ISSN (Online) 2394-2320

International Journal of Engineering Research in Computer Science and Engineering (IJERCSE)
Vol 5, Issue 2, February 2018

Modelling of DC Motor Analysis by Microcontroller through PV

[1] Priya D. Duggal, [2] Shradha.Aasti, [3] Ravi Ganpatrao Deshbhratar
[1][3] Prof, Department of Electrical Engineering, [2] Prof, Department of C.S.E Engineering
D.M.I.E.T.R Nagpur University, SPACE, Wardha, Nagpur University, RKNEC, Nagpur University, India

***Abstract* - Nowadays it's very difficult for electrical aspects by controlling the speed of DC Motor by technology PV. In this, we use A PIC microcontroller based closed loop speed control scheme has been developed for the speed control of a separately excited DC motor fed from PV array. Without power, electronic devices interface is not completed that An IGBT based boost converter is used as an interface between PV array and the DC motor. T**

hat also used to give the command and easily controlled speed by the microcontroller has been programmed to automatically vary the duty cycle of the boost converter depending upon the set/required speed of the motor. Modeling of the DC motor has been developed it speed with is controlled by manually and software. It studies and experimental investigations have been carried out on a laboratory size prototype separately excited DC motor fed from a PV array and the results are presented. Its case study by comparing of experimental shows very close agreement between the two thus validating the controller proposed.

Index Terms — Microcontroller, PV, Devices

I. INTRODUCTION

The DC Motor is an attractive piece of equipment in many Industrial applications requiring variable speed and load characteristics due to its ease of controllability Photovoltaic (PV) energy conversion is now recognized to be the most widely accepted method of harnessing renewable energy sources to benefit communities, especially in developing countries and remote areas. PV arrays provide direct conversion of solar energy into electrical energy without inducing environmental pollution. Recognizing these facts, extensive research and development efforts are devoted to photovoltaic's. Especially in countries like India where the government is facing oil crunch, the tapping of PV energy which is available in abundance throughout the year will be very important. One of the most popular applications of the PV array utilization is the water pumping system using DC motor as drive. However to utilize PV power more efficiently, load matching between PV array and DC motor as an intermediate matching circuitry is essential. Utilization of boost converters has been considered for this purpose.

II. MODEL OF SEPARATELY EXCITED DC MOTOR

When a separately excited motor is excited by a field current of If and an armature current of Ia flows in the circuit, the motor develops a back EMF and a torque to balance the load torque at a particular speed.

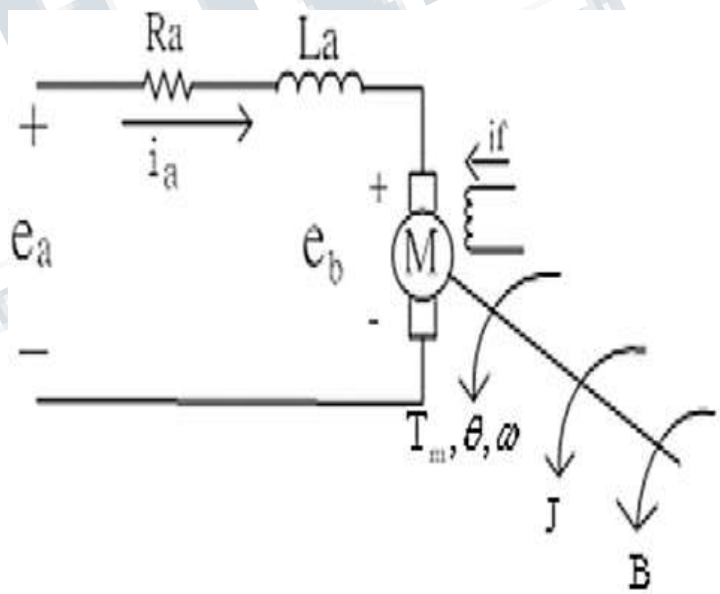


Fig.1 Separately Excited DC Motor

The If is independent of the Ia Each winding are supplied separately. Any change in the armature current has no effect on the field current. The If is normally much less than the Ia. The relationship of the field and armature are shown in below Equation.

Instantaneous field current:

Vf = Rf if + Lf dif /dt

Where R f and L f are the field resistor and inductor resp.

