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Speed Control of DC Motor using PIC 16F877A Microcontroller

Abstract

Control system design and analysis technologies are widely suppress and very useful to be applied in real-time development. Some can be solved by hardware technology and by the advance used of software, control system are analyzed easily and detail.

DC Motors can be used in various applications and can be used as various sizes and rates as per our applications. In this project we have control the actual speed of dc motor as per ours requirement. This can be achieved through PIC microcontroller. The microcontroller computes the actual speed of the motor by sensing the terminal voltage and displayed on LCD.

In this project firstly we are giving the supply to PIC microcontroller. Then controller generates the pulse generally 5 volt DC. The generated pulse is nothing but PWM signal. Which giving to driver circuit. The function of this driver circuit to generate 12v DC pulse. This is necessary to switch/trigging on MOSFET.Thus speed of DC motor is control through duty/PWM cycle. This PWM pulse is giving to MOSFET for trigging purpose.

The modeling and simulation of this project is done through MP-LAB software. It then compares the actual speed of the motor with the reference speed and generates a suitable control signal which is fed into the trigging unit using

MATLAB. Here we use PID Controller for error minimization purpose. This unit drives a Power MOSFET amplifier, which in turn supplies a PWM voltage to the dc motor.

Keywords: DC Motor, PIC Microcontroller, PWM Pulse, Duty Cycle, MOSFET, Driver Circuit, MP s/w.

1. INTRODUCTION

1.1 Background

Control system design and analysis technologies are widely suppress and very useful to be applied in real-time development. Some can be solved by hardware technology and by the advance used of software, control system are analyzed easily and detail. DC Motors can be used in various applications and can be used in various sizes and rates as per our applications. The DC-Motor is used in domestics and industrial purpose.

Whenever we think about any programmable devices then the embedded technology comes into fore front. The embedded is now-a- days very much popular and most of the product are developed with Microcontroller based embedded technology. The advantages of using the microcontroller is the reduction of the cost and also the use of extra hardware such as the use of timer, RAM and ROM can be avoided. This technology is very fast so controlling of multiple parameters is possible; also the parameters are field programmable by the user.

In this project we are controlling speed of DC motor. As we increase the speed of DC Motor as a result an increase in the productivity of material. The application of this is used in domestic's purpose examples are hair dryer, mixer, zero machine, elevator and industrial purpose examples are traction and elevator. In this project we have control the actual speed of dc motor as per our requirement. This can be achieved through PIC microcontroller. The microcontroller computes the actual speed of the motor by sensing the terminal voltage and displayed on LCD.

In this project firstly we are giving the supply to PIC16F8774 microcontroller. Then controller generates the pulse generally 5VDC. The generated pulse is nothing but PWM signal, which is given to the driver circuit. The function of this driver circuit is to generate 12V DC pulse. This is necessary to switch/trigger the MOSFET. Thus the speed of DC motor is controlled through duty/PWM cycle. This PWM pulse is given to MOSFET for triggering purpose.

The modeling and simulation of this project is done through MATLAB/PROTES software. It then compares the actual speed of the motor with the reference speed and generates a suitable control signal which is fed into the triggering unit using MATLAB. here we use PID Controller for error minimization purpose. This unit drives a Power MOSFET amplifier, which in turn supplies a PWM voltage to the dc motor. DC Motors can be used in various applications.

1.2 Objective of project

The main core of this project is to design a speed control system of DC Motor by using microcontroller. This system will be able to control the DC motor speed at desired speed regardless the changes of load.

1.3 Scope of Project

In order to achieve the objective of the project, there are several scope had been outlined. The scope of this project includes using MPLAB IDE to program microcontroller PIC 16F877A, build hardware for the system, and interface the hardware to computer by using RS232 serial port communication. Last but not least, a graph of speed versus time is obtained by using Visual Basic 6.0 at computer to observe the performance of the system.

