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Recognition of Geometrical Shapes in Visual Basic and Control of PMDC Motors for X-Y Plotter Application

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Abstract-- Visual Basic is an interface-oriented language. As compared to other languages, designing even complex graphical user interfaces (or GUIs) is quite simple. This paper presents the technique of reading different geometrical shapes using Visual Basic from the computer. The X and Y co-ordinates of the images are calculated. These co-ordinates are then used to drive the DC motors through microcontroller. DC motors are run by a driver circuit which is H-bridge. Speed of DC motors is varied by generating PWM of variable duty cycle. Serial communication is used between computer and microcontroller. Signals from the image decide the direction of motor as well as the speed with which two motor run simultaneously. This system can be used for X-Y plotter.

***Index Terms--* Visual Basic, DC Motor, H-bridge, Pulse Width Modulation, X-Y plotter**

I. INTRODUCTION

Visual Basic has both an Object-Oriented and an Event-Driven programming platform. It allows you to create programs which work within the Windows Graphical User Interface (GUI) Environment. Visual Basic is designed to be easy to learn and use. The language not only allows programmers to create simple GUI applications, but can also develop complex applications. The proposed method uses programming in Visual Basic to read the components of an image because in contrast to traditional, command-line interfaces, almost all user interfaces in Visual Basic are constructed using the WIMP, or "windows, icon, menu, pointer," GUI style. This means that Visual Basic programs interact with users almost exclusively using graphical elements, such as windows, buttons, toolbars, etc., with very few console-based applications. MATLAB is also widely used for graphic user interface. To interface hardware with personal computer, Most generally Serial communication is preferred. Here, Max 232 IC and Tx, Rx pin and serial interrupt of P89V51RD2 Micro controller are used to serially communicate with computer.

PM motors are usually physically smaller in overall size and lighter for a given power rating.DC motors are used in portable machine tools supplied from batteries, in automotive vehicles as starter motors, blower motors, and in many control applications as actuators and as speed and position sensing devices. High-volume everyday items, such as hand drills and kitchen appliances, use a dc servomotor known as a universal motor. Those motors can work well on both AC and DC power. Higher torques can be obtained using geared motors. The term geared motor is used to define a motor that has a gear reduction system (or gearbox) integrally built into the motor. The gearbox increases the torque generating ability of the motor while simultaneously reducing its output speed. There are mainly three methods of speed control of DC drives namely field control, armature voltage control and armature resistance control methods. In general, armature voltage control method is widely used to control the DC drives. In thyrister method, a controlled rectifier, or chopper is used to vary the supplied voltage by changing the firing angle but due to involvement of power electronics elements, nonlinear torque speed characteristics are observed which are undesirable for control performance. Phase locked loop control technique is also used for precise speed control and zero speed regulation. Pulse width modulation is a widely used method to control the speed of motor. In the basic Pulse Width Modulation (PWM) method, the operating power to the motors is turned on and off to modulate the current to the motor using MOSFETs. In this paper, method of analog pulse width modulation is discussed that drives DC motor by switching the MOSFETs connected in H-bridge.

II. RECOGNITION OF GEOMETRICAL SHAPES AND SPEED CALCULATION

Figure 1 shows the block diagram of X-Y plotter system in closed loop configuration. Any geometrical shape (excluding circular surfaces) is sensed from the computer screen by detecting starting point and end point of the straight lines. The difference between these two points is used to calculate the number of revolutions that motors will rotate. There are two motors, one for X direction and other for Y direction. The speed of Y axis motor will be directly proportional to the angle of slope of line whereas the speed of X-axis motor will be inversely

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proportional to the slope of line. If the difference of starting point and ending point is positive, motor runs in forward direction and if it is negative, motor runs in reverse direction.
These signals are passed to the microcontroller through serial communication using MAX 232. Max232 is used to convert RS232 logic level into the TTL logic level because micro controller is compatible with TTL logic. Software, written in computer, sends data to controller which generates serial interrupt in micro controller which indicates data receiving in SBUF register of controller. Then microcontroller operates two DC motors, one for X-axis direction and other for Y-axis direction, by sending signal to the driver circuit. Driver is required as the signals coming from microcontroller are not strong enough to drive the motor.

