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DC Motor Control Using Chopper for Remote Laboratory Set-up

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Abstract: In this paper, a technique for the remote control of chopper based DC motor is proposed. The main objective of the remote laboratory is to facilitate the students to avail the laboratory experiments 24x7. This paper explains the remote control operation of chopper based DC motor. Chopper is a power electronic DC-DC converter which converts fixed DC voltage to variable DC voltage. This variable DC voltage output of chopper is fed to DC motor armature terminals. Arduino uno is interfaced with LabVIEW to generate pulse width modulated(PWM) signals. The duty cycle of the PWM signals is controlled to control the output voltage of chopper. Remote control can be achieved either by team viewer or setting up an individual server. The simulation of DC motor control using chopper is carried out in MATLAB / Simulink.

Keywords: Remote control; DC motor; Chopper; LabVIEW; Arduino Uno

I. INTRODUCTION

NOWDAYS technology is becoming more advance and the work is going to be more precise and less time consuming. Remote control is more popular, the major concentration here is the application of remote control in establishing the academic remote labs [1].

The main aim of this remote labs is to help the students to carry out their experiments whenever they have a got free time from anywhere. To propose a remote control technique, an academic experiment titled as “DC motor control using chopper” [3] from the department of Electrical and Electronics Engineering [5] is considered in this paper.

In all drives where the speed and position are controlled, a power electronic converter is needed as an interface between the input power and the motor. The power electronic converter provides controlled voltage to the motor in order to control the motor current and, hence, the electromagnetic torque produced by the motor.

The process determines the requirements on the motor drive. For example, a servo drive is needed in robotics, whereas only an adjustable speed-drive may be required in an air conditioning systems[6].

The DC-DC converters are widely used in regulated switch-mode dc power supplies and in dc motor drive applications. The input to these converters is an unregulated dc voltage, which is obtained by rectifying the line voltage, and therefore it will fluctuate due to changes in the line-voltage magnitude.

Switch mode dc to dc converters are used to convert the unregulated dc input into a controlled dc output at a desired voltage level[6]. LabVIEW stands for Laboratory Virtual Instrument Engineering Workbench. It is a graphical programming language that uses icons instead of lines of text to create applications.

LabVIEW programs are called virtual instruments or Vis, because their appearance and operation resemble physical instruments. A VI contains the components such as front panel and block diagram.

Arduino uno is an open-source microcontroller board. It can be used for data acquisition using LabVIEW and also to perform a task by sending set of instructions to the microcontroller on the board.

All the hardware components are connected to the host computer. The host computer must have the necessary software, drivers, internet connection and equipped with uninterruptible power supply [UPS].

This experiment should be made remote control to access the experiment anytime from anywhere by the user. So the complete set up can be accessible and controlled through user’s personal computer.

This paper presents a proposed technique for the remote control of an experiment titled as DC motor control using chopper. The required components are power electronic dc-dc converter known as chopper, dc motor, arduino uno, LabVIEW software, host PC and remote PC.

Ultimate objective is to establish a remote labs for all the experiments of the electrical and electronics engineering department by using the fundamental techniques [5] from this experiment.

However this also can be extended to the other departments of the technical education, to facilitate the professors, students and also industries.