Instantaneous armature current:
$Va = Ra\ ia + La\ dia / dt + eg$
Where R a and L a are the armature resistor and inductor resp. The motor back EMF which is also known as speed voltage is expressed a
$eg = Kv\ w\ if$ Where Kv is the motor constant (in V/A-rad/s) and w is the motor speed (rad/s).
The torque developed by the motor is
$Td = K\ \phi\ if$
Where (Kt =K v) is the torque constant (in V/A-rad/s).
Sometimes it is written as:
$Td = Kt\ \phi\ ia$
For normal operation, the developed torque must be equal to the load torque plus the friction and inertia, i.e.:
$Td = J\ dw / dt + Bw + TL$ where B = viscous friction constant (N.m/rad/s) T L = load torque (N.m) J = inertia of the motor (kg.m 2)
Under steady-state operations, a time derivative is zero. Assuming the motor is not saturated. For field circuit,
$Vf = Rf\ if$ .The back EMF is given by:
$eg = Kv\ w\ if$
The armature circuit,
$Va = Ia\ Ra + Eg = Ia\ Ra + Kv\ w\ if$
The motor speed can be easily derived:
$W = Va - Ia\ Ra / Kv$ if R a is a small value (which is usual), or when the motor is lightly loaded, i.e. Ia is small,
$W = Va / Kv$ If That is if the field current is kept constant, the speed motor speed depends on the supply voltage. These observation leads to the application of variable DC voltage to control the speed and torque of DC motor

III. HARDWARE MODEL

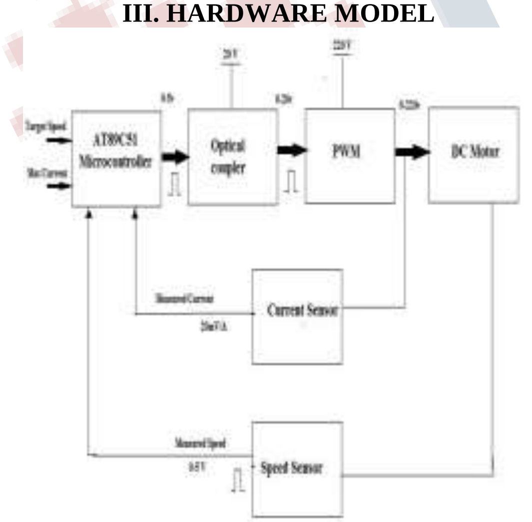
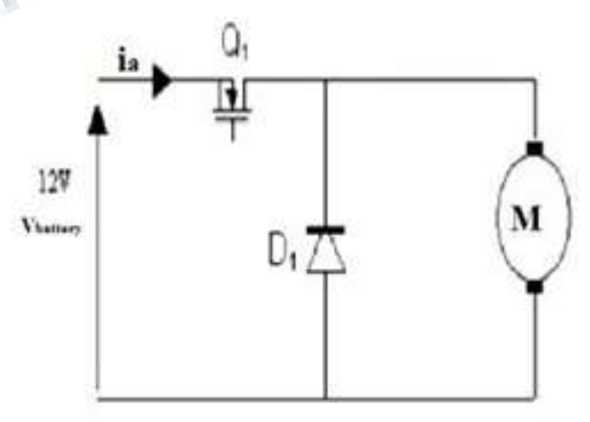


Fig 2 Block diagram of automatic speed control system.

The AT89C51 microcontroller implements the control algoritlm1 by conditioning the speed and current signals and performance the speed regulation according to speed reference fed through the switch. The software includes a routine to read the motor current and sends emergency shutdown signal to protect the dc motor from over current, also this signal can be activated manually by inserting a designated character by the switch, which causes a software interrupt and executes the emergency shutdown routine. The hardware control system includes the dc shunt motor, power circuit, AT89C51 microcontroller, speed sensor (shaft, encoder), and current sensor. The system hardware block diagram is shown in Fig. 6.

