SPEED CONTROL OF DC MOTOR USING ARDUINO

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ABSTARCT

DC motors are used extensively in industries where high torque is required. Because of it's flexibility in speed controlling and good speed-torque characteristics it is very much in demand. The PID controller is generated by an arduino program and used in the speed control of DC motor. The objective of this paper is to control the speed of the DC motor using Arduino. Arduino board plays the role of low cost data acquisition board.LM393 is a sensor which measures the revolutions. From sensor the output is sent back to the controller. The controller compares the actual speed of the DC motor with the set speed. If the speed is not the same the controller will try to minimize the error and bring the motor to the set point value.

KEYWORDS: *Arduino, DC Motor, PID Controller, LM393 IR speed sensor*

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1. Introduction

DC motor is an electrical machine which converts electrical energy into mechanical energy. In the past few years the use of DC motor has widely increased due to it's good characteristics like high starting torque, high response performance, rapid braking and easier to be liner control. Because of these characteristics it has gained a wide application in industries. DC motor are highly versatile and flexible in aspects of speed control and thus it is use in steel rolling mills, cutting tool, high precision digital tools and other applications etc. The advantage of using DC motor over AC motor is that the DC motor are simple and less expensive. Also the speed-torque characteristics of DC motor are superior to that of AC motor. There are several different control techniques adapted to control the speed of DC motors. In this paper the speed of DC motor is controlled by using Arduino microcontroller. Simulink will in turn pass this speed to the DC motor using a PWM pins on arduino uno board. The PID controller will generate corresponding PWM pulses to control the speed of DC motor.

2. Basic Block Diagram:-

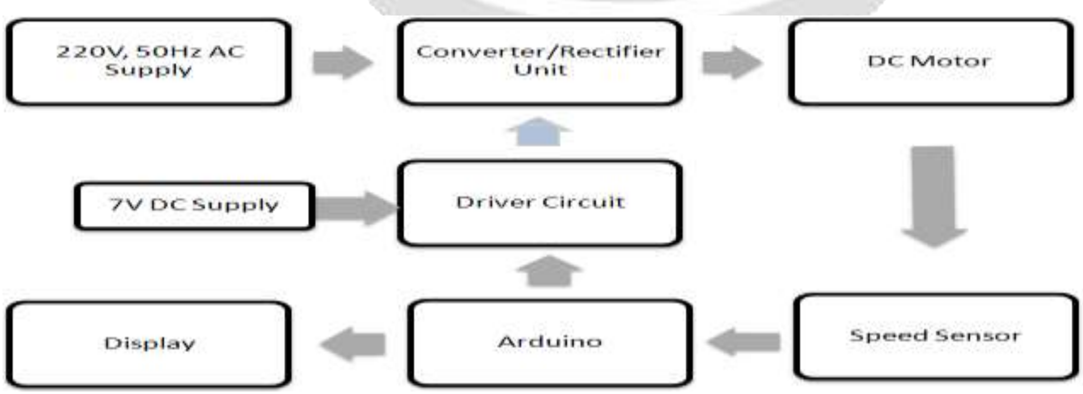

Fig.2.1

3. PID Controller

Feedback control is a control mechanism that uses information from measurements in a feedback control system, the output is sensed and the required action is taken by the controller. PID is widely used is feedback control of industrial processes. The pid controller can be understood as a controller that takes the present, the past and the future of the error into consideration. A proportional-integral-derivative controller (PID controller) is a closed loop control method. In this method there are three controllers namely-

1. Proportional Controller

2.Integral Controller

3.Derivative Controller

3.1 Proportional controller

This controller deals with the present error. It produces an output value equivalent to the error value to stabilize the system. It's response can be adjusted by multiplying the error value by constant value (K_p), which is known as the proportional gain constant. The proportional value can be represented as

$P_{out}=K_p*e(t)$

Depending on the change in the value of proportional gain the output for given error changes.

