DUAL AXIS SOLAR TRACKERS

A Project submitted in partial fulfillment of the requirements for the Award of Degree of
Bachelor of Science in Electrical and Electronic Engineering

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October - 2018

APPROVAL

This project "**DUAL AXIS SOLAR TRACKERS**" Submitted by Esanur Rahman and Md. Rezaul Karim to the Department of Electrical and Electronics Engineering, Daffodil International University, has been accepted as satisfactory for the partial fulfillment of the requirements for the degree of B.Sc. in Electrical and Electronics Engineering and approved by its style and contents. The presentation has been held on.

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CERTIFICATION

The project and thesis entitled **"DUAL AXIS SOLAR TRACKERS"** submitted by Esanur Rahman, ID: 151-33-2572 and Md. Rezaul Karim, ID: 151-33-2573 has been accepted as satisfactory in partial fulfillment of the requirements for the degree of **Bachelor of Science in Electrical and Electronic Engineering** on October 2018.

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DEDICATED

To

our beloved parent……

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LIST OF ABBREVIATIONS

BJT	Bipolar junction transistor
LCD	Liquid crystal display
LED	Light emitting diode
B	Battery
IC	Integrated circuit
LED	Light emitting diode
MD	Material dispersion
LDR	Light dependent resistor
PV	Panel voltage

ACKNOWLEDGEMENT

First of all, we give thanks to Allah. Then we would like to take this opportunity to express our appreciation and gratitude to our project and thesis supervisor Professor Dr. M. Shamsul Alam Dean, Department of EEE for being dedicated in supporting, motivating and guiding us through this project. This project can’t be done without his useful advice and helps. Also thank you very much for giving us opportunity to choose this project. A part from that, we would like to thank our entire friends for sharing knowledge, information and helping us in making this project a success. Also, thanks for lending us some tools and equipment. To our beloved family, we want to give them our deepest love and gratitude for being very supportive and also for their inspiration and encouragement during our studies in this University.

ABSTRACT

Today’s solar energy is one of the most popular renewable energy.The fact is, generally the solar panel power system is stationary, means that the solar panel will not always grab to the direction of sun, this make the light intensity falling on the solar panel is not in maximum level so the solar panel will not always work in its maximum performance.This project demonstrates a novel method which will automatically track the sun’s position and accordingly change the direction of the solar panel to get the maximum output from the solar cell with the help with PIC16F72, sensor and servo motor. This method enables the solar panel work in maximum performance because of the light intensity falling on the panel will be in maximum intensity level in all long day. A solar tracker is designed and experimentally tested. The information and design detail are shown in this report.

CHAPTER 1
INTRODUCTION

1.1 Introduction

Though in this area electricity is one of the most important part of our life, approximately 1.6 billion people still living without electricity. It's only for the high cost of power grid building and maintains. This vast quantity of energy crisis can be meeting up by renewable energy across the In PV power systems maximum power point trackers (MPPTs) has an important role. It's minimizing also the arrow efficiency as well as its cost is lower than the other power system. Another problem is that the position of this point is not fixed but it moves according to the irradiance, the temperature and load. Because of the relatively expensive cost of this kind of energy we must extract the maximum of watts of solar panels.

1.2 Historical Background

1839 – The Photovoltaic Effect**:** Edmond Becquerel, in 1839, a voltage developed when the light fell upon the electrolyte. The basic principle of solar power had been uncovered.Professor, William Grylls Adams, and his studentThis method was only able to achieve 1% efficiency, making it impractical for general use.Einstein set out for the first time the relationship between light and electrons. Although controversial at the time, it was gradually accepted by the scientific community and led to his winning of the Nobel Prize in 1921.

1954 – A Major Breakthrough**:** Three researchers at Bell Labs — Daryl Chapin, Calvin Fuller, and Gerald Pearson — discover silicon solar cells.

1.2.1 Earlier Research

Early charge controllers were only able to reduce the amount of voltage from the PV panels if too high for the batteriesPeople those days could not use microcontroller for the management of the total system.This system was first commercially introduced in Australia. Stuart Watkinson and his friend Barry

James Aston was first founded “Australian Energy research Laboratories (AERL),” in September 1985.The US department of Energy’s solar Energy research center in Colorado along with Florida StateUniversity’s solar research center at Cape Canaveral was also involved in early trials of the product. [4-5]

1.2.2 Recent research

Although the newer charge controller provide improved system efficiencies relative to the older model, they too often suffer from several shortcoming.

Now-a-days all digital MPPT controllers are controlled microcontroller. They automatically adjust the output, move the panel for sunlight and also shut down for microseconds if necessary.

1.2.3 State of art technology

The batteries store the power and supply the power at night time for producing current. Depending on the nature of PV panel, sun of sunlight on the sun strikes the panel, higher temperature, lower voltage and increase amount of sunlight, increase the output current.

By using MPPT algorithm, it increases the efficiency of the PV panel and insures the maximum use of the power of sunlight. Sometimes there may be difference voltage and current between PV panel and the batteries, to maintain this mismatch, there use a microcontroller. A charge controller works as DC-DC convertor. [5-6]

1.3 Future Scope of this study

Use of solar photovoltaic has been growing at a phenomenal rate worldwide installed capacity has seen sustained growth averaging 43 percent per year since 2000. To evaluate the prospects for sustaining such growth.

1.3.1 Recommendation

The converter design could be done to optimize the components and in turn increasing the power efficiency.Finally a future work can also improve the developed software in order to efficiently use the capabilities The whole system into a single integrated.

1.4 Limitations of this study

- Computing with other analog system, it is costly.
- Programming of microcontroller is complex.
- It depends on temperature and radiation of sun.

1.6 Objective of this work

For this a digital based automatic sun tracking system is proposed. The solar panel tracks the sun from east to west automatically for maximum intensity of light. The Objectives are:

1.6.1 Primary objectives

As the cost of traditional current source is increasing day by day, people can take The total system can be used both commercially and household generation. So, people can cover the crisis of electric energy, by their own-self. The total system, ensure the maximum efficiency with a low cost comparing other sources and generation system.

1.6.2 Secondary objectives

To fabricate two servo motors control interference with proposed circuit and assembly to move the panel from east to west as well as the sun track maximum angle.

