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Closed Loop Speed Control of DC Drive Using Atmega8L Microcontroller

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***Abstract* — Adjustable closed loop speed control of dc motor has many applications- in drive configurations. The main advantage of closed loop dc motor is that it is simple to control , high reliability, low cost and fast responded motors still find a wide range of use in various field where controlling of speed is the foremost requirement. Their field of application are as follows:-for driving constant speed line, for traction work, for intermittent high torque loads. In earlier times mainly rheostatic control was in practice for controlling the speed of dc motor. But this method has many disadvantages such as loss heat; smooth speed control is not possible also regenerative action is also not possible. So, this project aims at controlling the speed of dc motor by overcoming all the above stated problems. The main objective of motor speed control is to take signal which represents the required speed and to drive the motor at that speed. The easiest way to control the dc motor is provided by microcontroller. In this paper, the speed control of dc motor has been investigated by the using ATmega8L microcontroller. The PWM high frequency signal is driven by the chopper. This work has accuracy and high feasibility according to economic point of view. The main aim of this system is to achieve a constant speed at an different loading condition.**

***Key Words*—DC motor, PWM, Speed control, ATmega8L Microcontroller.**

I. INTRODUCTION

An electrical drive consists of electric motors, its power controller and energy transmitting shaft. In modern electric drive system power electronic converters are used as power controller. Electric drives are mainly of two types: DC drives and AC drives. The two types differ from each other in that the power supply in DC drives is provided by DC motor and power supply in AC drives is provided by AC motor. DC drives are widely used in applications requiring adjustable speed control, frequent starting, good speed regulation, braking and reversing. Some important applications are paper mills, rolling mills, mine winders, hoists, printing presses, machine tools, traction, textile mills, excavators and cranes. Fractional horsepower DC motors are widely used as servomotors for tracking and positioning. For industrial applications development of high performance motor drives are very essential. DC drives are less costly and less complex than AC drives. DC motors are used extensively in adjustable speed drives and position control system. The speed of DC motors can be adjusted above or below rated speed. Their speed above rated speed are controlled by field flux control and speed below rated speed is controlled by armature voltage. DC motors are widely used in industry because of its low cost, less complex control structure and wide range of speed and torque. There are various methods of speed control of DC drives – armature voltage control, field flux control and armature resistance control.

II. LITERATURE SURVEY

1)"Micro Controller Based Adjustable Closed-Loop DC Motor Speed Controller" Y. S. Ettomi, S. B. M. Noor, S. M.'Bashi and M. I. Hassan Department of Electrical and Electronic Engineering Faculty of Engineering, University Putra Malaysia UPM Serdang, Selangor, Malaysia In this paper, the use of micro-controller for speed control and protection of dc motor is presented. The peculiarity of this method is its adaptability to different ratings of motors. Experimental results shows the employment of microcontroller for acceleration, speed reversal, and deceleration and over current protection of a dc motor.

2)"International Journal of Engineering Research (ISSN : 2319-6890) Volume No.1, Issue No.2, 01 Dec. 2012 "Controlling DC Motor using Microcontroller (PIC16F72) with PWM" Shruti Shrivastava, Jageshwar Rawat, Amit Agrawal Department of Electronics and Telecommunication Takshshila Institute of Engineering and Technology, Jabalpur, India.

This paper is mainly concerned on DC motor speed control system by using microcontroller PIC 16F72. It is a closed-loop real time control system, where optical encoder (built in this project) is coupled to the motor shaft to provide the feedback speed signal to controller. Pulse Width Modulation (PWM) technique is used where its signal is generated in microcontroller.

3) "A Microcontroller based Power Electronic Controller for PV assisted DC motor Control Krithiga, and N. Ammasai Gounden**"**

This paper represents a PIC microcontroller based closed loop scheme for the speed control of a separately excited DC motor fed from PV array is used. An IGBT based boost converter is used as an interface between PV array and the DC motor. The microcontroller has been programmed to automatically vary the duty cycle of the boost converter depending upon the set/required speed of the motor.