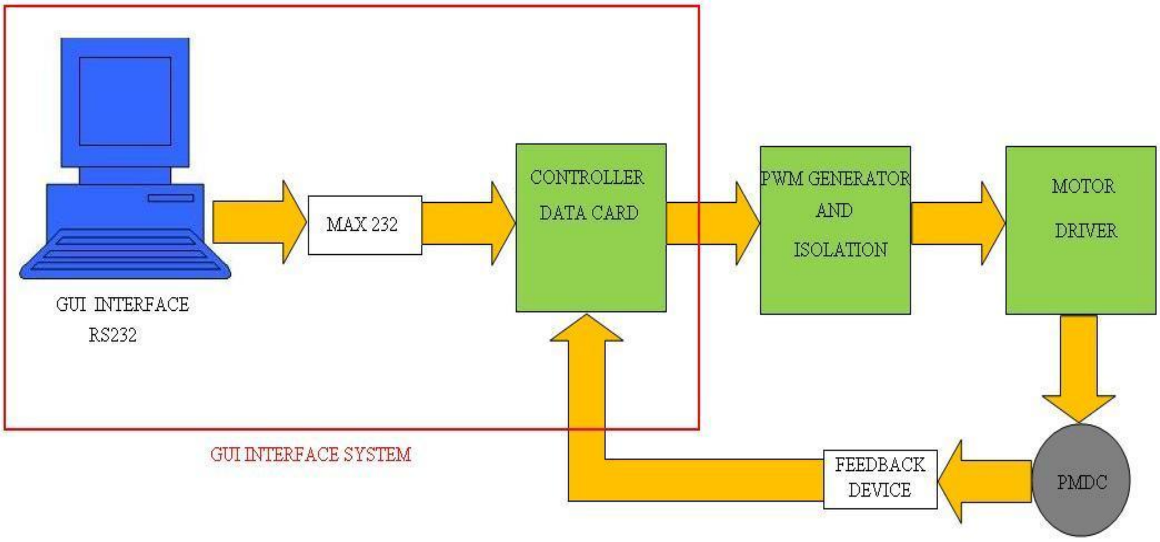

Fig 1. Block Diagram of X-Y Plotter System

III. BI DIRECTIONAL FULL BRIDGE CIRCUIT

Driving a brushed DC motor in both directions, by reversing the current through it, can be accomplished using a full-bridge circuit which consists of four N-channel MOSFETs. A full bridge circuit is shown in the figure 1. Each side of the motor can be connected either to battery positive, or to battery negative. Note that only one MOSFET on each side of the motor must be turned on at any one time otherwise they will short out the battery and burn out.To make the motor go forwards, Q4 is turned on, and Q1 has the PWM signal applied to it. The current path is from Q1 to Q4. Note that there is also a diode connected in reverse across the field winding. This is to take the current in the field winding when all four MOSFETs in the bridge are turned off.Q4 is kept on so when the PWM signal is off, current can continue to flow around the bottom loop through Q3's intrinsic diode. To make the motor go backwards, Q3 is turned on, and Q2 has the PWM signal applied to it.Q3 is kept on so when the PWM signal is off, current can continue to flow around the bottom loop through Q4's intrinsic diode.
For regeneration, when the motor is going backwards for example, the motor (which is now acting as a generator) is forcing current right through its armature, through Q2's diode, through the battery (thereby charging it up) and back through Q3's diode