1.7 Introduction to the project

This is a Maximum Power Point tracking base solar charge controller which will controlled by microcontroller. Microcontroller wills co-ordinate the total system., we have focused how to increase the efficiency of a solar charge controller with a reduced cost the overall system.

CHAPTER 2
SOLAR SYSTEM

2.1 Introduction

Solar panel is made of tiny combination of solar cell and solar cell is the devices that are designed to convert light can be used to make solar cells. The main purpose of using solar panel is getting the maximum energy by converting light energy to electric energy. Using solar tracker is the best way for getting the maximum energy because it's also an effective solution for get energy with solar panel

2.2 Solar panel

Solar panel is mainly design as a panel which grab the sun rays and convert light energy into electricity.

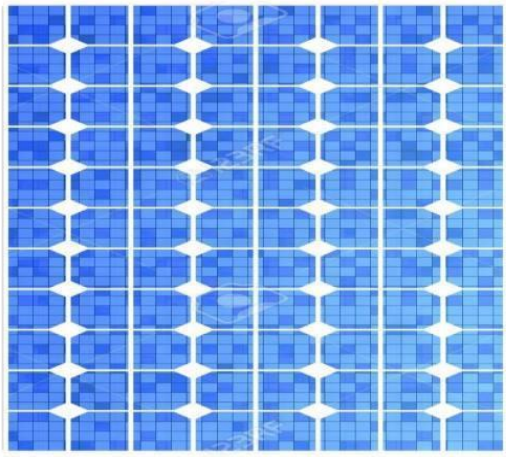

Fig 2.1:Module of solar panel

2.3 Photovoltaic Model

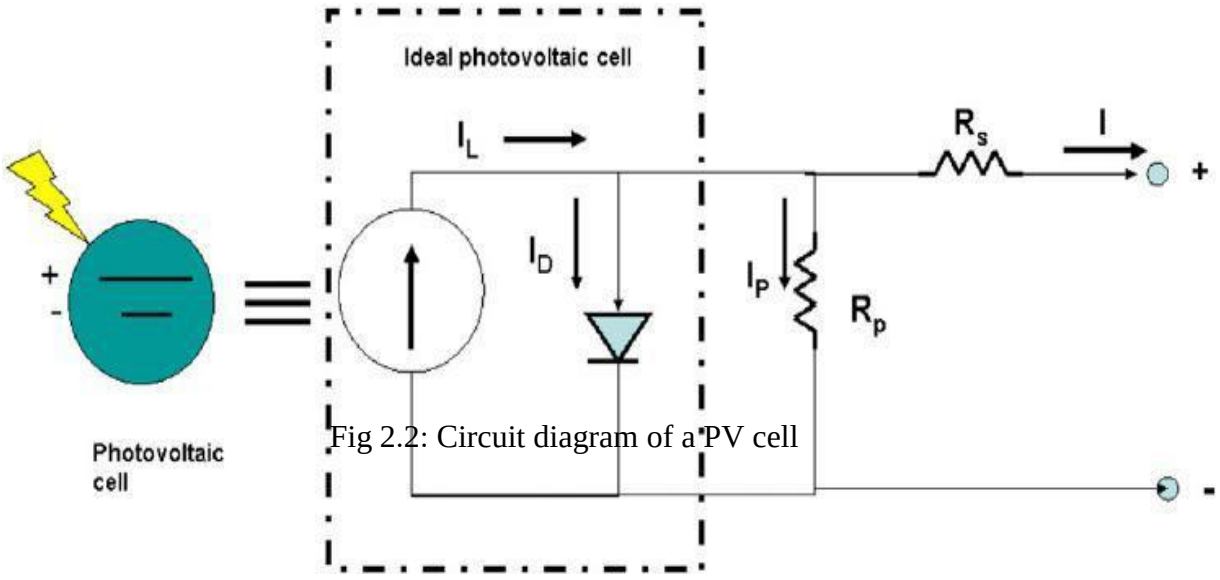

Fig 2.2: Circuit diagram of a PV cell

2.4 Maximum Power Point Tracking

a particular load resistanceIf the resistance is lower or higher than this value, the power drawn will be less than the maximum available, and thus the cell will not be used as efficiently as it could be. Maximum power point trackers utilize different types of control circuit or logic to search for this point and thus to allow the converter circuit to extract the maximum power available from a cell.

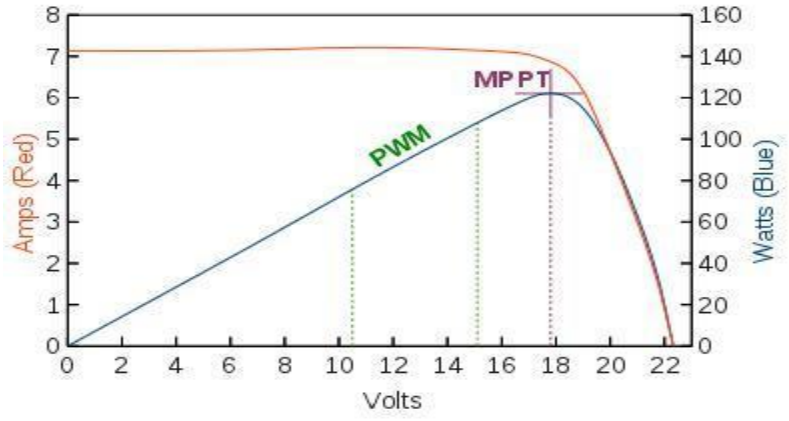

Fig 2.3: Maximum power tracking

2.5 Types of solar trackers & system

Solar Trackers are almost worldly used in case of Solar Thermal Technology because it generates high amounts of energy from sunlight .It's a way to install the PV panel that the sunlight reach them at perpendicularly or reduce the incidence angle as much as possible. Using tracker on solar panel makes this system smart and the tracker track the sun rays and it's rotate the panel according with rays.

2.5.1 Single axis solar tracker

Average output power of single axis solar tracker is 2.958 w. Average practical efficiency of solar panel for single axis is 6.55%. Average power gain of single axis solar tracker up to 18.32%.