3.2 Integral controller

This contributes to both the magnitude of error and duration of error. The error value in integral controller is multiplied with the integral gain (K_i) and is then added to the controller output to get the desired response. The integral term is given by

$I_{out}=K_i \int_0^t e(t)dt$

The integral term eliminate the steady state error and helps in accelerating the response of the system towards the setpoint.

3.3 Derivative control

The derivative term of the process error is calculated by determining the slope of the error overtime and multiplying this rate of change by the derivative gain(K_d). The value of the derivative term is given as

$D_{out}=K_d\frac{de(t)}{dt}$

4. Tuning Method used for PID

4.1 Trial and error method:-

This method is commonly used for tuning of PID. In this method different values for PID are set for desired output. Initially we set all the values to zero afterwards by varying the values in the order of P, I and D we achieve the desired response. However this method is time consuming.

5. DC Motor

Controlling the speed of DC motor is easier than AC motor. Also the speed-torque characteristics of DC motor are superior to that of AC motor. The specifications of the motor are

voltage -7V

Speed -5000rpm

current -3.2A

6. Arduino

The Arduino is a microcontroller board based on the ATmega 328 consisting of 14 digital input/output pins out of which 6 can be used as PWM outputs and other 6 can be used as analog inputs. It has 16MHz ceramic resonator, a USB connection, a power jack, ICSP header and a reset button. It is user friendly and has all the characteristics which are required in a microcontroller

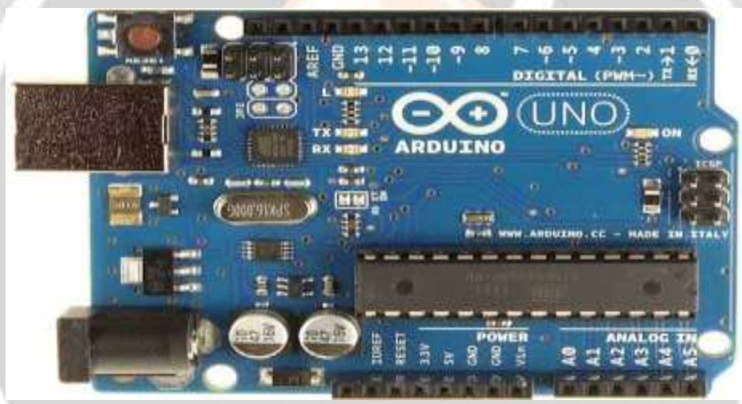

Fig.6.1:- Arduino Board

The specifications of Arduino:-

Microcontroller - ATmega 328

Operating voltage - 5V

Input voltage (recommended) - (6-20)V

DC current per I/O pin - 40mA

DC current for 3.3V pin - 50mA

Flash memory -32KB

SRAM -2KB

EEPROM -1KB

7. Speed sensor

For feedback purpose we have used the IR sensor which is used for speed sensing. The IR sensor which is used is LM393.It is mounted near the shaft of motor which has a rotary encoder disc. The encoder disc rotates in between the sensor and according to the working of sensor speed of gets feedback to the controller and depending on the set value and error value the controller takes the desired action.

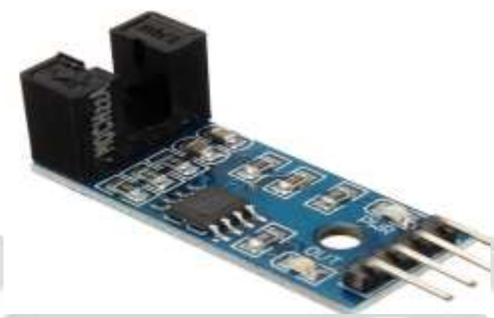

Fig.7.1:-Speed Sensor

Specifications:-

Main chip - LM393

Voltage - (3.3-12)V

Output format - digital(0-1)

Slot width - 5mm

8.Future scope

Implementation of this project on larger scale can be useful in various industrial applications like Steel rolling mills, paper mills, etc.

9.References

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