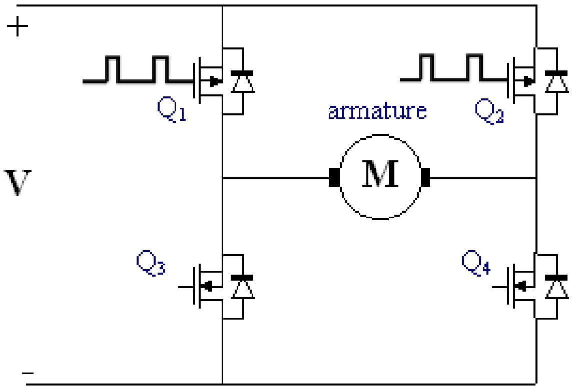

Fig 2. Full H-Bridge Driver Circuit Diagram

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The speed of a DC motor is directly proportional to the supply voltage, so if we reduce the supply voltage from 12 Volts to 6 Volts, the motor will run at half the speed. A better way is to switch the motor's supply on and off very quickly. If the switching is fast enough, the motor doesn't notice it, it only notices the average effect. This on-off switching is performed by power MOSFETs. This is the principle of switch mode speed control. Thus the speed is set by Pulse Width Modulation (PWM).

IV. PULSE WIDTH MODULATION

A simplest method to control the rotation speed of a DC motor is to control its driving voltage. Higher the voltage, higher is the speed the motor tries to reach. In many applications simple voltage regulation would cause lot of power loss on control circuit, so a pulse width modulation method (PWM) is used in many DC motor controlling applications. The ratio of "on" time to "off" time is what determines the speed of the motor. When doing PWM controlling, keep in mind that a motor is a low pass device. The reason is that a motor is mainly a large inductor. It is not capable of passing high frequency energy, and hence will not perform well using high frequencies. Reasonably low frequencies are required, and then PWM techniques will work. Lower frequencies are generally better than higher frequencies, but PWM stops being effective at too low a frequency. The idea that a lower frequency PWM works better simply reflects that the "on" cycle needs to be pretty wide before the motor will draw any current (because of motor inductance). A higher PWM frequency will work fine if you hang a large capacitor across the motor or short the motor out on the "off" cycle. The reason for this is that short pulses will not allow much current to flow before being cut off. Then the current that did flow is dissipated as an inductive kick - probably as heat through the fly back diodes. The capacitor integrates the pulse and provides a longer, but lower, current flow through the motor after the driver is cut off. There is not inductive kick either, since the current flow isn't being cut off. Knowing the low pass roll-off frequency of the motor helps to determine an optimum frequency for operating PWM. Here the motor is tested with a square duty cycle using a variable frequency, and then the drop in torque is observed as the frequency is increased. This technique can help determine the roll off point as far as power efficiency is concerned. However, when we work out the power dissipation in the stray resistances in our motor and speed controller, for the DC case:

$P= I^2R$

and for the switching case, the average power is

$P=(2I)^2R/2 \ + O^2R/2$

$P = 2I^2R$

So in the switching waveform, twice as much power is lost in the stray resistances. In practice the current waveform will not be square wave like this, but it always remains true that there will be more power loss in a non-DC waveform.

V. CHOOSING PWM FREQUENCY BASED ON MOTOR CHARACTERISTICS

The frequency of the resulting PWM signal is dependant on the frequency of the ramp waveform. One way to choose a suitable frequency is this: Say, for example, that we want the current waveform to be stable to within 'p' percent. Then we can work out mathematically the minimum frequency to attain this goal. Figure 2 shows the equivalent circuit of the motor, and the current waveform as the PWM signal switches on and off.

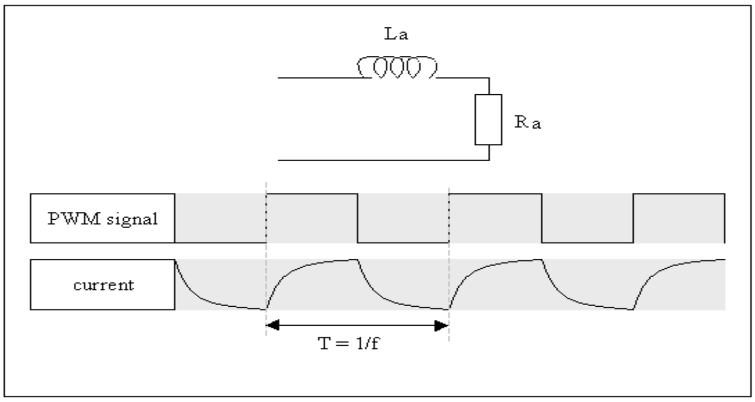

Fig 3. Effect of L/R on current

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This shows the worst case, at 50:50 PWM ratios, and the current rise is shown for a stationary or stalled motor, which is also worst case.'T' is the switching period, which is the reciprocal of the switching frequency. Just taking the falling edge of the current waveform, this is given by the equation

$i = Ie^{t/c} = Ie^{-tR/L}$

τ is the time constant of the circuit, which is L / R.

