

Speed and Direction Control of a DC Motor using Dual Converter Technique

Ubaid Hussain¹, Sohail Gul², Dr. Muhammad Naeem Arbaab³, Amjad Khan⁴

^{1,2,4}PG Research student, Dept. of EEE, University of Engineering and technology Peshawar, KP, Pakistan,

³Research Scholar, Dept. of EEE, University of Engineering and technology Peshawar, KP, Pakistan

Received: 10 March, Revised: 28 March, Accepted: 01 April

Abstract—This Paper presents the basic concept and methodology variable levels of DC voltage as well as reversal of polarity (without changing terminals physically). The circuit has been designed for this purpose can break into two parts: Dual H-bridge Converter and Microcontroller. Dual H-bridge converter is available in the form of L293D IC and L298N. The total power loss of existing system i.e. 8051 microcontroller with L293D was 1.7365W. While the total power loss of PIC microcontroller with L293D was 1.56165W. So, We have chosen proposed Atmega328 I.C because the power loss has been reduced to 1.560115w. The Microcontroller Atmega328 is programmed with C++ language. The Atmega328 microcontroller provides pulses to the gate of the NPN and PNP transistor for the required output DC voltage and polarity, which runs the DC motor.

Keywords— Machines, Motors, Speed Control, H-bridge Converter, Micro Controller.

I. INTRODUCTION

The major trouble in the advance power industries is to construct technical methods, algorithms, technologies, ideas for the design of procedure control systems which must be able to evolve, self-develop, self-organize, and self-evaluate and to self-improve. Speed and direction rheostat of a DC motor is needed and helpful in steel industries, cement industries and paper mills etc. it plays a significant part in the atomization of aforesaid industries. This paper provides speed as well as direction control of DC motor with higher efficiency. The simulated result is synchronized with the experimental results. Owing to ease of control and wide range applications of a DC motor, it becomes inherently recommended and used machine. Besides, a DC motor also rids the mechanism from the requirement of any power circuit switching.

Employing Pulse Width Modulation for the control mechanism of a DC motor is one of the several techniques available and commonly used for motor speed control. It is achieved through controlling the armature voltage. Either clockwise or anti-clockwise, both speeds can be controlled by the introduction of a microcontroller in the assembly. A wide and orderly arranged array of solar cells is often termed as a Solar panel. It is responsible for changing Sun's energy into electrical energy which can then be used in almost an unlimited

number of ways. A very high percentage in terms of efficiency can also be achieved when, though complex in nature, solar panels are perfectly aligned with the Sun, that is to say always facing towards the Sun. This research paper aims at furnishing a procedure for development of a hardware for maximum exposure of the PV panel to the Sun in a solar day by tracking the position of Sun at all times. The design indulges an 8051 microcontroller, a DC motor and a light sensor assembled on a single board. The output of the scheme is calculated to be 32.17 % more than the usually placed static flat solar panels. The L293D dual H-bridge converter controls the direction operation of the attached DC motor.

The highly trendy procedure of automation is currently going above the charts in usage by finding its applications in mega industries, factories, state of the art and tech facilities to homes. This research paper furnishes, based upon temperature variation, a cutting-edge mechanism regarding the control of speed of a DC motor. An interfacing was achieved through Lab VIEW owing to the dependence of motor speed on the variation in ambient temperature.

The temperature sensor that was utilized in this research paper is an LM35. Designing of the computer code and its execution, both the steps are carried out in the LABVIEW software. This software was already laden into an Arduino board in the first place. The Maker Hub makes possible the communication amid Lab VIEW software and the hardware board that is Arduino Uno board. For the starters, Pulse Width Modulation technique has been utilized for the generation of a duty cycle by changing the pulse width, for a range of temperatures. Next, generation of mean values of voltage for a duty cycle was carried out. Then, these generated voltage values are applied onto the DC motor so as to achieve the variation in the speed of the DC motor. The speed parameter regarding the DC motor has been controlled by the help of the program written in Lab View. It aimed at either increasing or decreasing the speed, depending upon the temperature.

This research paper furnished a practical and logical system for the speed control of a DC motor. Simulink (a tool in MATLAB) along with Arduino were utilized for the achievement of the speed control of a motor. This research paper work also furnishes a duo of Arduino board basics and PI controller of Simulink (used in a closed loop). It also describes the basics of coding program in Arduino Amalgamated with a

Simulink coder. Finally, the results of using a PI controller for DC motor speed will also be furnished towards the later stages device.