1.4 Block Diagram

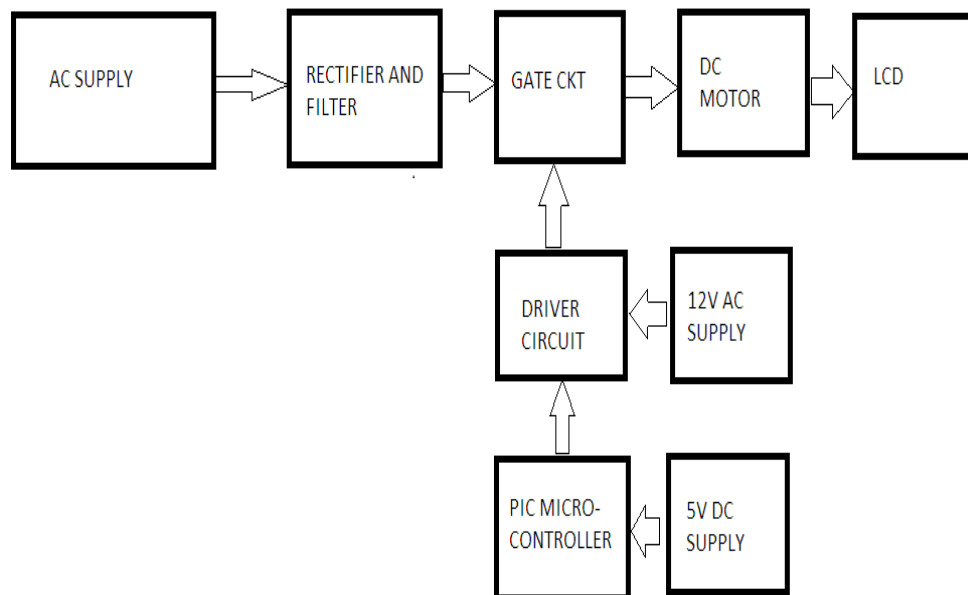


Fig.1 block diagram of project

1.5 Block diagram is consisting of following parts

- AC SUPPLY
- RECTIFIER AND FILTER
- GATE CURCUIT(MOSFET)
- DRIVER CURCUIT
- PIC 16F877A MICROCONTROLLER
- 5 VOLT DC SUPPLY
- BOOSTER CURCUIT
- DC MOTOR

1.6 5v Dc Power Supply

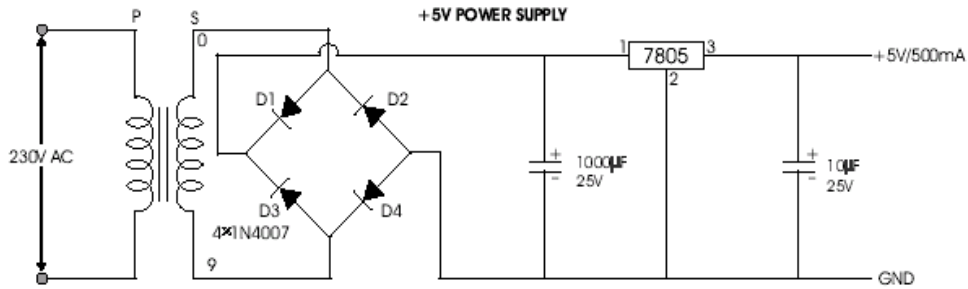


Fig.2 power supply

1.7 Working Principle of 5v dc power supply

The AC voltage, typically 220V rms, is connected to a transformer, which steps that ac voltage down to the level of the desired DC output. A diode rectifier then provides a full-wave rectified voltage that is initially filtered by a simple capacitor filter to produce a dc voltage. This resulting dc voltage usually has some ripple or ac voltage variation. A regulator circuit removes the ripples and also remains the same dc value even if the input dc voltage varies, or the load connected to the output dc voltage changes.