The conventional digital proportion MCU technique and the pulse width modulation (PWM) technique are adopted in dc motor control system. An optical encoder was used to measure the speed of the motor. The output of the encoder is a stream of pulses with variable' frequency according to the speed of the motor. The resolution of the encoder in this work was 500PPR.The current sensing was accomplished by using Hall Effect current sensor. It senses the current and feeds the current signal to microcontroller. Port PE4 of the microcontroller is dedicated for the current signal and a continuous conversion mode where used to read from the AID port. The opto-isolator was used to isolate the high voltage circuits from the low voltage controlling signals. The de motor is the plant that will be controlled. The rating of the motor should be chosen according to the rating of the power circuit switch. For this study a dc shunt motor with ratings 2400RPM, 220V, 2.2A, O.37kW is used.



Let us consider a simple circuit that connects a battery as power supply through a switch MOSFET (Metal-Oxide-Semiconductor Field Effect Transistor) as shown in Figure 2. When the switch is closed, the motor sees 12

ISSN (Online) 2394-2320

International Journal of Engineering Research in Computer Science and Engineering (IJERCSE)
Vol 5, Issue 2, February 2018

Volts, and when it is open it sees 0 Volts. If the switch is open for the same amount of time as it is closed, the motor will see an average of 6 Volts, and will run more slowly accordingly.

This on-off switching is performed by power MOSFETs. A

MOSFET (Metal-Oxide-Semiconductor Field Effect Transistor) is a device that can turn very large currents on and off under the control of a low signal level voltage.

The average of voltage that supply to DC motor is given by,

$V_{avg} = (t_{on} / T) * V_{in}$

Where

V_{avg} = average voltage supply to DC motor

t_{on} = time ON of switches
T = period of PWM
(t_{on} / T) =DC duty cycle

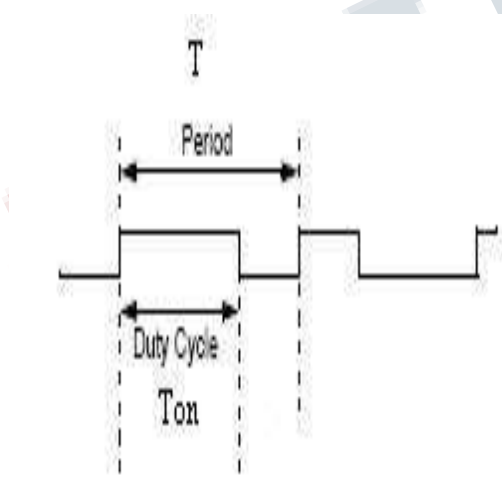


Figure.3. PWM signal

As the amount of time that the voltage is on increases compared with the amount of time that it is off, the average speed of the motor increases and vice versa.The hardware of the microcontroller includes mainly the AT86C51 system with LCD and keypad for user interface. Changing the terminal voltage by means of DC to DC chopper (the power circuit) that is controlled by the microcontroller generated PWM signal controls the speed of the motor.The motion of a DC motor is controlled using a DC drive. DC drive changes the speed and direction of motion of the motor. Some of the DC drives are just a rectifier with a series resistor that converts standard AC supply into DC and gives it to the motor through a switch and a series resistor to change the speed and direction of rotation of the motor. But many of the DC drives have an inbuilt microcontroller that provides programmable facilities, message display on LCD, precise control and also protection for motors. Using the DC drive you can program the motion of the motor, i.e., how it should rotate.

Here are some of the features of this DC motor controller:

1. Controlled through microcontroller AT89C51.

2. Message displayed on the LCD module.

3. Start, stop and change of direction of the motor controlled by pushbutton switches and indicated by LED.

4. Changes the running mode of the motor to continuous, reversible or jogging.

5. Changes the speed of the motor.

6. Time settings are possible for forward and reverse running of the motor.

The eight pushbutton switches are connected for eight different functions as –When S1 is pressed, the microcontroller sends low logic to port pin P2.5. The high output of inverter N2 drives transistor T1 into saturation and relay RL1 energises. So the output of NE555 is fed to inputs IN1 and IN2 of L293D through both the contacts of relay RL2. Now at the same time, after RL1 energises, the microcontroller starts generating PWM signal on port pin P2.4, which is fed to trigger pin2 of NE555 through inverter N3. The base frequency of the generated PWM signal is 500 Hz, which means the time period is 2 ms (2000µs). The output pulse width varies from 500 µs to 1500 µs. The R-C time constant of the monostable multivibrator is kept slightly less than 500 µs to generate exactly the same inverted PWM as is generated by the microcontroller.