II. PROPOSED TECHNIQUE FOR THE REMOTE CONTROL

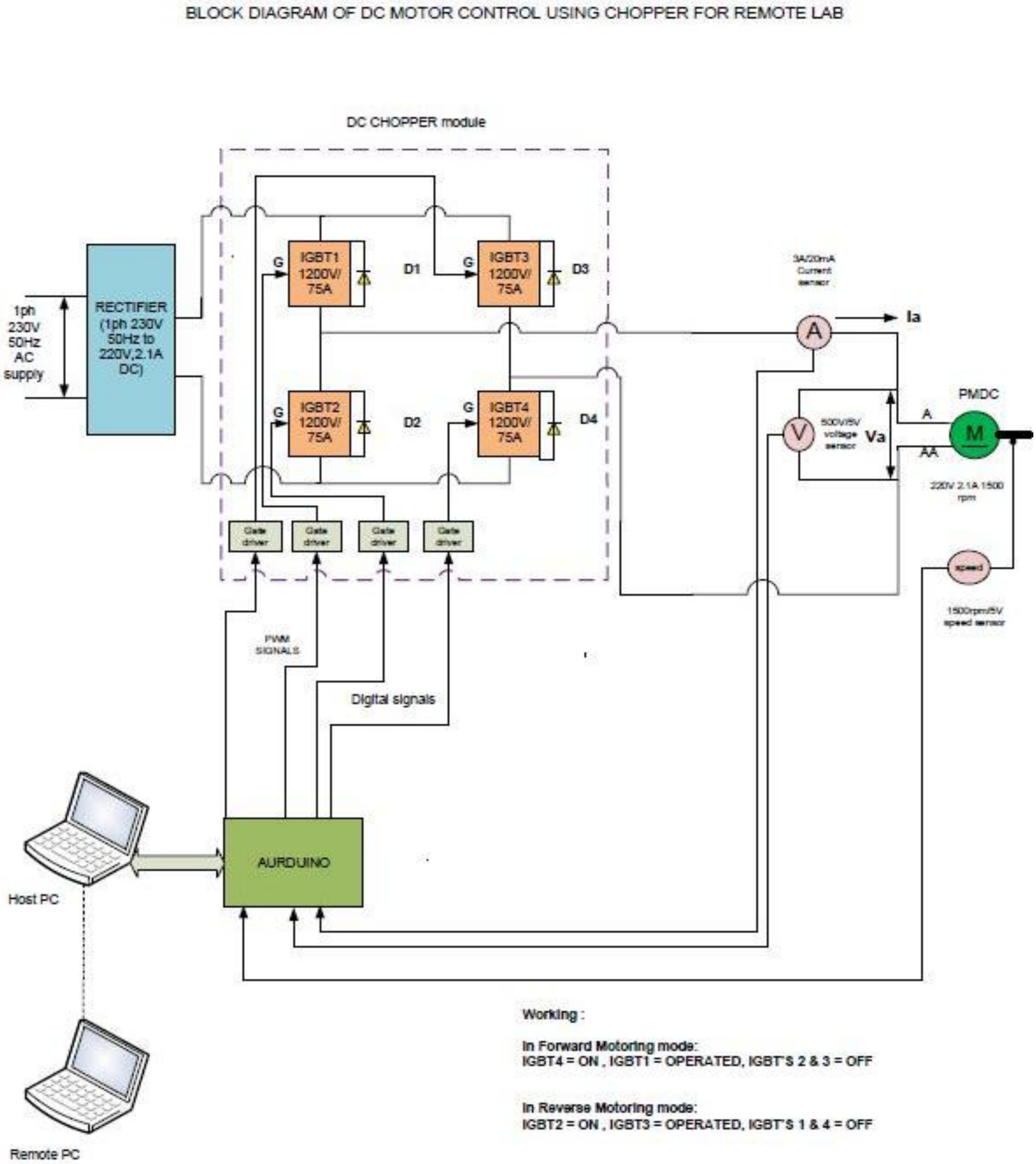

Fig.1 Block diagram of proposed technique for remote control

Components Required:

A. AC power supply
B. Rectifier
C. DC chopper module
D. DC motor
E. Gate drivers
F. Host PC with internet
G. Arduino uno board
H. Sensors

A. AC Power Supply

The available ac supply from ac mains is single-phase 230V, 50Hz. It is used as input to supply the whole system.

Here it is used single-phase ac supply but it depends upon the load requirement. In case of large loads, three-phase ac supply can be used.

B. Rectifier

It is a converter which is used to convert ac power into dc power. Here it is used to convert single-phase 230V, 50Hz ac supply into 220V, 2.1A DC. Output of this rectifier is fed to the chopper module as input.

C. DC Chopper module

Chopper is a power electronic dc-dc converter which is used to convert fixed dc voltage into variable dc voltage.

D. PMDC Motor

Permanent magnet DC motor is used. The ratings of this motor are 220V, 2.1A, 1500 rpm. Advantages of PMDC machines are absence of field supply, it does not require

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input power for the excitation which ultimately improves the efficiency and since the absence of filed coil overall size reduces.

E. Gate Drivers

The primary function of a drive circuit is to switch a power semiconductor device from the off state to the on state and vice versa. In the ON state the drive circuit must provide adequate drive power to keep the power switch in the ON state. Very often the drive circuit must provide reverse bias to the power switch control terminals to minimize turn off times and to ensure that the device remains in the OFF state.

The drive circuit is the interface between the control circuit and the power switch. The drive circuit amplifies the control signals to levels required to drive the power switch and provides electrical isolation when required between the power switch and the logic-level control circuits.

F. Host PC with Internet

The necessary hardware's, should be connected to the host PC. In addition the required software's, drivers and it must have internet connectivity also this PC should be equipped with uninterruptible power supply [UPS] for reliable operation. Along with the above it should have USB ports, latest LabVIEW / MATLAB software version installed, team viewer or server configuration for remote control.

G. Arduino Uno

It is a microcontroller board based on the ATmega328. It has 14 digital input/output pins (of which 6 can be used as PWM outputs), 6 analog inputs, a 16 MHz ceramic resonator, a USB connection, a power jack, an ICSP header, and a reset button. In this paper the function of Arduino Uno board is to generate the pulse width modulated [PWM] signals. These pwm signals are applied to DC chopper module and it can also be used to read the sensor output signals. However data acquisition cards are also can be used to serve the above purpose but Arduino is cost effective.