4) "Modelling, Simulation and Implementation of Speed Control of DC Motor Using PIC 16F877A" Payal P.Raval1, Prof.C.R.mehta2 1PG Student, Electrical Engg. Department, Nirma University, SG Highway,

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Ahmedabad, Gujarat, India. 2Asst. Prof. Electrical Engg. Department, Nirma University, SG Highway, Ahmadabad, Gujarat, In this paper, control techniques of PIC 16F877A microcontroller and MOSFET, mechanism assignments of analyzed by mainly focusing with the "Modeling and Simulation of DC Motor using MATLAB". The objective of this paper is to explore the approach of designing a microcontroller based closed loop controller. The interface circuit and the software are all designed to achieve a better performance.

III. MODELLING OF DC MOTOR FOR DRIVE SYSTEM

An electrical DC drive is a combination of controller, converter and DC motor. Here we will use chopper as a converter. The basic principle behind DC motor speed control is that the output speed of DC motor can be varied by controlling armature voltage keeping field voltage constant for speed below and up to rated speed. The output speed is compared with the reference speed and error signal is then fed to speed controller. If there is a difference in the reference speed and the feedback speed, Controller output will vary. The output of the speed controller is the control voltage Eg that controls the operation duty cycle of converter. The converter output gives the required voltage V to bring motor speed back to the desired speed. The Reference speed is provided through a potential divider because it is linearly related to the speed of the DC motor. Now the output speed of motor is measured by Tacho-generator. The tacho voltage we will get from the tacho generator contains ripple and it will not be perfectly dc. So, we require a filter with a gain to bring Tacho output back to controller level. The basic block diagram for DC motor speed control is shown in figure given below

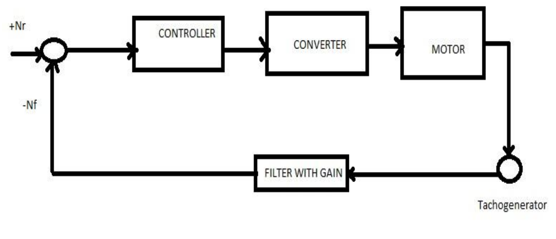

Fig 1 :- Closed loop model for speed control of dc motor

The controller used in a closed loop model of DC motor provides a very easy and common technique of keeping motor speed at any desired set-point speed under changing load conditions. This controller can also be used to keep the speed at the set-point value when the set-point is ramping up or down at a defined rate. In this closed loop speed controller, a voltage signal is obtained from the Tacho-generator attached to the rotor which is proportional to the motor speed is fed back to the input where signal is subtracted from the set-point speed to produce an error signal. This error signal is then fed to controller to make the motor run at the desired set-point speed. If the error speed is negative, this means the motor is running slow so that the controller output should be increased and vice-versa.

Different methods for controlling the speed of dc motor

There are three methods of controlling the speed of the shunt and separately excited dc motor

1. Armature control method.
2. Field control method.
3. By using chopper.
4. By using microcontroller

Microcontroller: AVR AT mega 8L

The ATmega8 is a low-power CMOS 8-bit microcontroller based on the AVR RISC architecture. By executing powerful instructions in a single clock cycle, the ATmega8 achieves throughputs approaching 1 MIPS per MHz, allowing the system designer to optimize power consumption versus processing speed. The AVR core combines a rich instruction set with 32 general purpose working registers. All the32 registers are directly connected to the Arithmetic Logic Unit (ALU), allowing two independent registers to be accessed in one single instruction executed in one clock cycle. The resulting architecture is more code efficient while achieving throughputs up to ten times faster than conventional CISC microcontrollers. The device is manufactured using Atmel.s high density non-volatile memory technology. The Flash Program memory can be reprogrammed .In-System through an SPI serial interface, by a conventional non-volatile memory programmer, or by an On-chip boot program running on the AVR core. The boot program can use any interface to download the application program in the Application Flash memory. Software in the Boot Flash Section will continue to run while the Application Flash Section is updated, providing true Read-While-Write operation. By combining an 8- bit RISC CPU with In-System Self-Programmable Flash on a monolithic chip, the Atmel ATmega8 is a powerful microcontroller that provides a highly-flexible and cost-effective solution to many embedded control applications. The ATmega8 AVR is supported with a full suite of program and system development tools, including C compilers, macro assemblers, program debugger/simulators, In-Circuit Emulators, and evaluation kits.