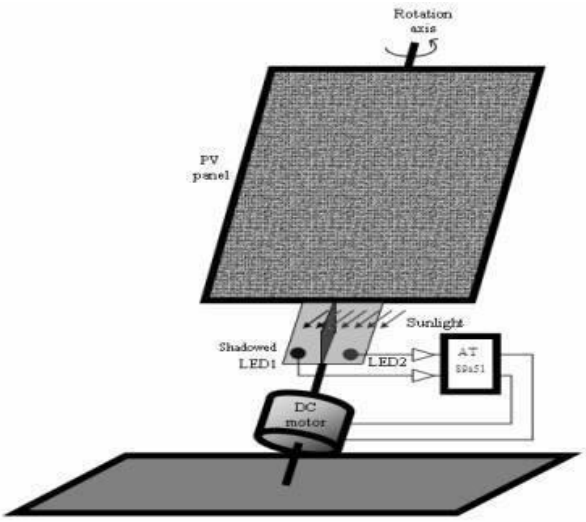

Fig 2.4: Single axis solar tracker

2.5.2 Dual Axis Solar Tracker

Fig 2.5: Dual axis solar tracker

2.6 Efficiency of solar panel

$$P_{max} = V_{OC} I_{SC} FF$$

$$\eta = \frac{V_{OC} I_{SC} FF}{P_{in}}$$

2.7 Advantages & disadvantages

There are several benefits that solar energy has and which make it favorable for many uses.

2.7.1 Advantages:

- Solar energy is a clean and renewable energy source.
- Solar cells are free of any noise. On the other hand, various machines used for pumping oil or for power generation are noisy.
- Solar energy can be used in very remote areas where extension of the electricity power grid is costly.

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2.7.2 Disadvantages

- Solar power stations do not match the power output of conventional power stations of similar size. Furthermore, they may be expensive to build.
- Generation of electricity from solar is dependent on the country's exposure to sunlight. This means some countries are slightly disadvantaged.

CHAPTER 3
COMPONENTS, DESIGN AND WORKING PRINCIPLE

3.1 LDR -Light dependent resistor

LDR can use for street lamp, This resistor's has different functions and resistance. Using LDR in a circuit or in a electronics project it is make circuit effective and the collection of LDR parts of the circuit are easily available and accuracy of this circuit is more than accuracy of other circuits. It is so much helpful for saving energy.

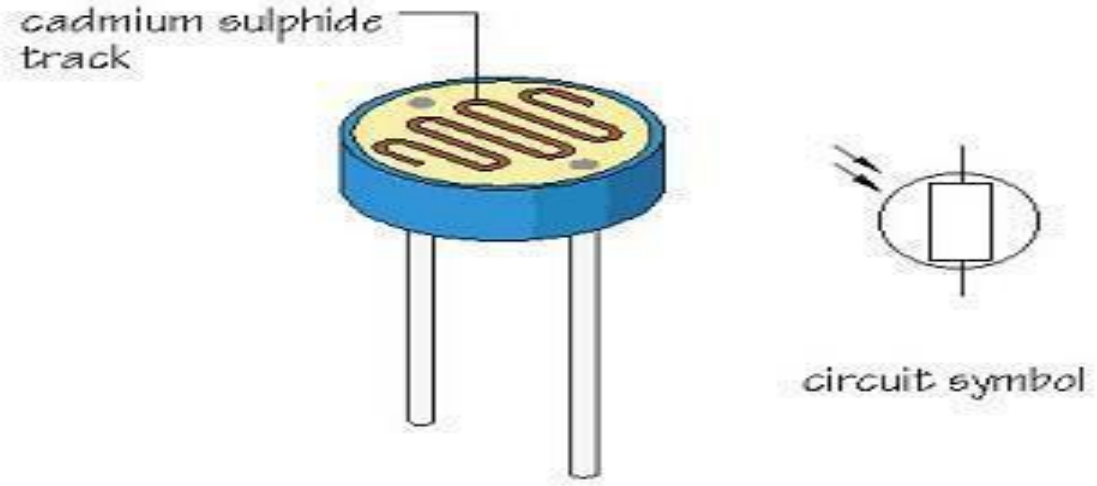


Fig 3.1: Light Dependent Resistor

3.1.1 Working Principle (LDR)

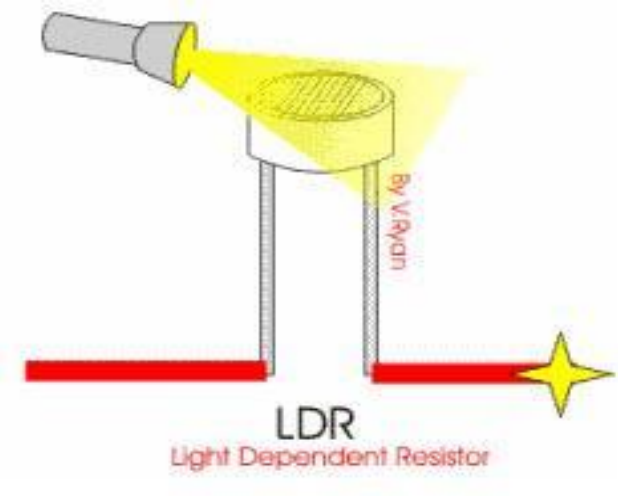


Fig 3.2: Working principle of LDR

3.1.2 The design and implementation of using three LDRs

We use here three LDRs. Each LDRs has two terminals. One of each are common and connect with +5V and other three of each terminal are connected with microcontroller through variable resistors.