When switch S2 is pressed, port-pin P2.5 goes high and RL1 de-energises to stop the motor.

When switch S3 is pressed, relay RL2 energises. Pin IN1 of motor driver L293D receives the PWM signal and pin

ISSN (Online) 2394-2320

International Journal of Engineering Research in Computer Science and Engineering
(IJERCSE)
Vol 5, Issue 2, February 2018

IN2 connects to ground. As a result, the motor rotates in one direction (say, clockwise).

When switch S4 is pressed again, relay RL2 de-energises. Pin IN2 of motor driver L293D receives the PWM signal and pin IN1 connects to ground. The motor now rotates in opposite direction (anti-clockwise).

When switch S3 is pressed, different modes are selected in cyclic manner as given below:

1. ***Continuous mode.*** The motor rotates continuously with the set speed in either direction

2. ***Reversible mode.*** The motor reverses automatically after the set time

3. ***Jogging mode***. The motor rotates for the set time in either direction and then stops for a few seconds and again rotates for the set time. It is also called 'pulse rotation'

Switches S5 and S6 are used to set the speed of the motor, either in increasing order or decreasing order, in continuous mode only. Switches S7 and S8 are used to set the time either in increasing order or decreasing order.

V . SOFTAWRE MODEL

After power on, using switch SW, the microcontroller reads the battery voltage with the help of in-built ADC and displays the charging condition of the battery on LCD. It monitors the input signal of the ADC and activate the load or charging Relay RL1.+5V is used as Vref of the ADC, the output voltage of the ADC should not exceed +5V. A potential divider is used at pin2 and pin4 of the microcontroller using resistors R2, R3, R4, R5,R6, and R7 to scale down the voltage from 0V – 5V. When the solar panel voltage is present, the current flows from the solar module throgh diode D1. The diode is preventing back currents flowing from the battery to the solar panel. The microcontroller activate the relay RL1 connecting the solar panel to the battery through a transistor Q2 and diode D3. The diode D3 helps dampen transient spikes that can be generated by the relay's coil. The battery will continue charging, to full charge (14.7V). When the battery is fully charged the microcontoller interrupts the charging current and start 5 – minute timer . At this stage " Batteryy full" will be displayed on LCD based on the regulator U2 which regulated the constant voltage value to be used by the PIC and the LCD. Diode D4 protect reverse of the regulated voltage back to the battery. Capacitors C1 and C2 at the output and input of the 7805 regulator U2 are used as ripple rejection and also to prevent debouncing of the switch. Atimes the switch cannot make smooth and clean contact but rather oscillate between low and high until settle, such oscillation will be prevented by the capacitors.

In the absent of solar radiation, the microcontroller senses this through ADC and activate the load by switching on MOSFET Q1 via a transistor Q3 from pin 33 of the microcontroller and " load on" message as well as the battery's voltage are displayed on the LCD. In this mode, the microcontroller monitors for low battery. When the battery voltage drops below 9.4Volt the microcontroller turns off MOSFET Q1 and " Battery low" message is dispalyed. Figure 3 shows the circuit of the microcontroller based charger.

