Scientific Journal Impact Factor (SJIF) : 3.518
International Journal of Modern Trends in Engineering and Research
ISSN (ONLINE) : 2349 - 9745 ISSN (PRINT) : 2393 - 8161

MEASUREMENT, PROTECTION, SPEED CONTROL AND GRAPHICAL OBSERVATION OF DC MOTOR PARAMETERS BY ATMEGA-16 USING EMBEDDED SYSTEMS

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Abstract— The objective of the present paper is to design a circuit which is applicable for multiple purposes of a dc motor. DC motors are widely used not only in the industries but also in daily life applications like drills, shapers, vacuum cleaner, spinning and weaving machines etc. So it is required to observe the basic parameters like voltage, current, speed and torque by measuring the values of those parameters. The experimental values are measured using different techniques and displayed in a 16x4 LCD. Two graphs have been plotted in 124X64 graphical LCD by taking the respective parameter values. Also it is designed for speed control of DC motor using PWM technique.

Keywords— DC motor, microcontroller, parameters calculation and displaying, graphical displaying, Speed control, PWM.

I. INTRODUCTION

The main objective of this project is to measure, protect, speed control and graphical observation of different parameters of a DC motor with a minimum cost, portable, reliable, easy operation and low power application. Large scale industries use different electric panels for controlling and smooth operation of high voltage DC motors. But it is difficult to invest that much of huge amount in small industrial labs, institutional labs, research centers, robotics clubs etc. It is neither affordable to use for daily life appliances like drills, hair driers, mixer, sewing machines, vacuum cleaners nor in small business purposed motor applications like lathes, boring mills, spinning and weaving machines, elevators, etc. So power electronics components and technology can be used both for improving the performance of the motor and implementation in its practical fields with the protection of the motor. It is also applicable to control the speed of the motor used in the machine by using PWM technique. This project is done using ATMEGA-16 microcontroller.

II. BLOCK DIAGRAM AND CIRCUIT DIAGRAM DESCRIPTION

Figure-1 shows the proposed blocks of the total project. The system is designed for a 12V, 1ampere, 200 rpm DC motor using ATMEGA 16A microcontroller programmed using the software AVR STUDIO-4 and SINAPROG. The project needs a L293D motor driver for controlling the speed of the DC motor. ACS712 current sensor is used to measure the current flows through the motor and gives the value of current to the microcontroller. Similarly speed sensor counts the number of rotations per minute and gives the value as input to microcontroller. Also 16X4 LCD displays the measured values and limit values entered in program and 128X64 graphical LCD shows the graphs by taking the respective values.

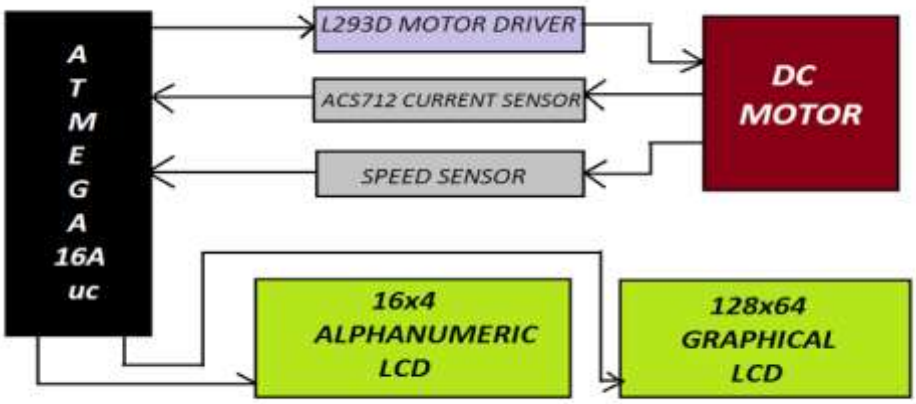

Figure 1:- Block diagram of measurement, protection, speed control and graphical observation of dc motor

Note: Power supply unit is not shown here, it is connected to each blocks.