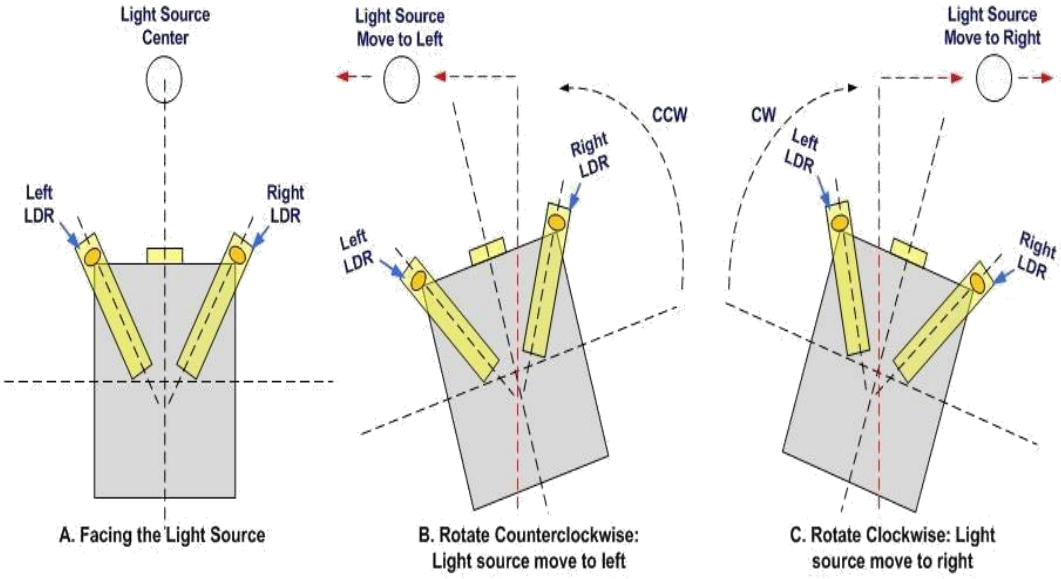


Fig 3.3: The sensing element and signal processing

The Sensing Element and Signal Processing There are several method was proposed and used to track the position of sun light. We used four LDRs to track our module properly.

3.2 LCD (2 Line 16 Carriers)

LCD (Liquid crystal display) is an electronic display which show the value of LDRs and battery voltage.

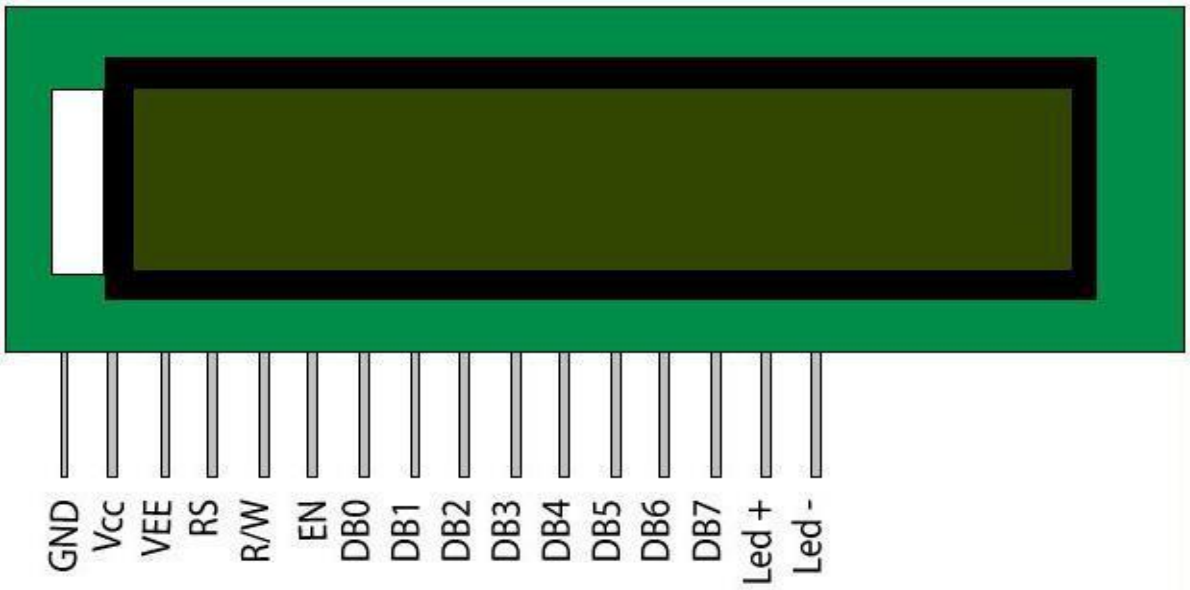


Fig 3.4: LCD (liquid crystal display)

This LCD contain 16 pin. Pin 1 and 2 used in VDD and GND and pin no 15 and 16 used in back light of the LED. And 8 pins are used for display the value of LDRs and other functions. Four pin is unused.

3.2.1 Pin description

The 16 pin of LCD description in given bellow:

Pin	Symbol	Description	
1	V_{SS}	Ground	0 V
2	V_{CC}	Main power supply	+5 V
3	V_{EE}	Power supply to control contrast	Contrast adjustment by providing a variable resistor through V_{CC}
4	RS	Register Select	RS=0 to select Command Register RS=1 to select Data Register
5	R/W	Read/write	R/W=0 to write to the register R/W=1 to read from the register
6	EN	Enable	A high to low pulse (minimum 450ns wide) is given when data is sent to data pins
7	DB0	To display letters or numbers, their ASCII codes are sent to data pins (with RS=1). Also instruction command codes are sent to these pins.	8-bit data pins
8	DB1		
9	DB2		
10	DB3		
11	DB4		
12	DB5		
13	DB6		
14	DB7		
15	Led+	Backlight V_{CC}	+5 V
16	Led-	Backlight Ground	0 V

Table 3.1: Pin description of LCD

3.3 Servo Motor

Servo motor is a self-contained electronic device and simple electrical motor and which is controlled by the help of servomechanism. The cost of this motor also less than others motors and also simple to used

Fig 3.5: Standard Servo Motor SG-90

In a market there are found two types of servo motor, one are made up of metal gear and another are made up of plastic gear. The metallic one is much heavier than other gear one. The size of metallic gear servo motor is also bigger than plastic gear servo motor.

3.3.1 Component of servo motor SG-90

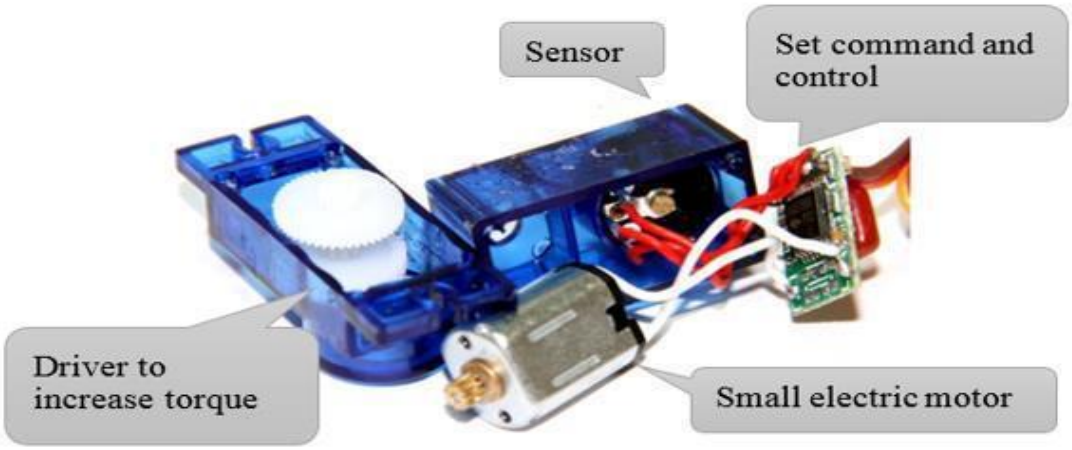


Fig 3.6: Physical Construction of Servo SG-90

In our work we used servo motor SG90 and it's easy to use because it is small in size which makes our work comfortable. In briefly below we discussed on SG90.