TABLE I
ARDUINO UNO SPECIFICATIONS

Microcontroller	ATmega328
Operating Voltage	5V
Input Voltage	7-12V
Digital I/O Pins	14 (6 PWM)
Analog Input Pins	6
Clock Speed	16 MHz

Arduino interface with LabVIEW: Install the latest LabVIEW software, then install the add on package for the Arduino from the VI package manager. After successful installation the separate palette for Arduino will be available in the LabVIEW.

H. Sensors

These are used to measure the input, output voltage, currents along with shaft speed. The sensor outputs will be read either by the Arduino board or Data Acquisition cards. Sensor outputs also calibrated and viewed through the LabVIEW software. Voltage sensors used are 6:1 scaling transformer, current sensors used are model ACS712 with sensitivity 100 mv/A and speed sensor used is Inductive and proximity type.

III. WORKING PRINCIPLE

Here single phase 230V, 50Hz AC supply is rectified into 220V DC and it is given to dc chopper as input. Output terminals of the chopper are connected to dc motor terminals. Now arduino is interfaced with labview software in host PC to generate PWM pulse and Digital signal. These signals are applied to pwm inputs of dc chopper module. Also voltage, current and speed sensors are placed to measure armature voltage, armature current, and speed respectively. Output of these sensors are acquired using arduino interfaced with labview.

Now for remote control, remote pc and host pc are connected through internet and pulse width of the pwm signals can be controlled in control panel of the labview. As the host pc and remote pc are connected through internet, control panel in the host pc can be controlled using remote pc. Also acquired signals are monitored in the control panel itself.

IV. RESULTS AND DISCUSSIONS

A. Pulse Generation

In the dc motor control using chopper experiment, duty cycle of the pwm signals that are applied to chopper is varied to have control over the dc motor. It is the manual control used to vary the duty cycle here. To achieve remote control over this experiment, duty cycle should be controlled remotely. For that LabVIEW and arduino uno board are used.

LabVIEW and arduino uno are interfaced with each other. LabVIEW has two major components such as front panel and block diagram. In block diagram program is written to generate pwm signal and knob is created in front panel to vary duty cycle of pwm signal. All this should be done in host PC so it should have internet facility. Remote PC is used to access this host PC through internet.

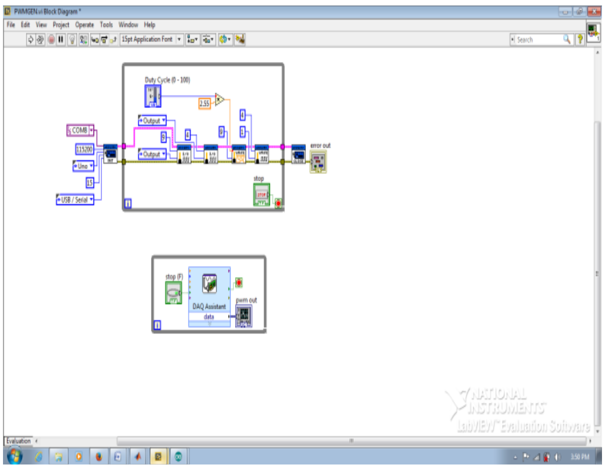

Fig.2 LabVIEW program to generate pwm signal

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Fig.2. shows program written in block diagram of LabVIEW to generate pwm signal from arduino uno and to aquire generated pwm signal using X-series DAQ system. The generated pwm signal will be available at digital pwm out pins.

Fig.3. shows front panel of LabVIEW which is showing generated pwm signal and also knob to vary the duty cycle of pwm signal.

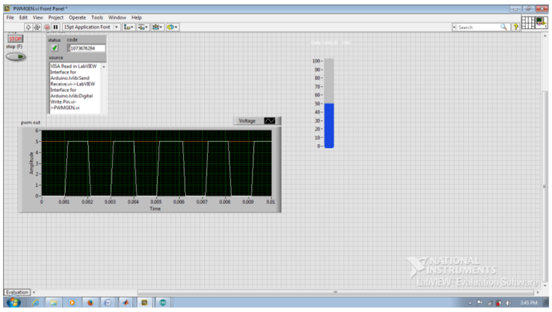

Fig.3 Output pwm signal and knob to vary duty cycle

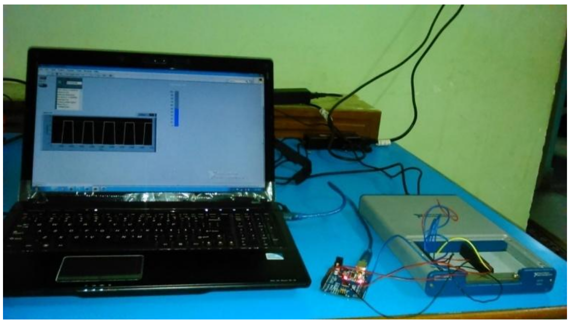

Fig.4 Practical connections made to generate PWM signal

Fig.4. shows practical connections made to generate and aquire pwm signal. It consists of laptop with labview software installed, arduino uno board, X-series DAQ.