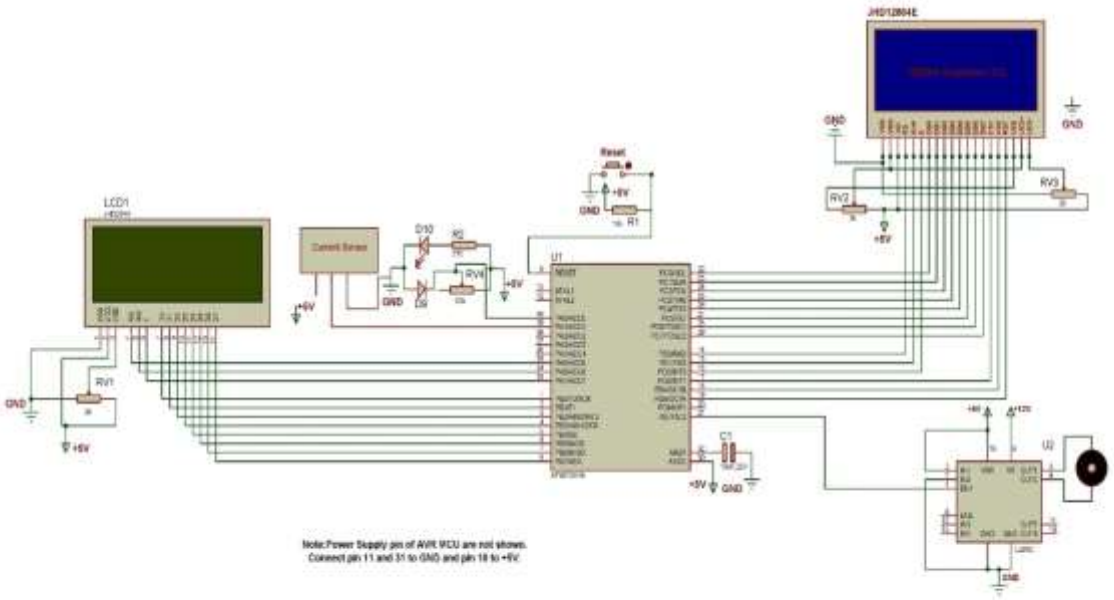

Figure 2:- Circuit diagram of measurement, protection, speed control and graphical observation of dc motor

III. METHEDOLOGY

The total project consists of four sections i.e

A. Displaying the measured parameters(V,I,N,T) of a DC motor
B. Giving limit values for protection purpose
C. Graphical observation of respective parameters(N~I, V~t)
D. Speed control by PWM technique

A. Displaying measured parameters of DC motor:-

The project is done to measure the basic parameters of the DC motor i.e. voltage, current, speed and torque which are the most important parameters for different loads. The different parameters are measured by different techniques.

The voltage is measured across the supply terminals of motor by using voltage divider circuit and ADC converter. The (0-12)V voltage level of motor is compared with (0-5)V of the uc voltage level

and according to that uc sends the voltage value by doing the comparison. The current flows through motor is measured by ACS712 current sensor which is connected to the 39th and 40th pin of microcontroller as shown in circuit diagram. It is connected in series in between motor driver and the DC motor so that the current flows through it. The speed is counted by using a IR sensor which provides increment of counter value per rotation by doing a small circle in wheel. Finally it provides the number of rotations counted in one minute. The required torque parameter value is calculated by ATMEGA-16 microcontroller by the required equation

$$Torque\ (N.m) = \frac{Power\ in\ Watts}{2\pi \times Rotational\ Speed}$$

Figure 3:- 16X4 LCD displaying parameters value and limit values

B. Giving limit values for protection purpose:-

A dc motor should be protected against the parameters like current, voltage, speed, torque, etc. The voltage is measured and given as input to the microcontroller. Here power supply circuit is supplied through a 12V, 1 amp adapter so voltage level will not exceed to 12V. SO the voltage limit is given as 8V below which uc is programmed to stop the motor. Similarly the ACS712 current sensor gives the current value in milliampare. It is programmed to protect the motor against over current. The limit value given is 200 mamp. The uc will stop the motor if I value exceeds the limit. The speed sensor gives thr rpm value as input to the uc and the limit value is given 100 below which the uc stops the motor. Similarly the maximum torque value is given 90 N-cm.