3.3.2 Servo Motor Control

There are three terminal of a servo motor. Tow of this used in VCC and GND and another one is use in PWM. Pulse width modulation is controlled the servo motor. Microcontroller gives the PWM to the servo motor.

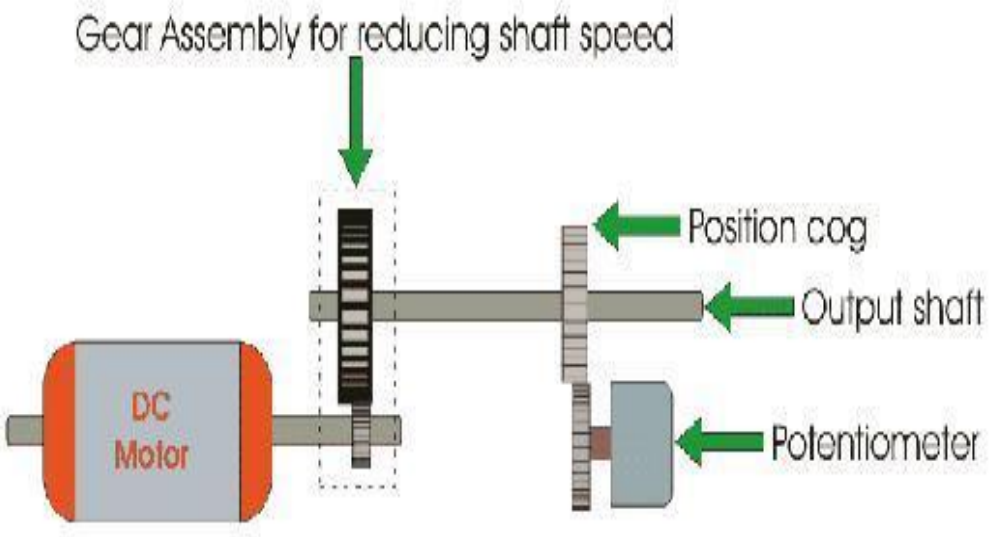


Fig 3.7: Servo gear assembly

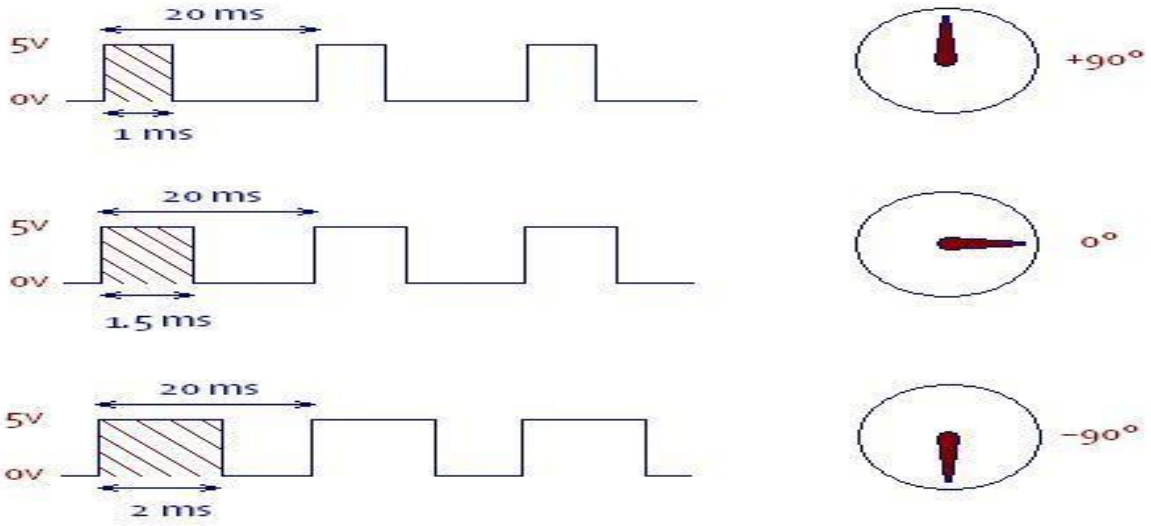


Fig 3.8: Variable pulse width control servo position

3.3.3 Advantage and disadvantage of using servo motor

There are some advantages and disadvantages of using servo motor. In below we discussed about advantages and disadvantages of servo motor.

Advantages:

- Servo motors are the better option for high speed and high torque.
- Servo motors are available at much faster speed.
- Servo motors are accurate positioning.
- Servo has efficiency of about 80-90%.
- Servo motors are small is size.
- Servo motor has a resonance and vibration free operation.

Disadvantages:

- Servo motors are expensive to buy.
- Servo motors have required setup to stabilize feedback loop. Servo motor can be damaged for overloading.

3.4 Microcontroller:

Fig 3.9: PIC16F72 Microcontroller

- Central processing unit (CPU)
- Random Access Memory (RAM)
- Read Only Memory (ROM)
- Input/output ports
- Timers and Counters
- Interrupt controls
- Analog to digital converter
- Digital to analog converters
- Serial interfacing ports

3.4.1 PIC16F72 pin diagram

The 16F72 is one of the most popular and advanced microcontrollers from microchip and it are easy to implement in a circuit. This controller is widely used for experimental cause its application range is wide, high quality, ease of availability and low cost.