1.8 PIC 16F877A Microcontroller

Peripheral Interface Controller (PIC) is introduced by Microchip technology. PIC 16F877A is a family of CMOS 8-bit Flash microcontroller. Power consumption is very low. PIC16F877A is a 40/44-pin device which can operate at up to 20 MHz clock speed. It has 8K * 14 words flash program memory, 368*8 RAM data memory, 64bytes of EEPROM nonvolatile data memory, 8-bit timer with watchdog timer, Only 35 single-word instructions to learn, external and internal interrupt sources and large sink and source capability. The architecture is given by

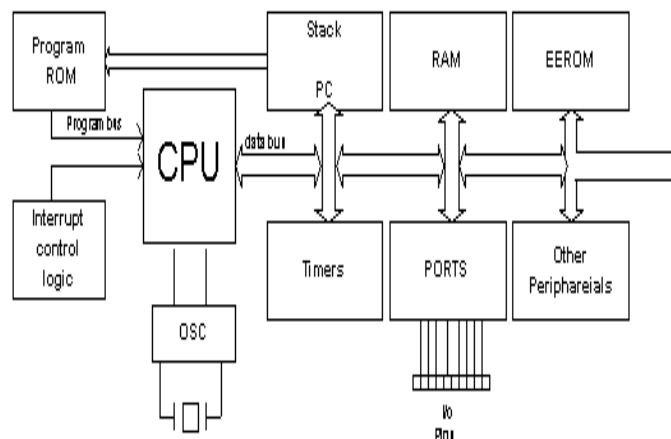


Fig.3 PIC controller block diagram

PIC microcontrollers have a data memory bus of 8-bit and a program memory bus of 12, 14 or 16 bit length depending on the family. All PIC microcontrollers have a mix of different on-

chip peripherals like A/D converters, Comparators, weak pull-ups, PWM modules, UARTs, Timers, SPI, I2C, USB, LCD, and CAN etc.

1.9 Driver circuit

The driver circuit is divided into following parts:

1. Buffer Circuit
2. Isolation Circuit
3. Phase Shifting (Transistor)
4. Darlington pair

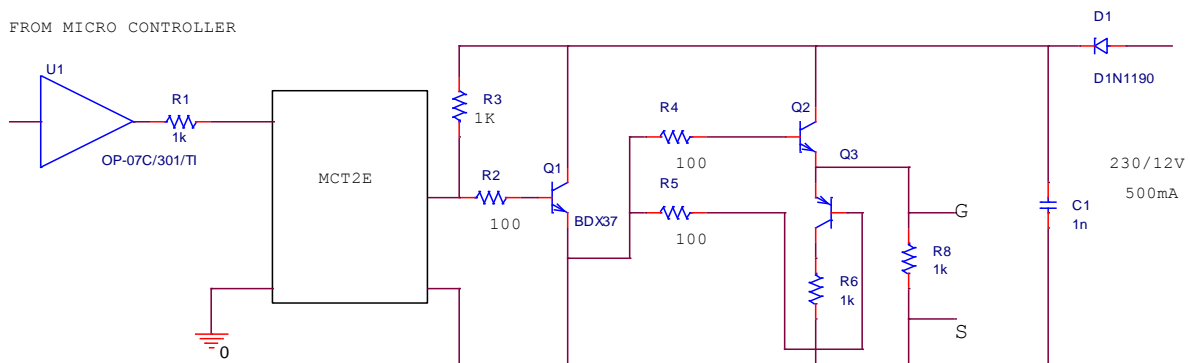


Fig.4 Driver circuit

1.9.1 Buffer Circuit

The buffer IC used here IC 4050 is used for pulse generation to generate triggering pulse. There are pull up resistors to provide a resistance in series with the microcontroller which acts as a current source here. This IC acts as an impedance improvement buffer IC. Voltage follower concept is used and the signal is getting inverted. Now it is given to the isolator.

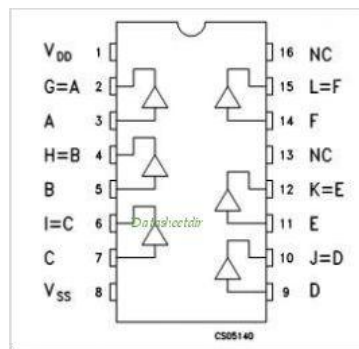


Fig.5 Pin out of buffer IC

Since the microcontroller is a sensitive device and MOSFET carries high current, in order to provide isolation between the two, isolation is being provided by the opt coupler required.