So the current at time t = T/2 (i_1) must be no less than P% lower than at t = 0 (i_0). This means there is a limiting condition:

$i_1 = (1 - P/100)i_0$

$I\,e^{-TR/2L} = (1-P/100)Ie^0$

$e^{-TR/2L} = (1-P/100)e^0$

$-TR/2L = \ln(1 - P/100)$

$T = -2L/R\ \ln(1 - P/100)$

since the frequency $f = 1/T$

$f = R/-2L\ \ln(1 - p/100)$

Some values are tried to get different frequencies. The motor parameters are as follows:

R = 0.04Ω L = 70μH

We must also include the on-resistance of the MOSFETs being used, 2 x 10mΩ, giving a total resistance of R = 0.06 Ω.

Table I

Frequency and allowable ripple **Percentage**	**frequency**
1	42 kHz
5	8.2 kHz
10	4 kHz
20	1900 Hz
50	610 Hz

As shown in graph (Figure 4), a reasonably low ripple can be achieved with a switching frequency of as little as 5 kHz. Unfortunately, motor manufacturers rarely publish values of coil inductance in their datasheets, so the only way to find out is to measure it. This requires sensitive LCR bridge test equipment which is rather expensive to buy.

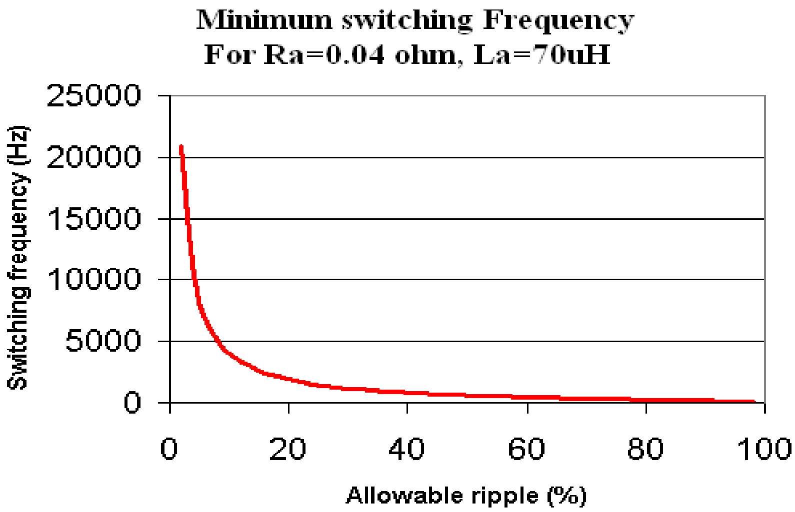

Fig 4. Allowable Ripple versus Switching Frequency

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VI. SIMULATION RESULTS

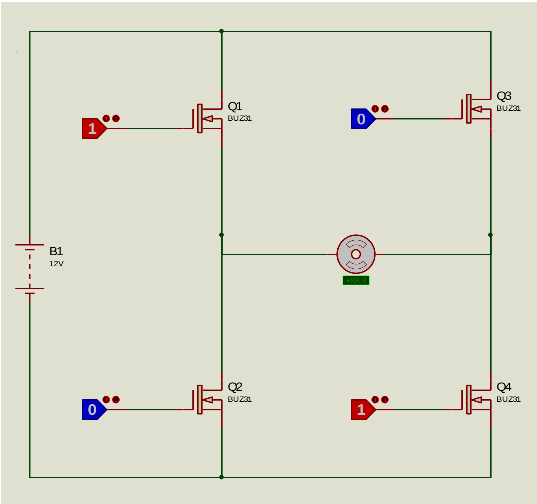

Fig 5 H-Bridge Driving DC Motor

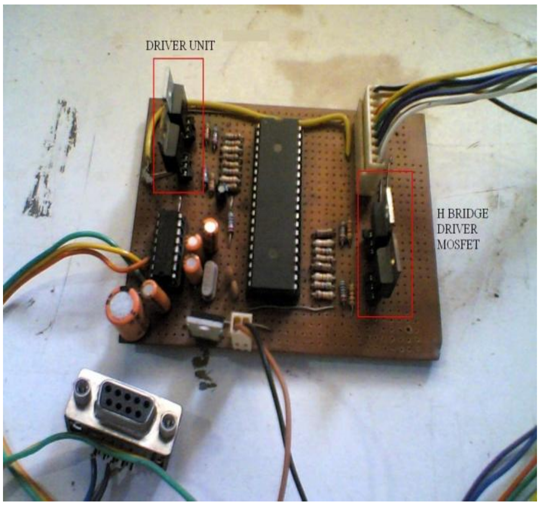

Fig 6 Schematic Diagram Of Driver Circuit

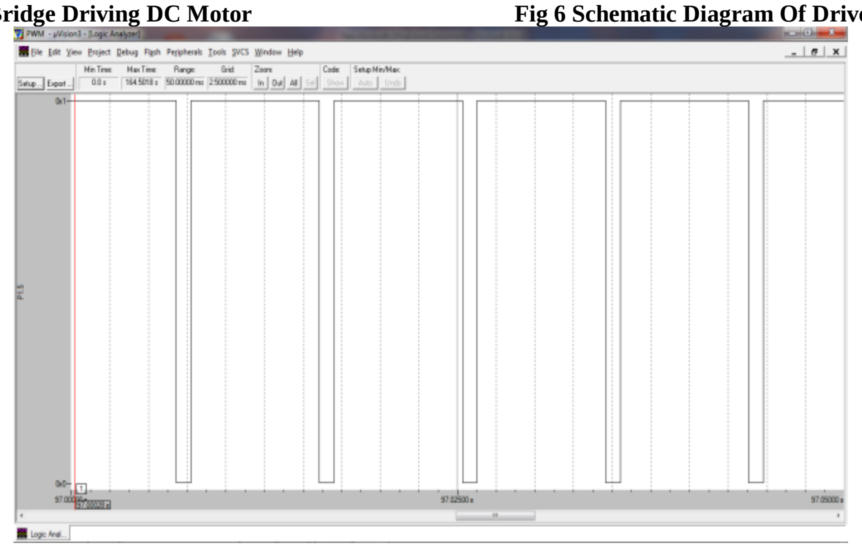

Fig 7. PWM Signal Generation With 90 % Duty Cycle

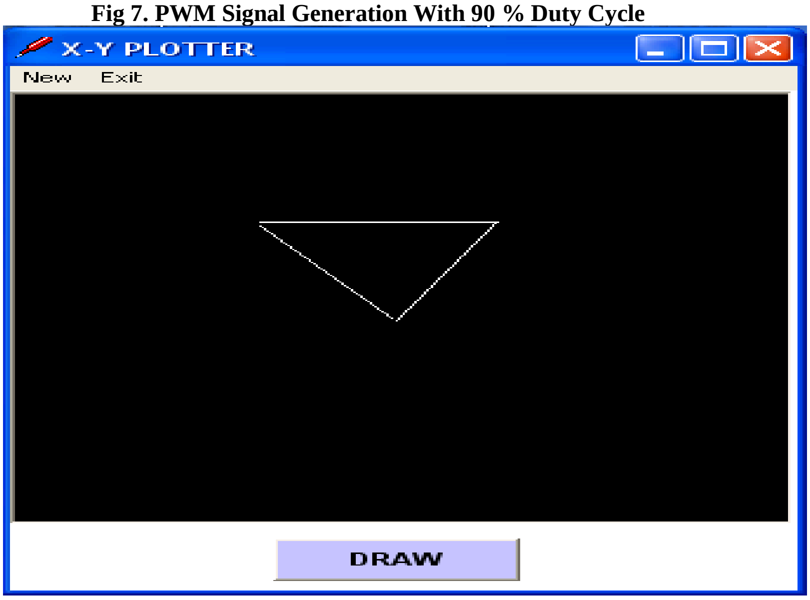

Fig 8. Screen of X-Y Plotter

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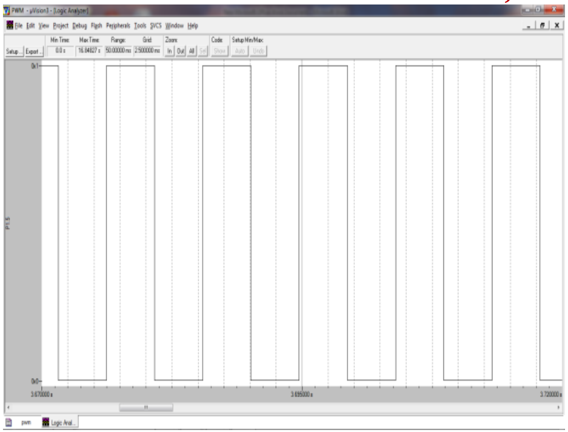