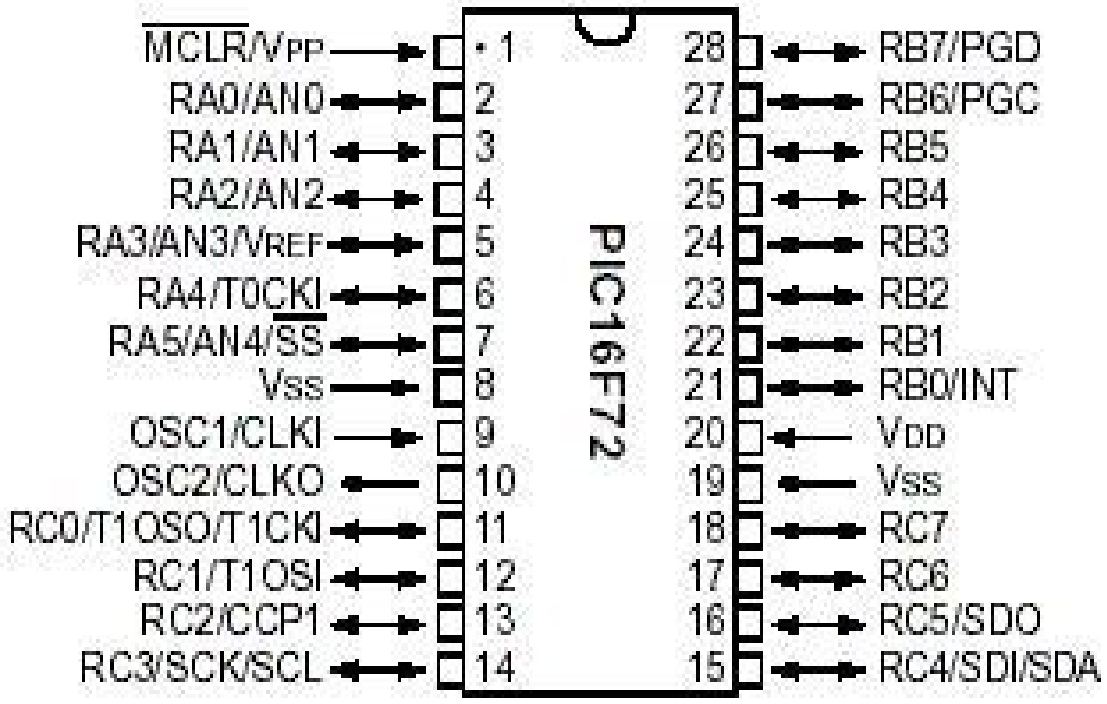


Fig 3.10: PIC16F72 Microcontrollers pin diagram

3.4.2 Block Diagram

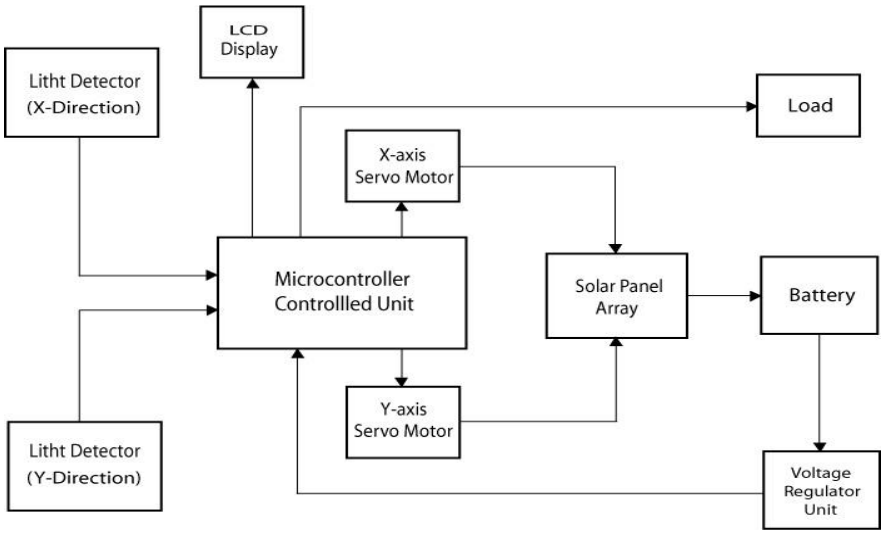


Fig 3.11: Block Diagram

3.4.2 Circuit Diagram

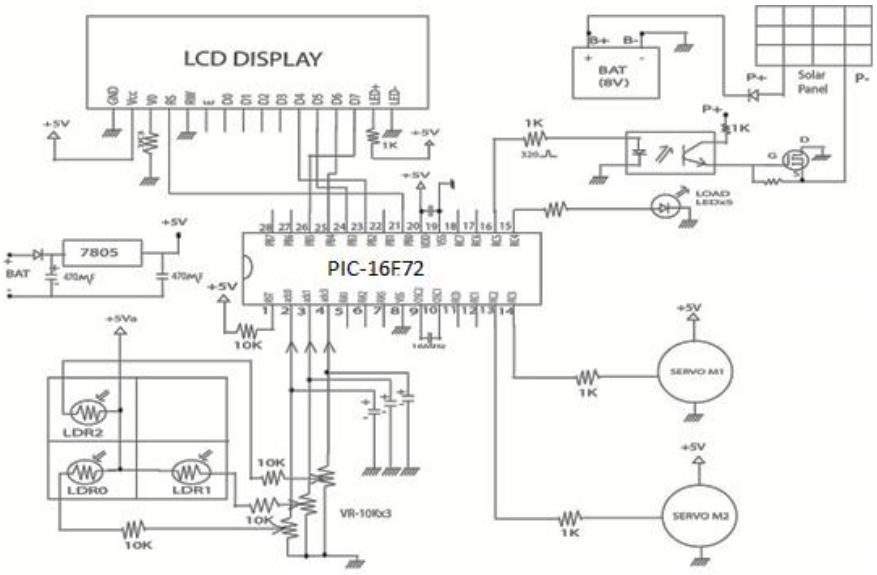


Fig 3.11: Circuit Diagram

3.4.3 The feature of PIC16F72

- 1,000 erase/write cycle FLASH program memory typical
- Processor read access to program memory