II. SYSTEM DESCRIPTION

The block diagram of the system is shown below. In the following block diagram DC motor can be operated by powering it through the battery storage or the mains via an adaptor. TON and TOFF are displayed along with frequency and the duty cycle on an LCD. There are also two relays for causing the current direction to swing from one phase to another. Just keeping one relay ON will cause the current to remain in one phase only, that is to say that current will remain either positive or negative. It therefore causes the motor to run in either one direction or the other. The desired speed of the motor can be achieved through the control mechanism through the analog pin A0. The PWM is controlled through the potentiometer using pot.

Here, the employment of the H-Bridge converter (L293D) is done so as to provide DC motor with 12V dc with at least 5V. Transistors in the bridge mechanism can be turned ON and OFF by the help of the input voltage. This technique is therefore much more unswerving and competent. The two motor pins, located on the outer area of the Atmega328, namely M1 and M2 are connected to two separate relays. Only the PWM control pin is the one that is in connection with both the relays. Pressing the “A” key causes motor to run in anti-clockwise direction, “C” causes it to run in clockwise direction. Whereas pressing the “S” key turns OFF both of the relays, thereby halting any supply of power to the DC motor. As a result, the DC motor stops.

Block Diagram

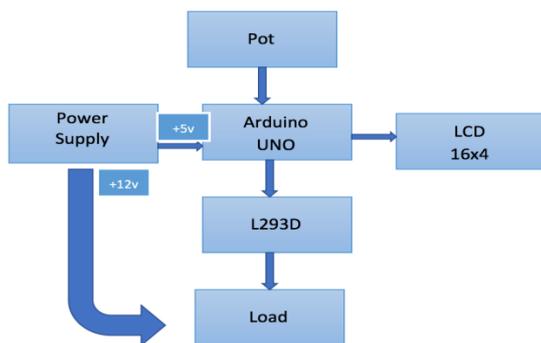


Figure 1. Block Diagram

III. SIMULATION RESULTS

A. Potentiometer

A maximum amount of current will flow towards the load when the resistance of the potentiometer is at its maximum and vice versa. The basic code is written in the C language, conversion to hexadecimal format has been carried out in the Arduino.

B. Micro-Controller

It is responsible for the control mechanism of the direction and speed of the DC motor. Micro controller is connected with the set of relays, a dual H-bridge converter and a speed controlling potentiometer.

C. Dual H-bridge Converter (L293 D)

This IC is responsible for driving the motor. It comes with an array of 4 high current diodes and a half H driver built inside of it. The aim of having this circuitry is to control not one but two motors simultaneously. The output current is rated at 600 mA, while voltage is maintained in a range of a minimum of 4.5 V to a maximum of 36 V.

This is a motor driver IC in which half H driver with quadruple High current is designed for controlling two motors at a time. It Provides drive currents of 600 mA that are bi-directional and the value of voltage is in the range of 4.5v - 36v.

D. DC Motor

A permanent 12 V DC motor has been employed. Variation in the speed of Dc motor is controlled by the variation in voltage. The Dc motor draws around 100mA of current. Stepper motor can also be used instead of the DC motor.

The frequency of the Pulse Width Modulation signal on a large amount of the pins is around 0.490 KHz. Pin 5 and pin 6 are the ones on a UNO board that give access to a frequency as an input for the system which is rated at around 0.980 KHz. The below figure is showing that duty cycle is 0% due to which output voltage is zero and no current will flow through the dc motor in fig.3.

In this image fig.4, we have seemed that the duty cycle is now 50% adjusted by potentiometer so that output voltage i.e. 12v is 50% off and 50% on and only 50% current of the peak current has been supplied to the dc motor.

In the above image fig.5, we have seen that the duty cycle is now 100% adjusted by potentiometer so that output voltage i.e. 12v is 0% off and 100% on and now 100% current peak current has been supplied to the dc motor.