Fig 9. PWM Signal Generation With 50 % Duty Cycle

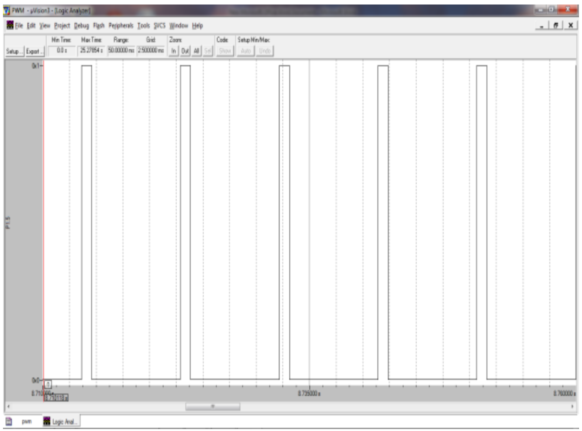

Fig 10. PWM Signal Generation With 10 % Duty Cycle

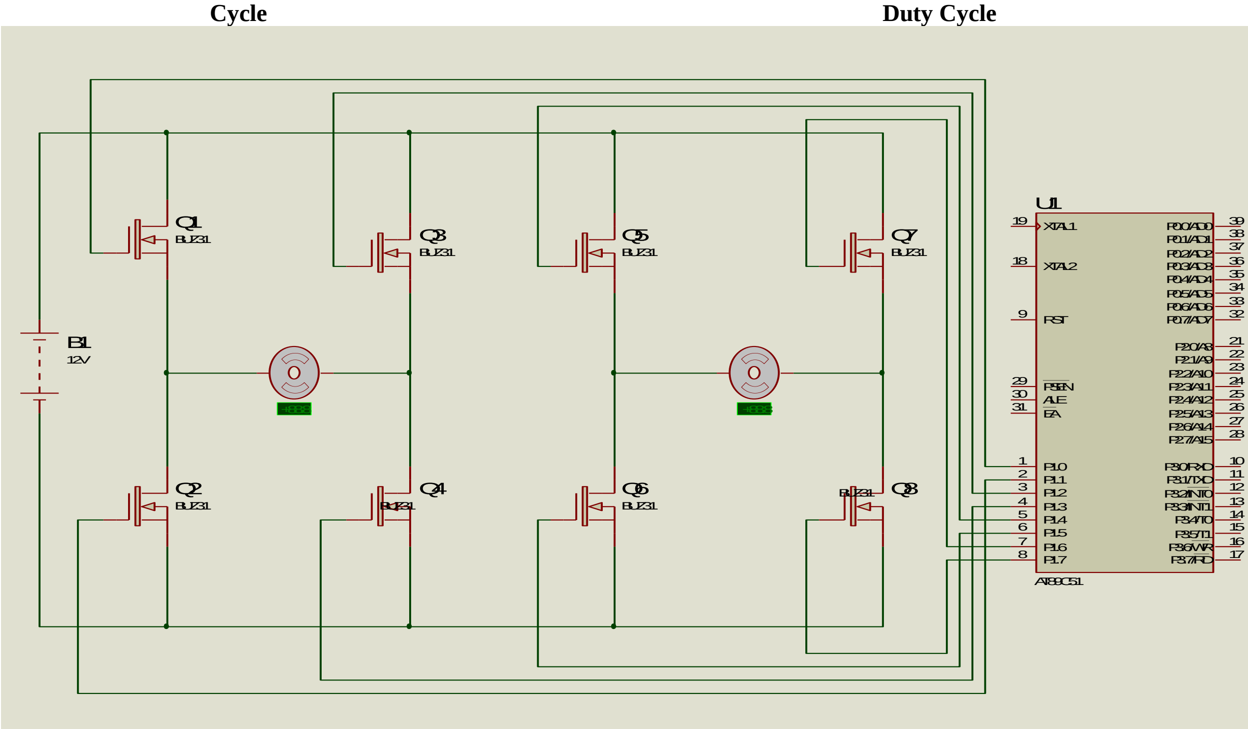

Fig 11. Microcontroller Interfacing with DC Motor

VII. CONCLUSION

Graphic user interface is most effectively achieved using Visual Basic programming language. Speed control of DC motor can be achieved using Digital or Analog Pulse Width Modulation technique. When digital PWM is used, control is obtained at two levels, high and low. Whereas using analog PWM, control can be obtained over a wide range of values. In the proposed method, duty cycle is varied from 0 percent to 90 percent and motor is controlled at different speeds. Intervals are taken at every 10 percent. At 50 percent of duty cycle, speed of DC motor is observed to be half of that at full voltage. More precise control can be obtained by dividing the scale into more number of intervals.

REFERENCES

[1] Remya Ravindran, Arun Kumar," A DC Motor Speed Controller using LABVIEW and Visual Basic", IJECT Vol. 3, Issue 1, Jan. - March 2012.

[2] N. Milivojevic, Mahesh Krishnamurthy and Yusuf Gurkaynak," Stability Analysis of FPGA- Based Control of Brushless DC Motors and Generators Using Digital PWM Technique", IEEE Transactions on Industrial Electronics, Vol. 59, no. 1, January 2012.