3.5 Capacitor

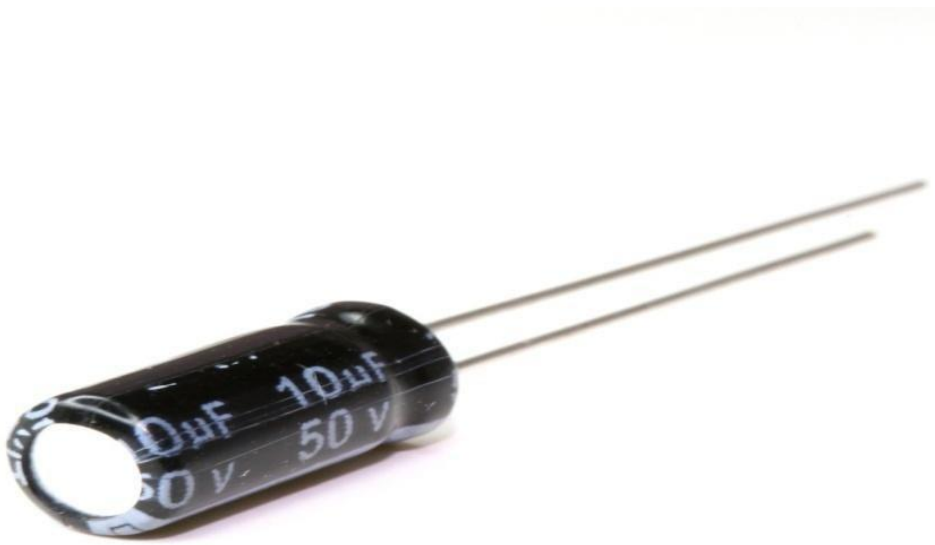


Fig 3.12: Capacitor.

3.6 Resistance

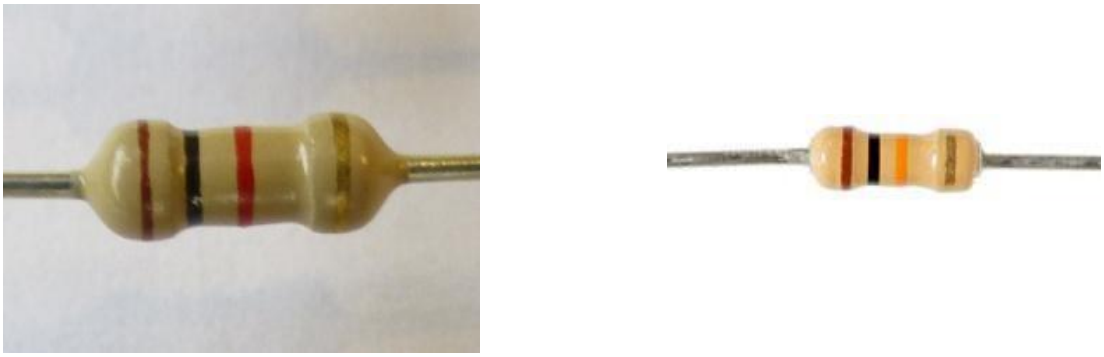
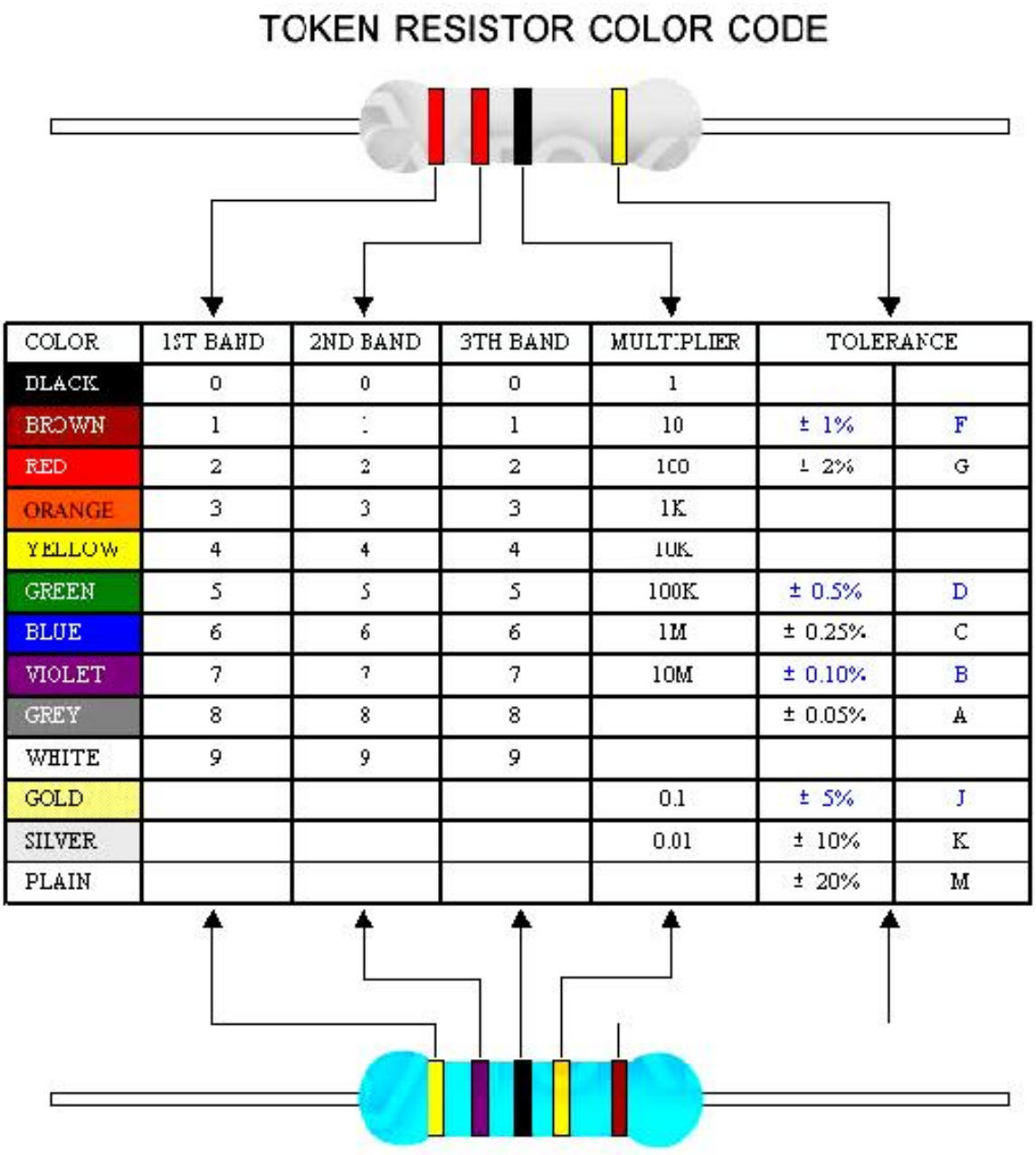


Fig 3.13: 100k &10k Resistance.