1.9.2 Optocoupler

In electronics, an opto-isolator (or optical isolator, optocoupler or photocoupler) is a device that uses a short optical transmission path to transfer a signal between elements of a circuit, typically a transmitter and a receiver, while keeping them electrically isolated — since the signal goes from an electrical signal to an optical signal back to an electrical signal, electrical contact along the path is broken.

A common implementation involves an LED and a light sensor, separated so that light may travel across a barrier but electrical current may not. When an electrical signal is applied to the input of the opto-isolator, its LED lights, its light sensor then activates, and a corresponding electrical signal is generated at the output. Unlike common implementation involves an LED and a light sensor, separated so that light may travel across a barrier but electrical current may not. When an electrical signal is applied to the input of the opto-isolator, its LED lights, its light sensor then activates, and a corresponding electrical signal is generated at the output. Unlike a transformer, the opto-isolator allows for DC coupling and generally provides significant protection from serious overvoltage conditions in one circuit affecting the other transformer, the opto-isolator allows for DC coupling and generally provides significant protection from serious overvoltage conditions in one circuit affecting the other.

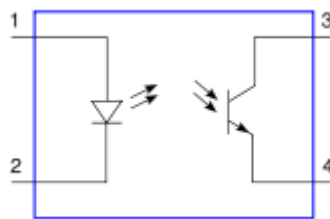


Fig.6 Opt coupler

With a photodiode as the detector, the output current is proportional to the amount of incident light supplied by the emitter. The diode can be used in a photovoltaic mode or a photoconductive mode.

Device rating:

OPTOCOUPLER MCT2E – 1 K, 100 Ω resistance

1.9.3 Phase shifting transistor

The function of this phase shifting transistor is to shift the output pulse of PIC microcontroller to exact 0 and 1 binary form.

This transistor removing over pulse voltage to suitable voltage pulse which is necessary for next operation.

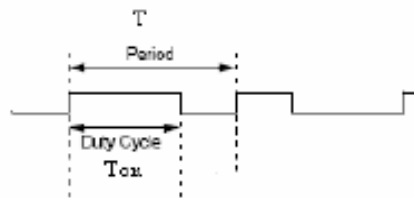
1.9.4 Darlington amplifier

In electronics, the Darlington transistor is a semiconductor device which combines two bipolar transistors. It is used for boosting the current gain, which is required for MOSFET.

A similar transistor configuration using two transistors of opposite type (NPN and PNP) is the Sziklai pair, sometimes called the "complementary Darlington". Finally the amplified signal is sent to the multilevel inverter and the output is obtained.

2. CONTROL TECHNIQUE

In this project we are using PWM control technique. This technique is used from PIC microcontroller. The PWM pulse is coming from PORT C of microcontroller. This PWM pulse is divided into various duty cycles, e.g., 25%, 50%.



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

$$V_{ave} = \frac{t_{on}}{T} \times V_{in}$$

3. BOOSTER CIRCUIT

The main function of a booster circuit is to boost the supply to the required demand of the motor.

The booster circuit is divided into various components. These are as follows:

- 1) AC Power supply
- 2) Transformer
- 3) Rectifier
- 4) Inductor
- 5) Switch (MOSFET)