C. Graphical observation of respective parameters:-

A 128X64 graphical LCD is used for graphical observation of the motor characteristics and the parameters. Here the LCD is programmed to divide into two parts horizontally. One part will show the different characteristics of dc motor like N~I, T~I, N~T and the other part will show any required different parameters like here it is programmed in the AVR STUDIO-4 for the voltage in X-axis and
Time in Y-axis. As, So it is observed that torque is directly proportional to the armature current. Also,

$$T_g = k_a \phi I_A$$

$$Where,\ k_a = \frac{P.Z}{2\pi A}$$

Figure 4:- 128x64 Graphical LCD

$$Torque\ (N.m) = \frac{Power\ in\ Watts}{2\pi \times Rotational\ Speed}$$

From the equations torque (T) is inversely proportional to speed (N) and torque (T) is directly proportional to current (I) so that speed (N) and current (I) are inversely proportional to each other.

D. Speed control by PWM technique:-

So many methods are there for controlling the speed of a DC motor. Pulse width modulation id the simplest method to control the speed. PWM is implemented using a microcontroller, dependent on an input value for generating variable pulse widths, for driving motor at variable speed.

PWM method generates binary signals, which has two periods of signals i.e. low and high. The width (W) of each repetitive pulse signal changes in between 0 and the total pulse period (t).The basic principle of PWM is to control the speed by changing the duty cycle. The load speed can be controlled by the conduction period of the pulse signal.

Let t1= conduction time period (voltage level is maximum)
t2= non-conducting time period t2 (voltage level is zero)
Then the total time period is t (total)= t1+t2
Duty cycle= t1 / t(total)

So the motor speed can be increased by increasing the numerator value i.e. the conduction time period t1.

In this project the motor speed is changing from zero to maximum by changing the pulse given to the L293D. The three pins of L293D are connected to +5V, +12V and ground of the power supply circuit. Motor driver supplies +12V power to the motor. According to the pulse level from microcontroller (0-5V) it supplies to the motor (0-12V). In this way the speed changes from zero to the maximum.

IV. RESULTS AND DISCUSSIONS

The project model is supplied with 12V adapter through the dc socket. When the power switch is switched ON the 3 pins of 7805 voltage regulator provides three voltage levels i.e +12V, +5V and ground. From the three pins the total circuit is supplied according to the requirement. The ATMEGA-16A microcontroller is supplied with +5V. And the L293D motor driver is connected with the three pins of power supply unit. The motor starts rotating and all the measuring elements starts to measure the parameter values. LCD is displaying name of the parameters and both the measured values and limit values in first, second and third column respectively. From this experiment two graphs are plotted in GLCD from the observation values. The first graph is plotted by programming N~I out of the three characteristics curves. Figure-4 shows the graphical observation of N~I curve where speed is inversely proportional to current. The second graph is plotted by programming for any parameters. Here it is taken voltage vs time. The figure shows that voltage is constant with respect to time. The graph can be changed by taking any parameters

according to the requirement by changing the variable names in X-axis and Y-axis respectively in the program.