[3] Hong Wong and Vikram Kapila, "Internet-Based Remote Control of a DC Motor using an Embedded Ethernet Microcontroller".

[4] Monica Chinchilla, Santiago Arnaltes and Juan Carlos Burgos," Control of Permanent-Magnet Generators Applied to Variable-Speed Wind-Energy Systems Connected to the Grid", IEEE Transactions on Energy Conversion, Vol 21, No March 2006.

[5] Rohit Gupta, Ruchika Lamba and Subhransu Padhee,"Thyristor Based Speed Control Techniques of DC Motor: A Comparative Analysis", International Journal of Scientific and Research Publications, Volume 2, Issue 6, June 2012.

[6] Zuo Zong Liu, Fang Lin Luo and Muhammad H. Rashid," Speed Nonlinear Control of DC Motor Drive With Field Weakening", IEEE Transactions on Industry Applications, Vol. 39, No. 2, March/April 2003.

[7] Abu Zaharin Ahmad and Mohd Nasir Taib. A study on the DC Motor Speed Control byUsingBack-EMF Voltage. Asia sense sensor, 2003, pg. 359-364.

[8] Chia-An Yeh and Yen-Shin Lai,"Digital Pulse width Modulation Technique for a Synchronous Buck DC/DC Converter to Reduce Switching Frequency", IEEE Transactions on Industrial Electronics, Vol. 59, No. 1, January 2012.

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