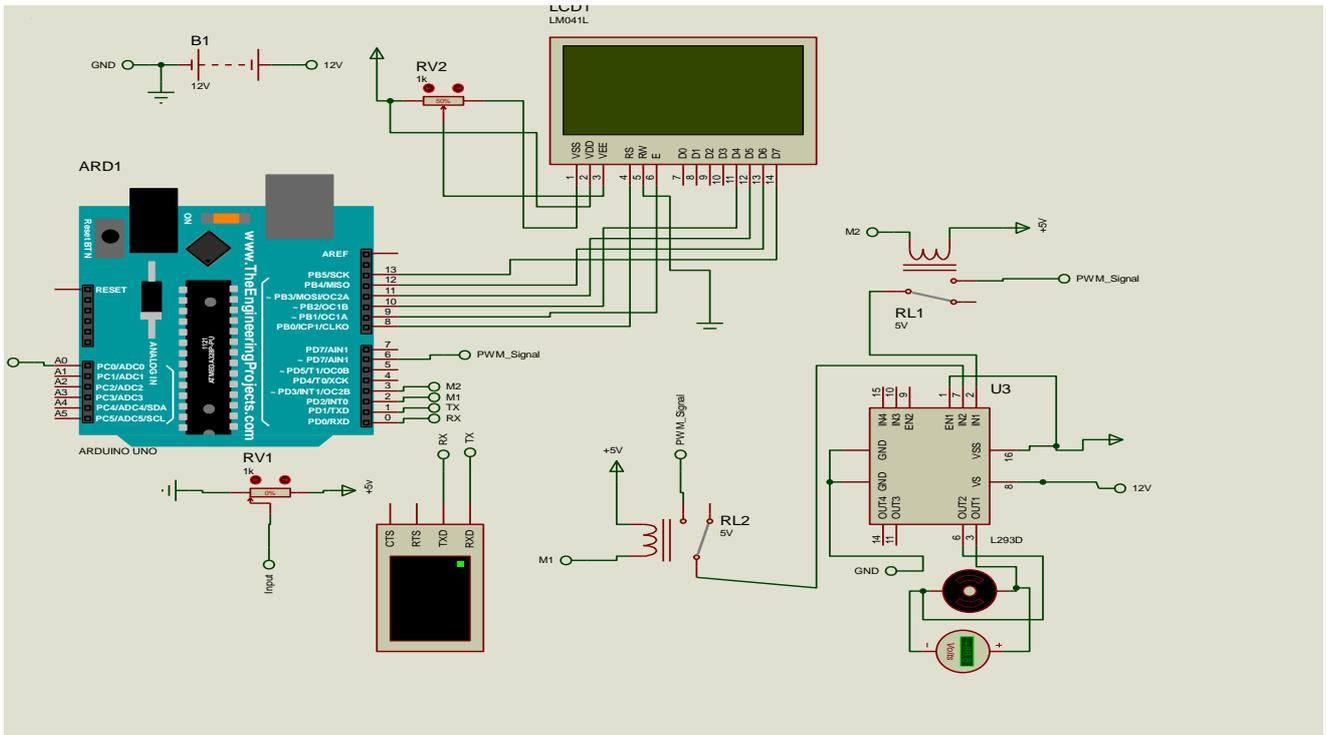


Figure 2. Complete Simulation Diagram

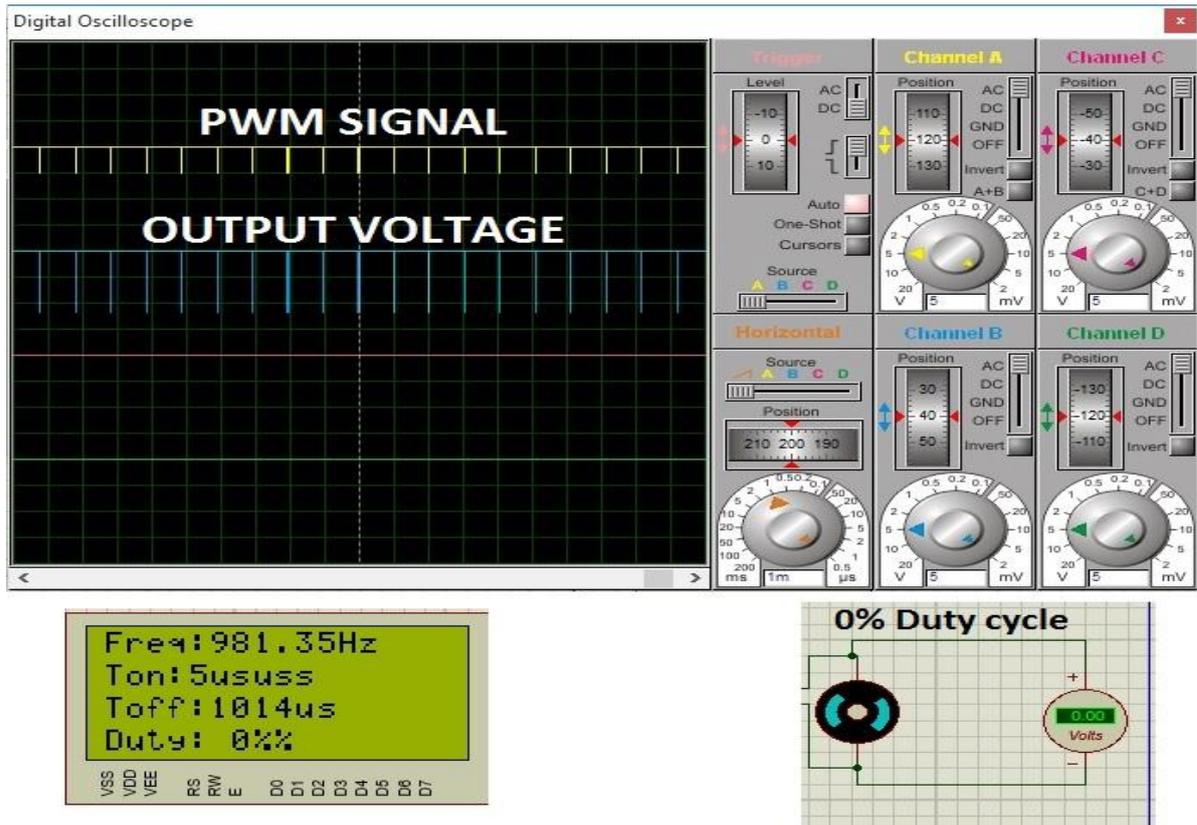


Figure 3. Figure of Motor is off at zero Duty Cycle

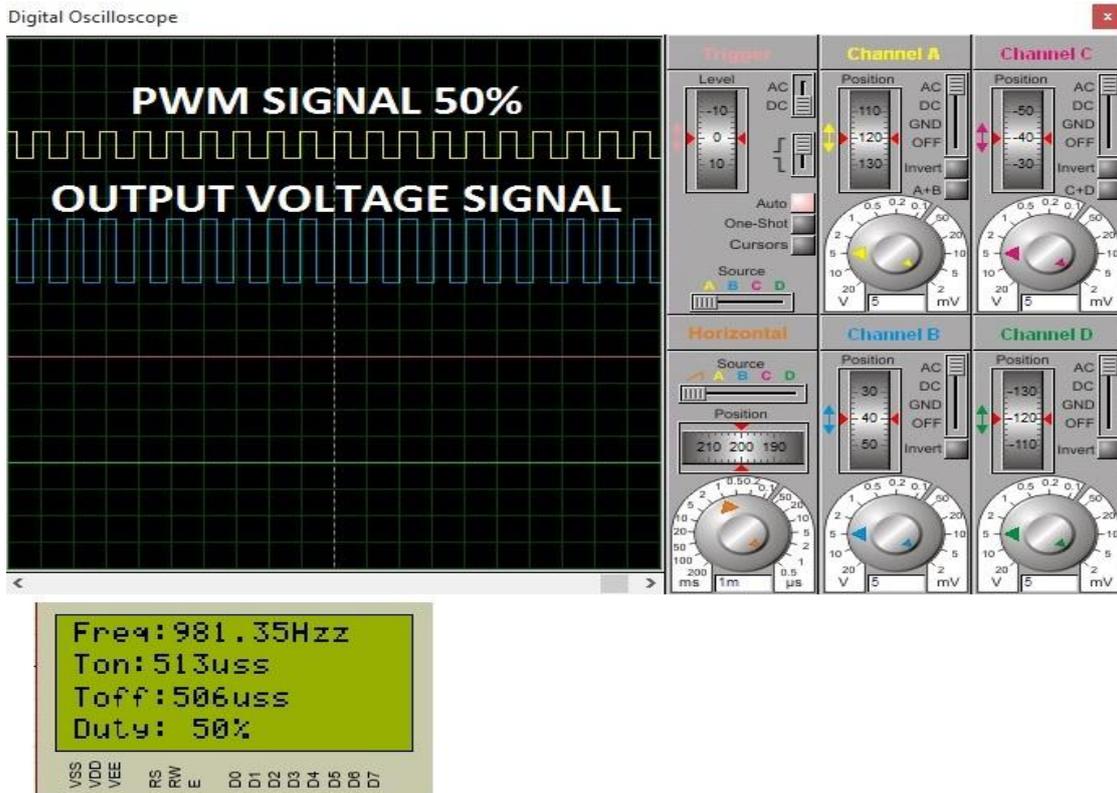


Figure 4. Figure of Motor is half on and half off at 50% Duty Cycle

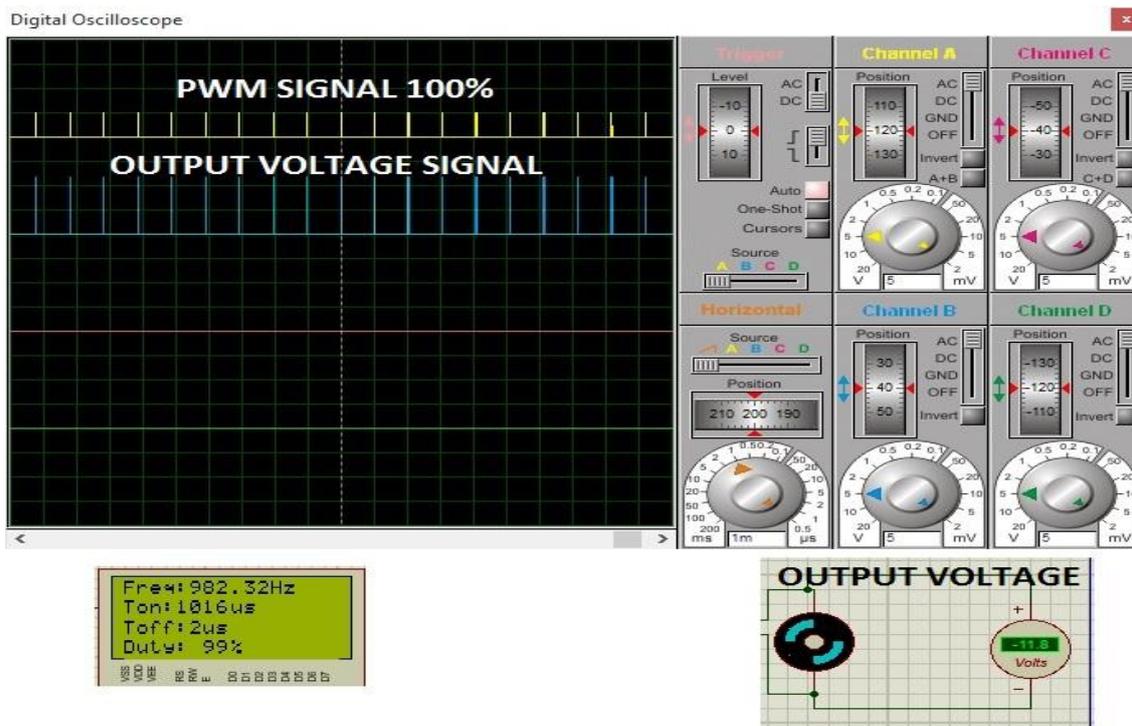


Figure 5. Figure of Motor is fully on at 100% Duty Cycle

E. Why Arduino Uno Atmega 328

Dual H-bridge Converter (L293D) Power consumption is Voltage drop = 2.6v, current = 0.6 so power loss is 1.56w.

We did not choose 8051 microcontroller and PIC microcontroller because of their high costs. System designing complexity and power losses are higher as compared to the Arduino UNO (Atmega 328) and are as given below the cost of a PIC microcontroller is Rs 200 along with pick it program burner (2000), Adapter (150) and wires/crystal/ PCB (100) due to which cost of the system will increase to \$24 and

Power consumption is 3.3v, 0.5mA, 1.65mW.