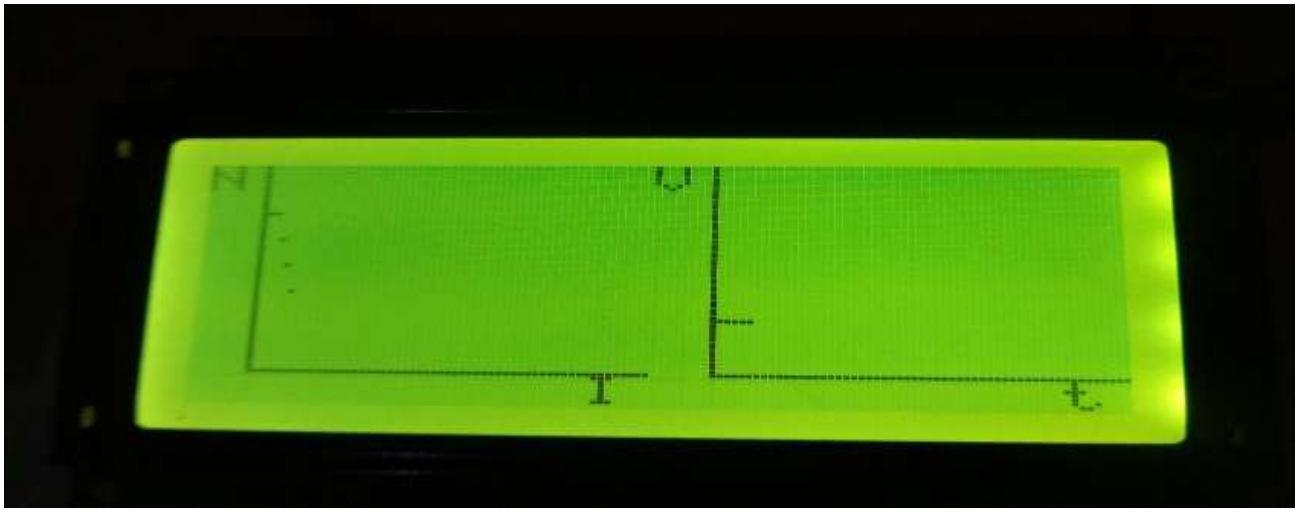

Figure 5:- Graphical displaying of measured values in 128x64 GLCD

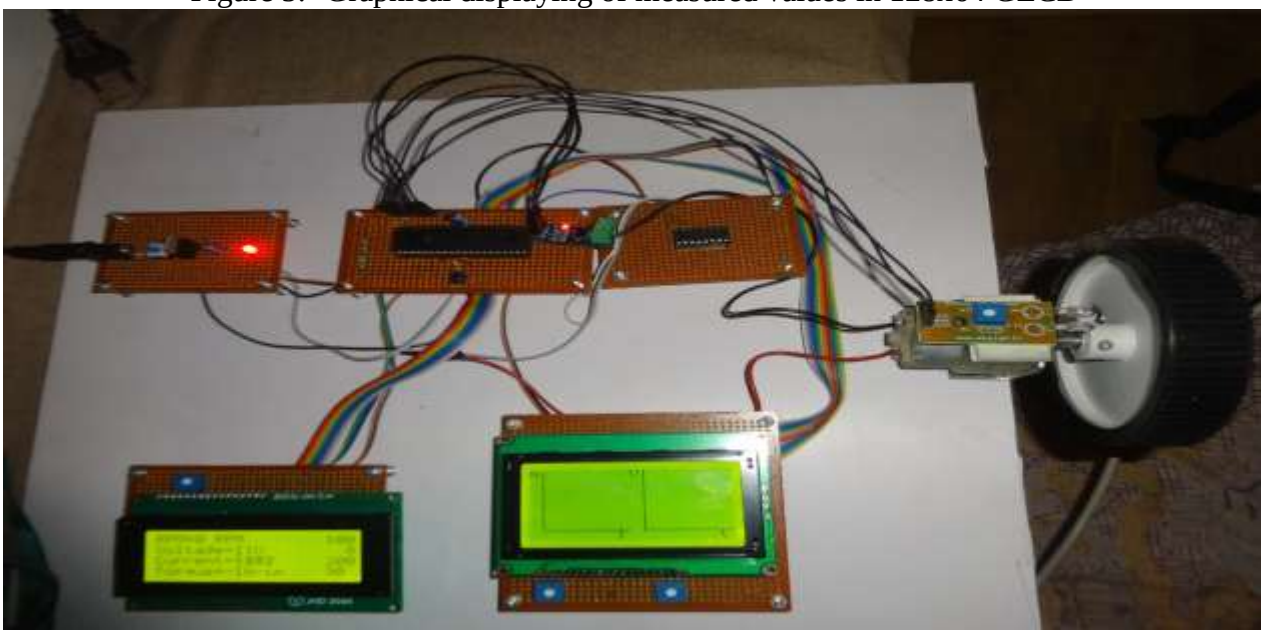

Figure6:-Project Model of measurement, protection, speed control and graphical observation of dc motor

V. CONCLUSION AND FUTURE APPLICATIONS

The basic goal of this project is to calculate parameters, to provide protection, to control the speed and to draw graphs according to respective parameters. In large industries it the same task is done using different panels which are very costly and are not affordable for small applications which are mentioned in introduction part. In this project the total four objectives are operated by a single ATMEGA-16 microcontroller. So it is very cheap compared to the total operations done by it. For this reason it can be used as an application in different products like in drill machines for over current protection, mixer machine for speed control, in lathe and spinning and weaving machines to show the speed of operation and limit value for smooth operation, in research centers for graphical observations, in boring mills to show speed and torque, etc. Also in future it can be implemented like a product by interfacing a keypad to the total circuit through which the limit values can be entered for different product applications according to their voltage, current, speed and torque ratings. So it can be modified as a displaying, protecting, speed controlling and graphical curve plotting product for universal dc motor based applications.

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