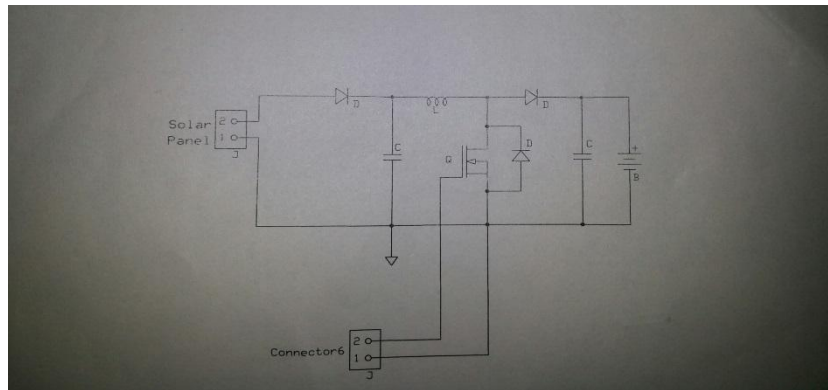


Fig.7 booster circuit

- 6) Diode
- 7) Capacitor

4. DC MOTOR

Direct current (DC) motors have variable characteristics and are used extensively in variable-speed drives. DC motor can provide a high starting torque and it is also possible to obtain speed control over wide range. Why do we need a speed motor controller? For example, if we have a DC motor in a robot, if we just apply a constant power to each motor on a robot, then the poor robot will never be able to maintain a steady speed. It will go slower over carpet, faster over smooth flooring, slower up hill, faster down hill, etc. So, it is important to make a controller to control the speed of DC motor in desired speed.

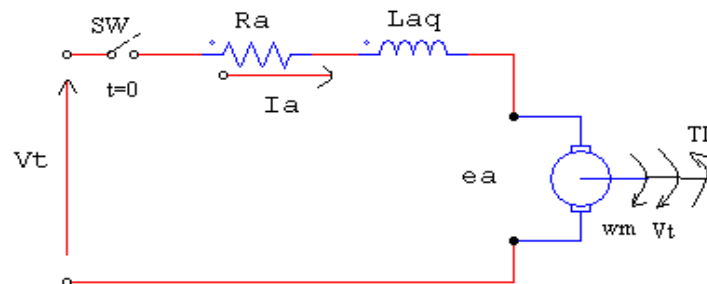


Fig.8 DC-Motor

DC motor plays a significant role in modern industrial. These are several types of applications where the load on the DC motor varies over a speed range. These applications may demand high-speed control accuracy and good dynamic responses.

5. HOW TO DOWNLOAD PROGRAM IN PIC MICROCONTROLLER USING MPLAB SOFTWARE

Procedure:

1. Open mplab software.
2. Select project and project wizard.
3. Choose pic16f68774 controller
4. Select complier-hitech
5. Give floder path and finish
6. Creat new source file.
7. In that space type code of project.
8. Save as extension .c
9. Source file right click and add file .c
10. Open and run (black icon)
11. Ensur that rs232 cable is coonect to dump kit.
12. Select programmer and RIC kit 2
13. Download the program in pic controller
14. after that kit is ready this massage will come.