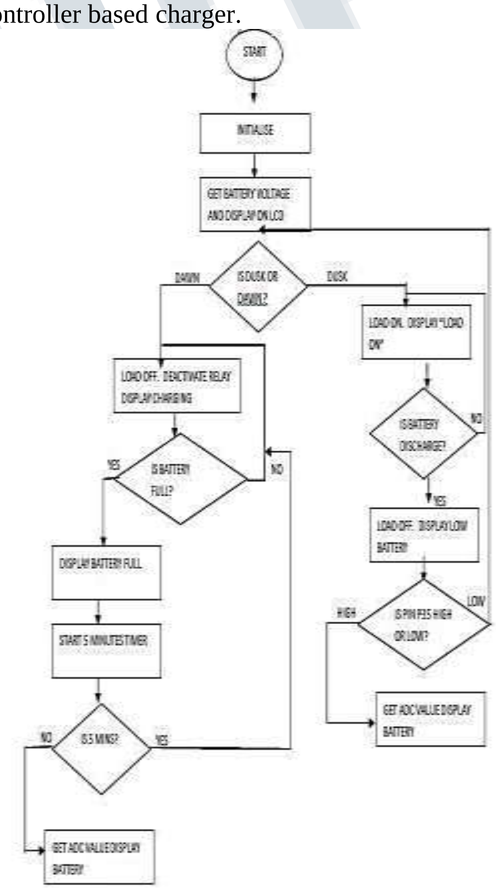


Figure.4. Software signal

VI. RESULTS AND DISCUSSION

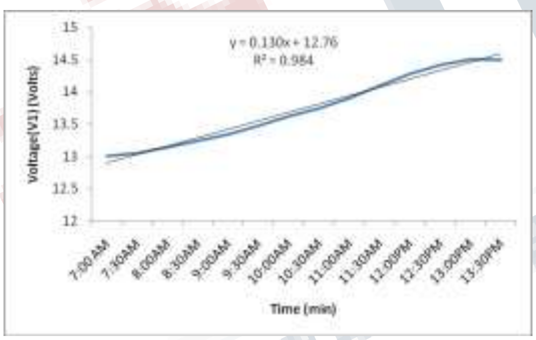
ISSN (Online) 2394-2320

International Journal of Engineering Research in Computer Science and Engineering (IJERCSE)
Vol 5, Issue 2, February 2018

The test was conducted at the PV demonstration room, Sokoto Energy Research Centre (SERC) on March 7, In conducting the charging test, 80W solar module (LM08OAAOO), was used to provide charging voltage. A digital multimeter was used to measure the initial voltage of the battery as well as solar panel voltage. Another digital meter was connected across the solar module to measure the solar panel current. With the connection completed, the charge controller was switched on. A message reading "charging" as well as the battery voltage were displayed on the LCD.

The solar panel voltage charging voltage were noted and recorded at the beginning of the charging experiment. Subsequently, the values were recorded after every 30 minutes interval. All the values obtained were then tabulated. The experiment continued until the battery became fully charged. At this point the LCD displayed "Battery full".

The result obtained during charging test is presented in table 2. The measured parameters included among others, battery voltage (V1), PV array voltage (V2), PV array current (I) and LCD voltage (V3). The data were taken at 30 minutes interval. The result is tabulated in table 2.



VII CONCLUSION

In Nigeria today, we have a very disturbing scenario where the cost of energy from the conventional source for generating electricity continues to increase and the need to turn to renewable energy like solar energy becomes the only viable and sustainable alternative or solution. The microcontroller based solar charge control technique presented in this paper prevents overcharging by reducing the flow of energy in to the battery when the battery approaches a full charge state.

During day time, the load is disconnected from the battery and the battery is to be recharged with the current from the solar panel. The microcontroller needs to know the presence of the solar panel to decide whether the load is to be connected or disconnected from the battery whether the battery should be in charging mode or discharging mode. A simple sensor circuit is built using a potential divider. The relay RL1 connects the solar panel to the battery through diode D1. This allows charging current from the panel to flow into the battery, when the battery reaches full charge the microcontroller interrupts the charging current.

In the absence of solar radiation, the microcontroller activates the load by switching on the MOSFET via a transistor. When the battery voltage drops to 9.5V, the microcontroller turns off the load to avoid over-discharge. The system displays the battery status on a liquid crystal display (LCD).

VIII REFERENCE

[1] Enric, P.U and Michael M.D (1998): Recommended Practices for Charge Controllers. Renewable Energy and Hybrid System Group CANMET Energy Diversification Research Laboratory.

[2] Gazi, S.M., Muhaiminul, I and Salim, K.M (2009): Design and Construction of Microcontroller Based Maximum Power Point PWM Charge Controller for Photovoltaic Application. Development in Renewable Energy Technology (2009) 1st International Conference, Pp. 1-4.

[3] Jaya, N. I (2012): PIC Based Solar Charging Controller For Battery. International Journal of Engineering Science and Technology (IJEST), Pp 384.

[4] Vikas, K. (2012): Microcontroller Based solar charge controller for power Application. International Journal of Electronics Communication and Computer Engineering. Volume 3, Issue 1.