformer without centre tap), are needed. Single semiconductor diodes, double diodes with common cathode or common anode, and four-diode bridges, are manufactured as single components.

*B. Chopper*

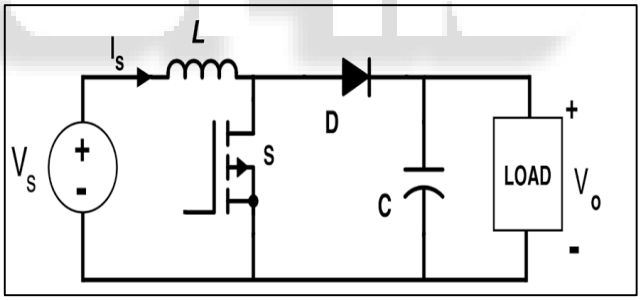



Fig. 6: Chopper

A chopper is a high speed “on" or “off” semiconductor switch. For the sake of highlighting the principle of chopper operation, the circuitry used for controlling the on, off periods is not shown. When the chopper is on and load voltage is equal to source voltage Vs during the period Ton. When the chopper is off, load voltage is zero during the period Toff. In this manner, a chopped dc voltage is produced at the load terminals.

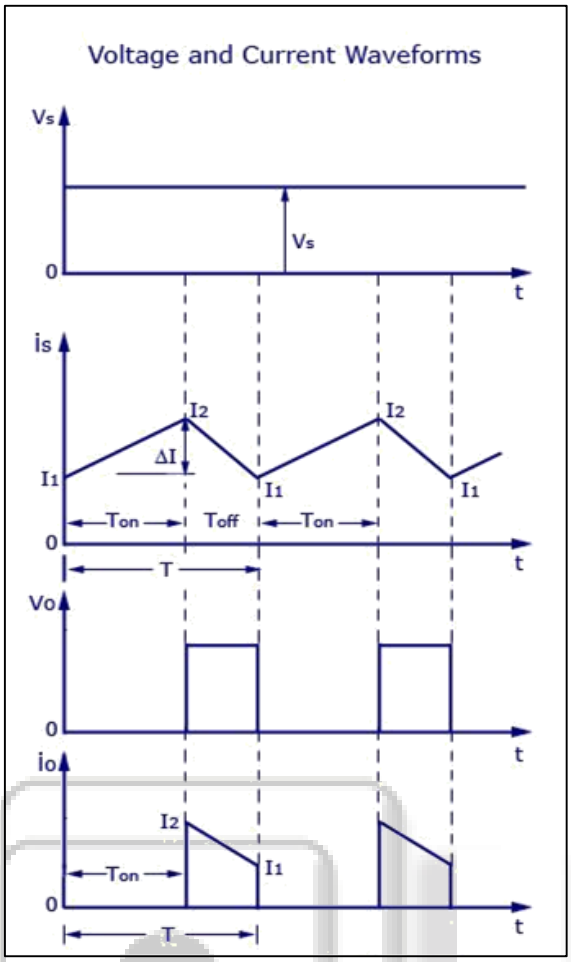



Fig. 7: Waveform of Chopper

*C. Controller:*

A controller calculates an "error" value as the difference between a measured process variable and a desired set point. This is composite control mode obtained by combining the proportional and integral mode. The important advantage of this control is that one to one corresponds of proportional mode is available while the offset gets eliminated due to the integral mode the integral mode part of such a composite control provides a reset of the zero-error output after a load change occurs. It improves the steady state stability. It increases the rise time so that time response becomes slow. It decreases the bandwidth of the system. It filters out high frequency noise. It makes the response more oscillatory.

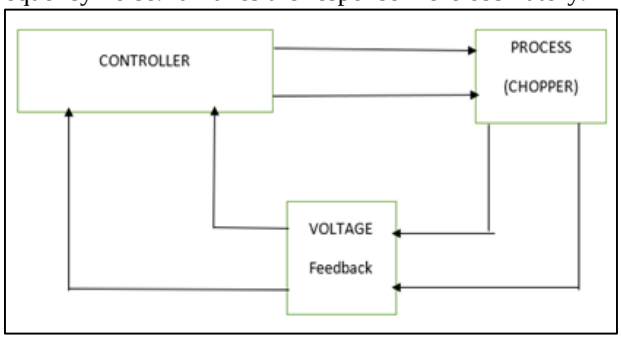
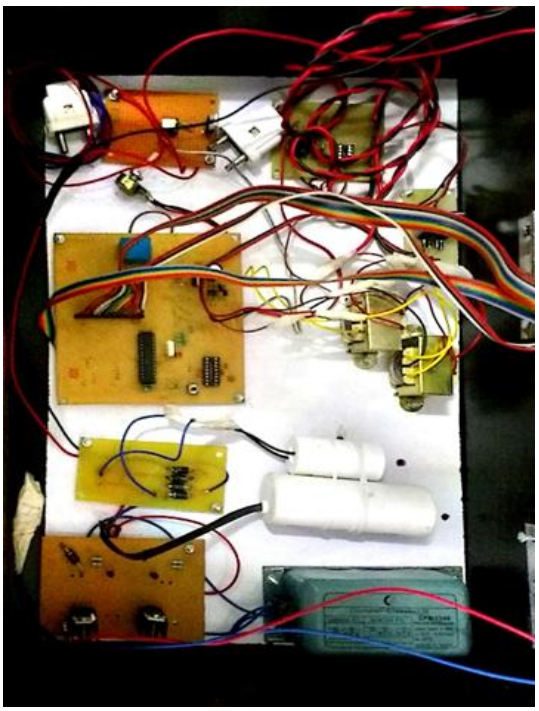



Fig. 8: PI Controller

## IV. HARDWARE IMPLEMENTATION



## V. CONCLUSION

Speed control of DC motor 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 motor terminals. As we know that the traditional methods of speed control of DC motor are less efficient, the loses are taking place more and more so to overcome these losses we use different controlling techniques using the software. As Microcontroller based and Bluetooth based controlling has no accuracy about the speed control variations. By using the Arduino, we can obtain the ease speed control and variety of speed can be achieved. This gives the high accuracy.

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