6. RESULTS OF PROJECT

Microcontroller Pwm Pulse

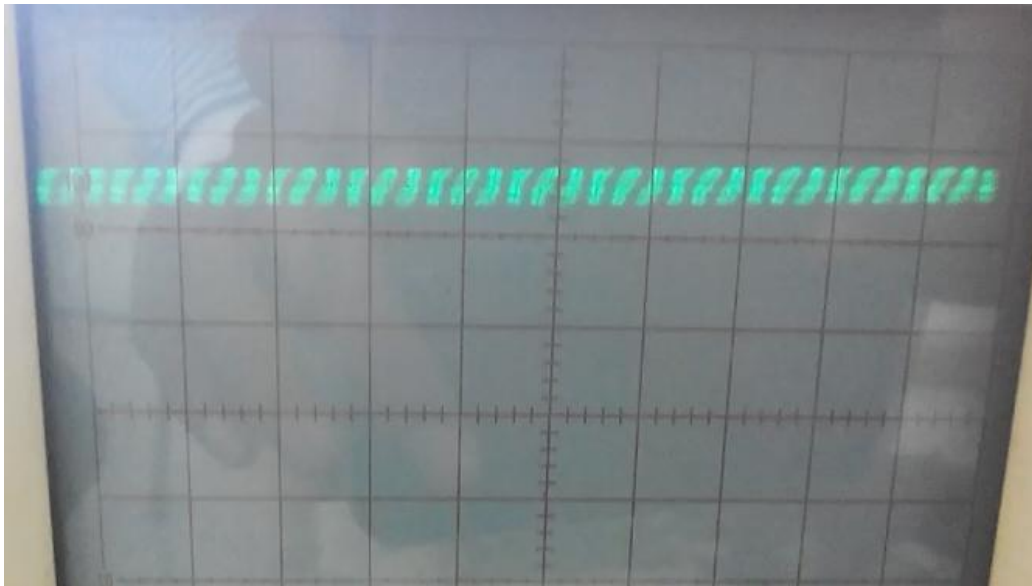


Fig.9 Output pulses of PIC16F877A through pwm for25 % Duty cycle.

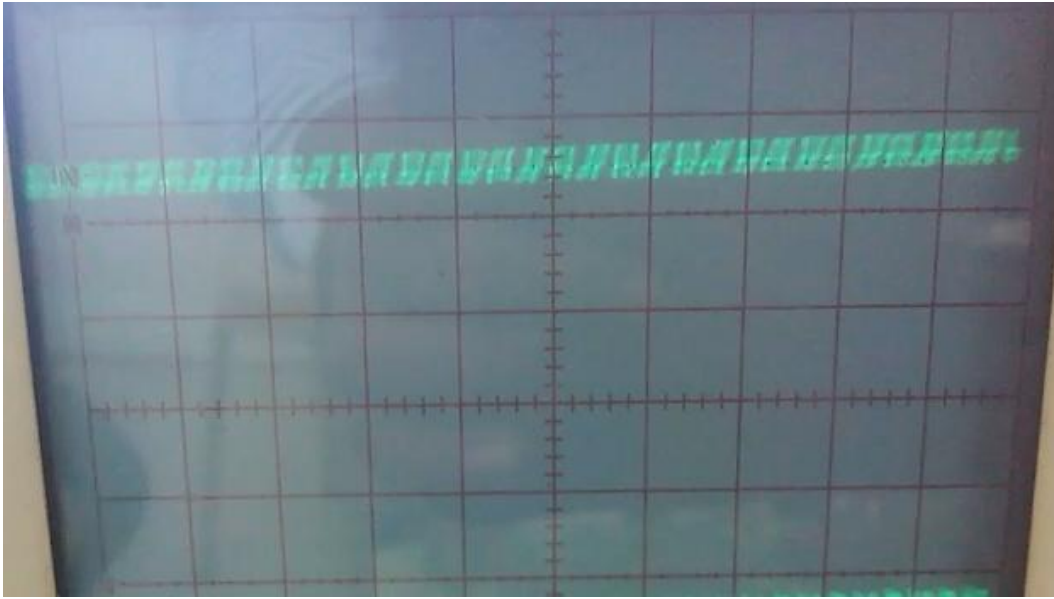


Fig.10 Output pulses of PIC16F877A through pwm for50 % Duty cycle.