While 8051 microcontroller costs are Rs. 180 along with programming kit which costs Rs. 800, an adapter that is available for Rs 150, 100 pieces of wires/crystal/PCB for about Rs 100. So, the total cost increased to \$12. In addition, system designing and complexity are also complicated. Therefore, after this cost analysis, we have decided to go for ARDUINO UNO (Atmega328) Microcontroller and the cost is \$6 including the adapter. The power consumption is (5V and 0.023mA) = 0.115mW.

Parameters	8051 MICROCONTROLLERS	PIC-MICROCONTROLLER	ARDUINO UNO ATMEGA 328
Power loss	82.5mW	1.65mW	0.115mW
Total cost	12 dollars	24 dollars	6 dollars
Libraries	Less libraries	Less libraries	Vast number of libraries
Prototype	Slow prototype	Slow Prototype	Quick Prototyping
Oscillating Crystal	External	External	Mounted on board
Programming Language	Assembly Language	C/C++	C/C++
System Design	Complex	Complex	Simple

IV. SCOPE

Converter-controlled electrical machine drives are very important in modern industrial applications. Some examples in the high-power range are metal rolling mills, cement mills, and gas line compressors. In the medium-power range are textile mills, paper mills. Machine tools and computer peripherals are examples of converter-controlled electrical machine drive applications in the low-power range. The dual H-bridge converter normally provides the variable dc output voltage i.e. 12v to change the direction of dc motor in forward and reverse direction using Atmega328 I.C mounted on Arduino UNO developing board. The drive system efficiency is high because the converter operates in switching mode using power semiconductor devices. Speed and direction rheostat of a DC motor is needed and helpful in steel industries, cement industries and paper mills etc. it plays a significant part in the

atomization of aforesaid industries. This paper provides speed as well as direction control of DC motor with higher efficiency. The simulated result is synchronized with the experimental results. Owing to ease of control and wide range applications of a DC motor, it becomes inherently recommended and used machine. Besides, a DC motor also rids the mechanism from the requirement of any power circuit switching.

A. Future Work

In future, we can also employ the PID controller so as to control the speed of the motor in the efficient way.

CONCLUSION

Dual H-bridge convertor is the most efficient and effective for the sake of controlling the rotor speed and maintaining the direction of rotation of rotor in a DC motor. We have selected Atmega328 which is mounted on ArduinoUNO developing board has less power loss if we compared it with 8051 microcontroller and PIC microcontroller. In addition, the system i.e. Atmega328 (ARDUINO UNO) with LT93D H-bridge reduced the complexity of the system as well as the cost.

REFERENCE

- [1] Asha K R, SuhadaTasleemP“Reals Time Speed Control of a DC motor by Temperature Variation using LabVIEW and Arduino” 2017 International Conference on Recent Advances in Electronics and Communication Technology, 16-17 March 2017
- [2] Mario Gavran*, MatoFruk** and GoranVujisić“ PI controller for DC motor speed realized with Arduino and Simulink” 22-26 May 2017
- [3] L.Boaz1, S.Priyatharshini2 “DC Motor Direction and Speed Control byArduino through RF Wireless Technique” International Journal of Innovative Research in Computerand Communication Engineering ,Vol. 4, Special Issue 2, April 2016.
- [4] Lei Zhao, ChuangyuXu, XuemeiZheng and Haoyu Li “A Dual Half-Bridge Converter with Adaptive EnergyStorage to Achieve ZVS over Full Range ofOperation Conditions” Energies Article, 28 March 2017.
- [5] ShashiBhushan Kumar, Mohammed Hasmat Ali*, AnshuSinha, “Design and Simulation of Speed Control of DC Motor by Artificial Neural Network Technique” International Journal of Scientific and Research Publications, Volume 4, Issue 7, July 2014.
- [6] Oun Lee, Shin-Young Cho, and Gun-Woo Moon “Phase-Shifted Dual H-Bridge Converter with a Wide ZVS Rangeand Reduced Output Filter” IEEE, 2012.
- [7] Zhe Zhang and Michael A. E. Andersen “Interleaved Boost-Half-Bridge Dual-Input DC-DCConverter with a PWM plus Phase-Shift Control forFuel Cell Applications” IECON, IEEE, 2013.
- [8] WasanPhetphimoon “Modeling and Simulation of Bidirectional Half Bridge DC-DC Converter” ELEKTRO, IEEE, 2016
- [9] G.SUDHA1, “Performance Based Comparison Between Various Z-N Tuning PID And Fuzzy Logic PID Controller In Position Control System Of Dc”, International Journal on Soft Computing (IJSC) Vol.3, No.3, August 2012.
- [10] Manoj Kushwah1 and Prof. Ashis Patra2, “Tuning PID Controller for Speed Control of DC Motor Using Soft Computing Techniques-A Review” Advance in Electronic and Electric Engineering, Volume 4, Number 2 (2014), pp. 141-148.
- [11] J. C. Basilio and S. R. Matos, “Design of PI and PID Controllers With Transient Performance Specification”, IEEE Trans. Education, vol. 45, Issue No. 4, 2002, pp. 364- 370
- [12] AdityaPratap Singh, “Speed Control of DC Motor using PID Controller Based on Matlab” International Conference on Recent Trends in Applied Sciences with Engineering Applications, Vol.4, No.6, 2013.
- [13] Rahul Malhotra1, Narinder Singh2, Yaduvir Singh3, “SOFT COMPUTING TECHNIQUES FOR PROCESS CONTROL