Features:-

1) 8K bytes of In-System Programmable Flash with Read-While-Write capabilities.
2) 512 bytes of EEPROM, 1K byte of SRAM.
3) 23 general purpose I/O lines.
4) 32 general purpose working registers.
5) Three flexible Timer/Counters with compare modes.
6) Internal and external interrupts.

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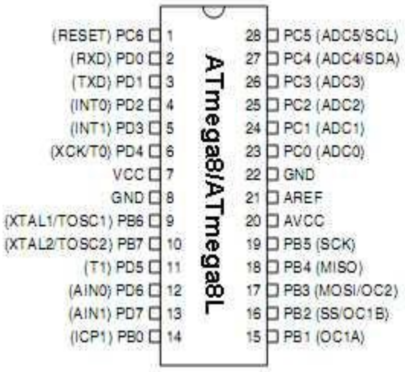
7) A serial programmable USART.
8) a byte oriented Two-wire Serial Interface.
9) A 6-channel ADC (eight channels in TQFP and QFN/MLF packages) with 10-bit accuracy.
10) A programmable Watchdog Timer with Internal Oscillator.

PIN CONFIGURATION



III. PROJECT OBJECTIVE

- Speed of motor will remain constant at different loading condition.
- Analysis of motor at different loading condition
  1. Practically.
  2. Theoretically.

IV. METHODOLOGY

230 Volt AC input supply is given to the rectifier which is used to convert AC to DC in which it is giving DC pulse which consist of some harmonics or ripple which is get filtered by a filter and in this the motor is controlled by DC source through chopper and the sensor will sense the speed which gives the voltage as output and this voltage is given to the microcontroller to drive the speed of the motor. The block showing here as an user interface from which we can manage the operation of the system.

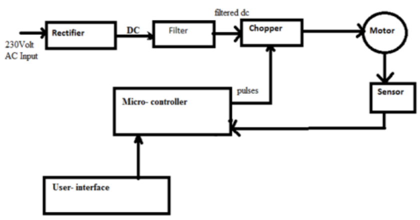
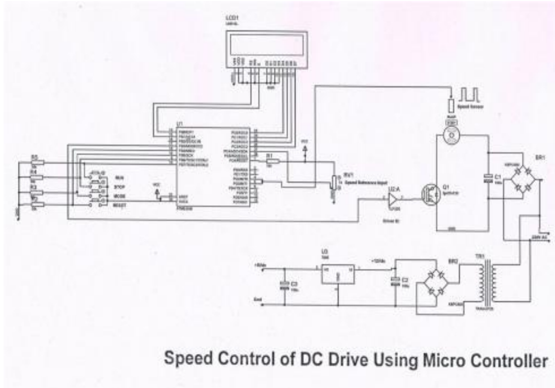


Figure given below shows an block diagram of an proposed system Schematic view of an proposed system

The main component of an proposed system is microcontroller ATmega8L in which the pulses are generated and it is given to the chopper besides this input supply is given to the bridge rectifier in which it is giving DC pulse which consist of some harmonics/ ripple Here we are using Capacitor as filter which is of ratinf 100micro-farad. After this the DC power is fed to the motor and its rotating and the rotation of the motor is get sensed by speed sensor and this sensor is giving output to the microcontroller at port5 and at port20 the auxiliary power supply is given to the microcontroller at 5V.



Speed Control of DC Drive Using Micro Controller

Pulse-width modulation (PWM)

Pulse-width modulation (**PWM**) is a very efficient way of providing intermediate amounts of electrical power between fully on and fully off. A simple power switch with a typical power source provides full power only, when switched on. PWM is a comparatively recent technique, made practical by modern electronic power switches. The term "pulse width modulation" explains how each transition of the alternating voltage output is actually a series of short pulses of varying widths. By varying the width of the pulses in each half cycle, the average power produced has a sine-like output. The number of transitions from positive to negative per second determines the actual frequency to the motor. The term duty cycle describes the proportion of on time to the regular interval or period of time; a low duty cycle corresponds to low power, because the power is off for most of the time. Duty cycle is expressed in percent, 100% being fully on.