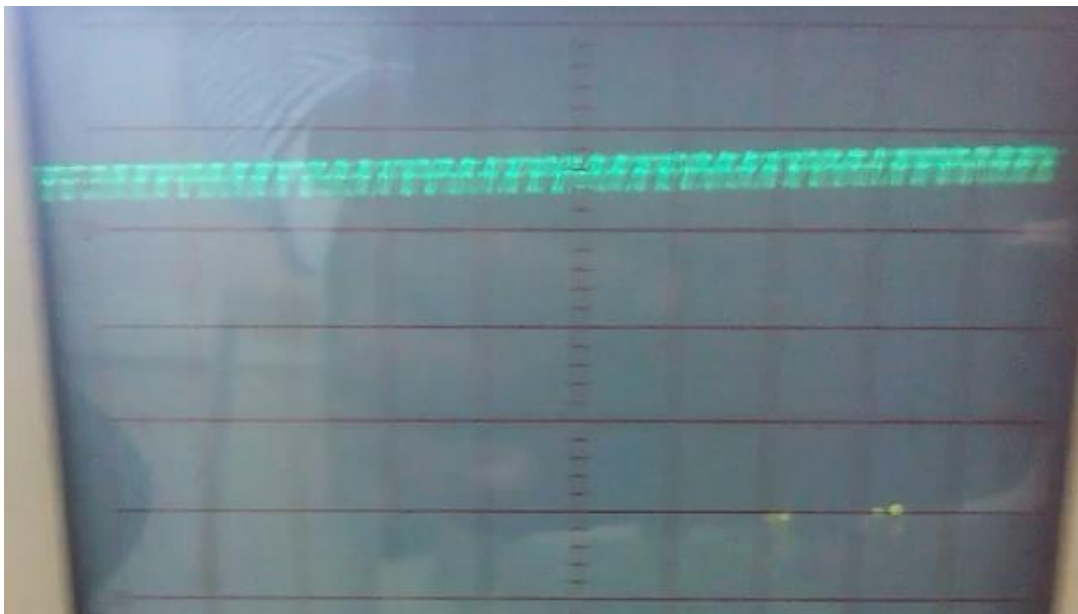


Fig.11 Output pulses of PIC16F877A through pwm for75 % Duty cycle.

7. OVERALL HARDWARE KIT OF PROJECT

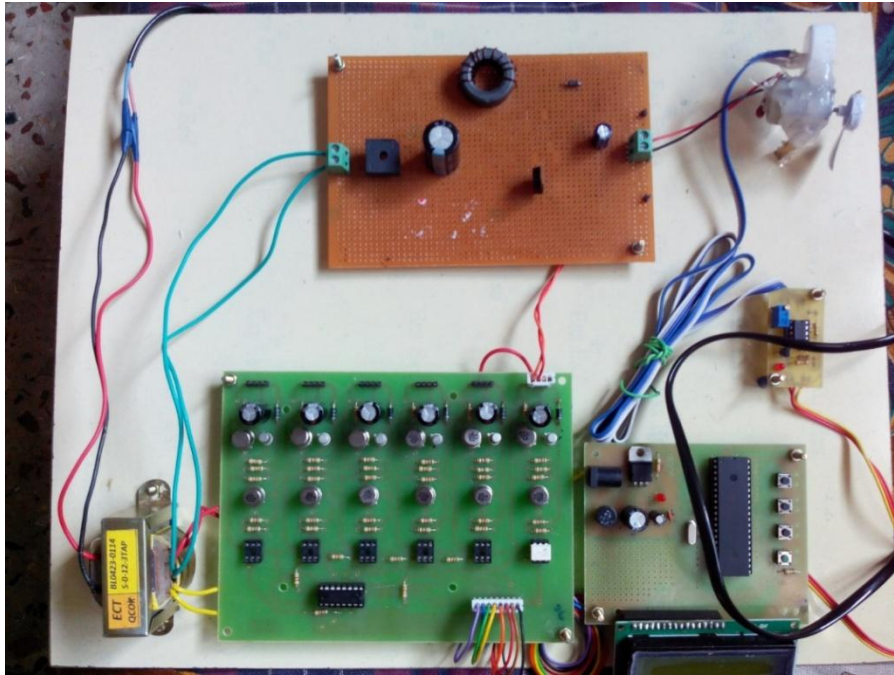


Fig.10 overall project diagram

8. CONCLUSION

Recent developments in science and technology provide a wide range scope of applications of high performance DC motor drives in area such as rolling mills, chemical process, electric trains, robotic manipulators and the home electric appliances require speed controllers to perform tasks. DC motors have speed control capabilities, which means that speed, torque and even direction of rotation can be changed at anytime to meet new condition.

The goal of this project is to design a DC motor speed control system by using microcontroller PIC16F877A. The controller will maintain the speed at desired speed when there is a variation of load. By varying the PWM signal from microcontroller to the motor driver, motor speed can be controlled back to desired value easily.

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