APPLICATIONS” International Journal on Soft Computing (IJSC), Vol.2, No.3, August 2011.

- [14] MdAkram Ahmad, PankajRai, “Speed control of a DC motor using Controllers” Automation, Control and Intelligent Systems,2014; 2(6-1): 1-9
- [15] Ramesh Chandra Chourasia, Mukesh Kumar, “Speed Control of S.E.D.C. Motor by Using Pi and Fuzzy Logic Controller” International Journal of Soft Computing and Engineering (IJSCE),Volume-3, Issue-2, May 2013.
- [16] J. C. Basilio and S. R. Matos,“Design of PI and PID Controllers With Transient Performance Specification”, ,” IEEE Trans. Education, vol. 45, Issue No. 4, 2002, pp. 364- 370.
- [17] ShashiBhushan Kumar, Mohammed Hasmat Ali*, AnshuSinha, “Design and Simulation of Speed Control ofDC Motor by Artificial Neural Network Technique” International Journal of Scientific and Research Publications, Volume 4, Issue 7, July 2014.
- [18] KapinjayUcharia, Himmat Singh, “International Journal of Scientific Engineering and Technology” Volume No.3 Issue No.3, pp : 235 – 239 1 March 2014.
- [19] AdityaPratap Singh, “Speed Control of DC Motor using Pid Controller Based on Matlab” Innovative Systems Design and Engineering, Vol.4, No.6, 2013 - Selected from International Conference on Recent Trends in Applied Sciences with Engineering Applications.
- [20] P. M. Meshram, Rohit G. Kanojiya “Tuning of PID Controller using Ziegler-Nichols Method for Speed Control of DC Motor” IEEE-International Conference On Advances In Engineering, Science And Management (ICAESM -2012) March 30, 31,2012 117.

Ubaid Hussain Shah received the B.Sc degree from the Department of Electrical and Electronics, University of Engineering and Technology CECOS Peshawar, Khyber Pakhtunkhwa, Pakistan, in 2013.He is doing his Master from the UET Peshawar with specialization in Electrical Power. His research interests are to design and simulate the Speed and Direction Control of DC Motor Using Dual Converter Technique. His email address is obaidshah891@gmail.com.

Sohail Gul received the B Tech degree from the Department of Electrical and Electronics, University of Engineering and Technology Peshawar, Khyber Pakhtunkhwa, Pakistan, in 2009.He is doing his Master from the SARHAD University with specialization in Electrical Power. His research interests are to design and simulate the Speed and Direction Control of DC Motor Using Dual Converter Technique. His email address is sohailgul4@gmail.com.

Dr Muhammad Naeem Arbab received the B.Sc degree from the Department of Electrical and Electronics, University of Engineering and Technology Peshawar, Khyber Paktun Khwa, Pakistan, in 1989 and M.S. and Ph.D. degrees from University of Manchester, UK. He is currently a professor in Department of Electrical Engineering of UET Peshawar. His email address is mnarbab@yahoo.com

Amjad khan received the B.Sc degree from the Department of Electrical and Electronics, University of Engineering and Technology Peshawar, Khyber Pakhtunkhwa, Pakistan, in 2013.He also received Master from the same University with specialization in Electrical Power. Now he is doing PhD from the same university His research interests are in to power system Analysis, control and designing. His e-mail address is k_amjad461@yahoo.com.