B. Simulation Results

Simulation is carried out for the experiment dc motor control using chopper. In this experiment the objective is to verify forward motoring and reverse motoring operations. To achieve this operations the chopper should be operated in first and third quadrants, respectively.

i) Forward Motoring

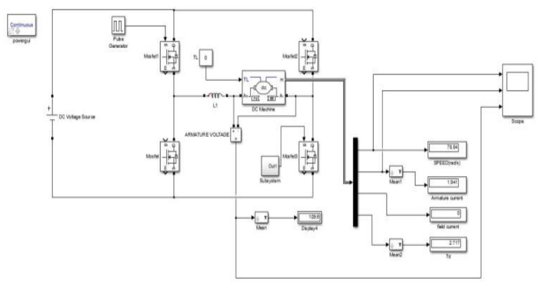

Fig.5. Simulink model for forward motoring operation

Fig.5. shows simulink model for forward motoring (first quadrant) operation. In this operation, switches 1 and 2 are operated, switches 3 and 4 are in OFF state. Output terminals of chopper are connected to pmdc motor terminals. Scopes are used to show measured parameters such as speed, armature current and voltage.

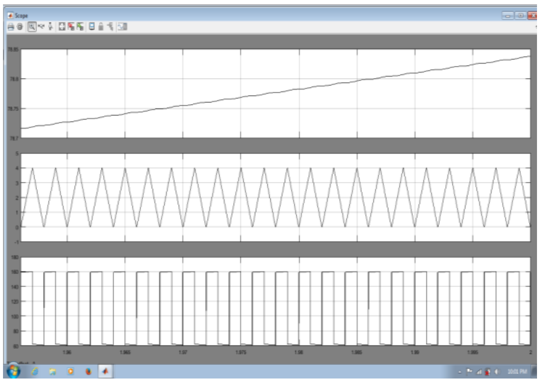

Fig.6. Output waveforms for forward motoring operation

Fig.6. shows output parameters such as speed, armature current and voltage. As this is forward motoring operation, speed is increasing in positive direction. Armature voltage is also positive.

ii) Reverse Motoring

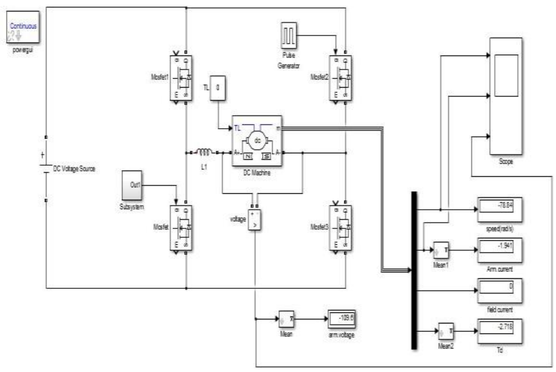

Fig.7. Simulink model for reverse motoring operation

Fig.7. shows simulink model for reverse motoring (third quadrant) operation. In this operation, switches 3 and 4 are operated, switches 1 and 2 are in OFF state.

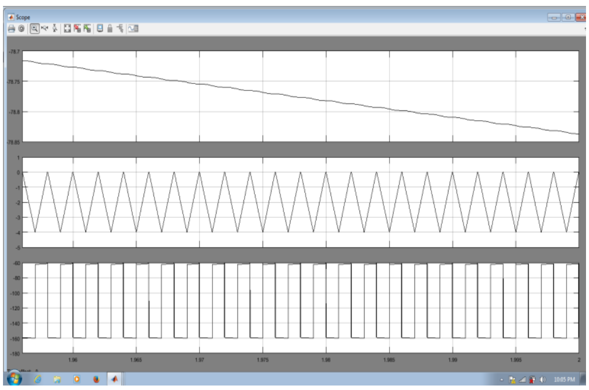

Fig.8. Output waveforms for reverse motoring operation

Fig.8. shows output parameters such as speed, armature current and voltage. As this is reverse motoring operation, speed is increasing in negative direction. Armature voltage is also negative.

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V. CONCLUSION

In this paper a technique for the remote control over the academic experiment dc motor control using chopper is presented. The components required and working principle of the proposed technique are discussed. LabVIEW and arduino uno are interfaced with each other for pulse generation. Also, the duty cycle of the pwm signal is remotely controlled through server. Simulation of forward and reverse motoring operations is carried out in MATLAB\Simulink.

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BIOGRAPHIES

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