PCB Layout

PCB design of the system

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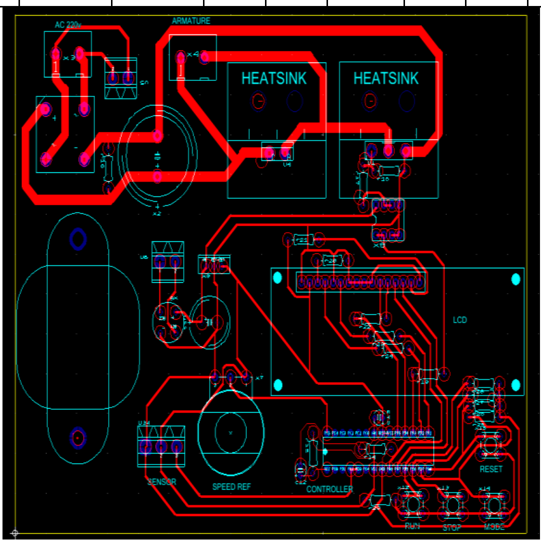
Duty cycle	Set Speed	Actual speed	I_g	V_g	I_f	V_a	I_a	Load
0.3	325	320.2	1.2	42	0.74	48	3	2 Kw
0.6	693	692.3	2.7	95	0.74	102	4.8	2 Kw



3D view of the system

V. EXPERIMENTAL RESULTS

Fig showing Pictorial view of the hardware.

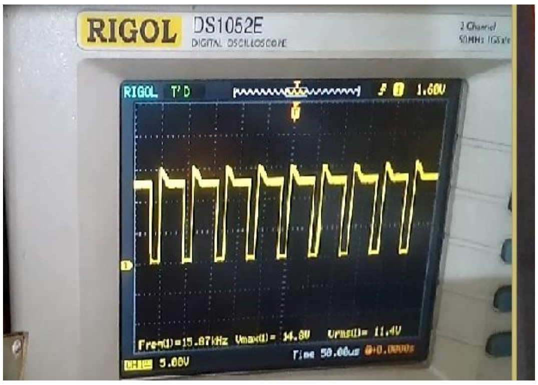
Open loop without load
V_{dc} = 210 volt

Duty cycle	Set speed	Actual speed	I_a	I_f	V_g	I_g	V_a
0.3	391	390.8	1.8	0.78	57	0	56
0.6	846	840.2	1.6	0.75	122	0	120
0.9	1325	1320	2	0.75	184	0	195

Open Loop mode with load Vdc =210 Volt

Close loop mode with and without load V_{dc} = 210 Volt

V_g	I_g	V_a	I_a	I_f	Set Speed	Actual Speed	Loading condition
110	0	90	1.5	0.6	584	583	No-load
100	1.8	95	3	0.6	584	586	1KW
95	0	105	3.5	0.6	626	621	No-load
90	2.4	110	4	0.6	626	624	2KW
145	0	115	1.8	0.6	846	80	No-load
115	3	120	4.8	0.6	846	841	2KW
170	0	130	1.8	0.6	1120	1120	No-load
125	3.2	155	4.6	0.6	1120	1125	2KW



Practical output pulse of Atmega8L in CRO

VI. CONCLUSION

Our main aim of economical speed control of DC motor is achieved by controlling the switching of IGBT using microcontroller .In this project , speed can be controlled both in open loop and closed loop but only below the based speed this is because we are using the armature voltage control only and not the field control.

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REFERENCES

[1] Muhammad H. Rashid: "Power Electronics Circuits, Devices & Application" PHI, New Delhi,2001

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[2] W. Leonhard, Control of Electrical Drives, Springer-Verlag Berlin Heidelberg, New York, Tokyo, 1985.

[3] B.K. bose, "Adjustable speed AC drives – A technology status review", IEEE transaction, Vol.70, No.2, PP-116-33, Feb-1982.

[4] V.K. Varma & Dr. Promod Agarwal, Short term summer course on "Micro controlled A.C. drives" University of Roorkey (U.P.) – April – 1995.

[5] Gopal K. Dubey, Fundamentals of Electrical Drives, 2nd edition, Narosa Publishing House, New Delhi-2007.

[6] A Khoei Kh. Hadidi, "Microprocessor Based Closed-Loop Speed Control System for DC Motor Using Power MOSFET", 3rd IEEE international conference on Electronics, Circuits and Systems(1996) vol.2, pp.1247-1250.

[7] Peter Spasov, "Microcontroller Technology: The 68HC11" Prentice Hall, 5th edition, 2004.