In general, when the applied voltage is held constant, the current in a direct-current (DC) electrical circuit is inversely proportional to the resistance. If the resistance is doubled, the current is cut in half; if the resistance is halved, the current is doubled. This rule also holds true for most low-frequency alternating-current (AC) systems, such as household utility circuits.The electrical resistance per unit length.

3.6.1 Resistor Color Code



COLOR	1ST BAND	2ND BAND	3TH BAND	MULTIPLIER	TOLERANCE	
BLACK	0	0	0	1		
BROWN	1	1	1	10	± 1%	F
RED	2	2	2	100	± 2%	G
ORANGE	3	3	3	1K		
YELLOW	4	4	4	10K		
GREEN	5	5	5	100K	± 0.5%	D
BLUE	6	6	6	1M	± 0.25%	C
VIOLET	7	7	7	10M	± 0.10%	B
GREY	8	8	8		± 0.05%	A
WHITE	9	9	9			
GOLD				0.1	± 5%	J
SILVER				0.01	± 10%	K
PLAIN					± 20%	M

Fig 3.14: Resistor color code.

3.7 Voltage regulator

The voltage regulator must be stable with its condition.

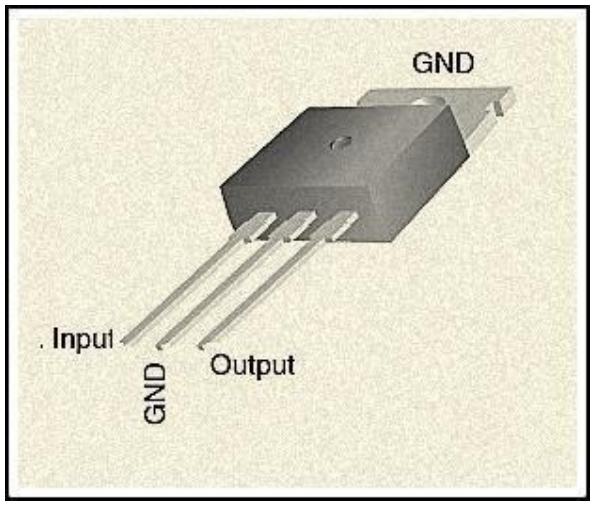


Fig 3.15: Pin Diagram of Ic 7805

3.8 Crystal

The internal oscillator of the microcontrollers are RC oscillators.

Fig 3.16: 16MHz crystal oscillator

3.9 The designing tools

We use CCS C as Microcontroller programing compiler and proteus design suite as a powerful electronic design application. A Short description given bellow:

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3.9.1 CCS C Compiler

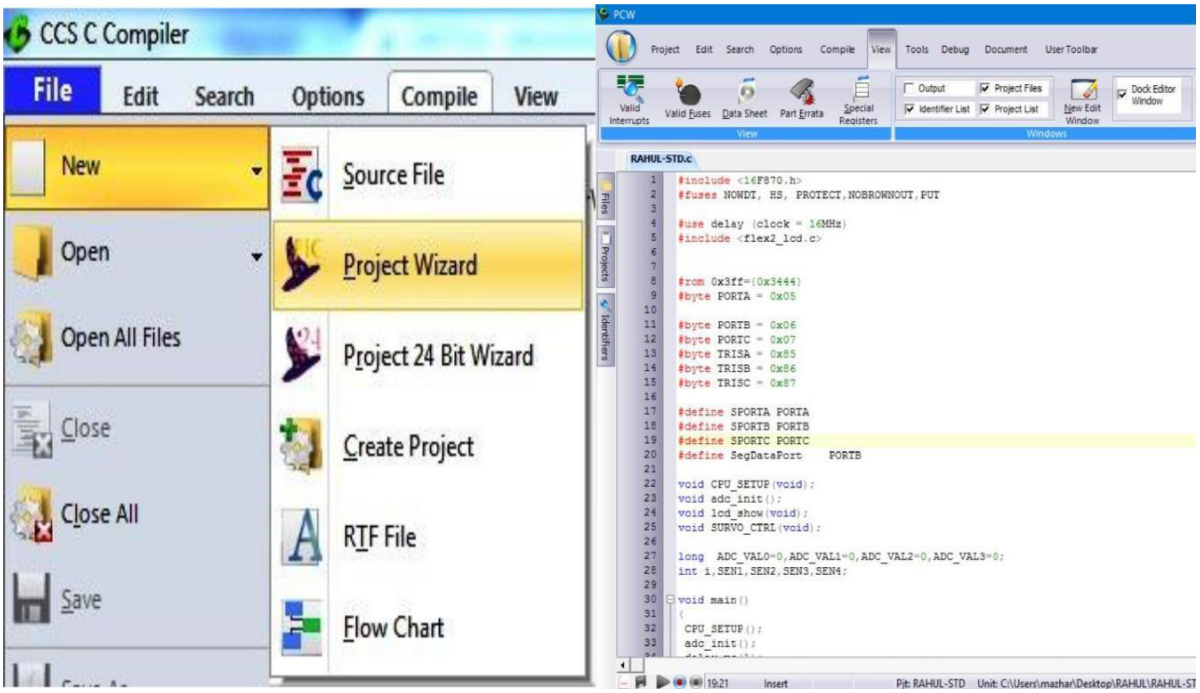

Fig 3.17: CCS C Compiler

3.9.2 Proteus design suite

- Schematic capture
- Mixed-mode (analogue and digital circuit) electronic circuit simulation
- Microprocessor / microcontroller simulation
- PCB design with manual and AutoRoute options Graph-based simulation

3.10 Soldering Wire

When the soldering wire cooled off an electrical connection will conduct. This is getting a good mechanical connection or joint between the wires. The filaments of each wire should be twisted together, behave more like a single entity. First step is to prepare the wires then tinning the wears, next to join the wires and solder splice together.

Fig 3.18: Soldering two wires

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3.11.1 PIC16F72 Development Board

The immensely popular PIC16F72 development board for the PIC16F72 is already included .

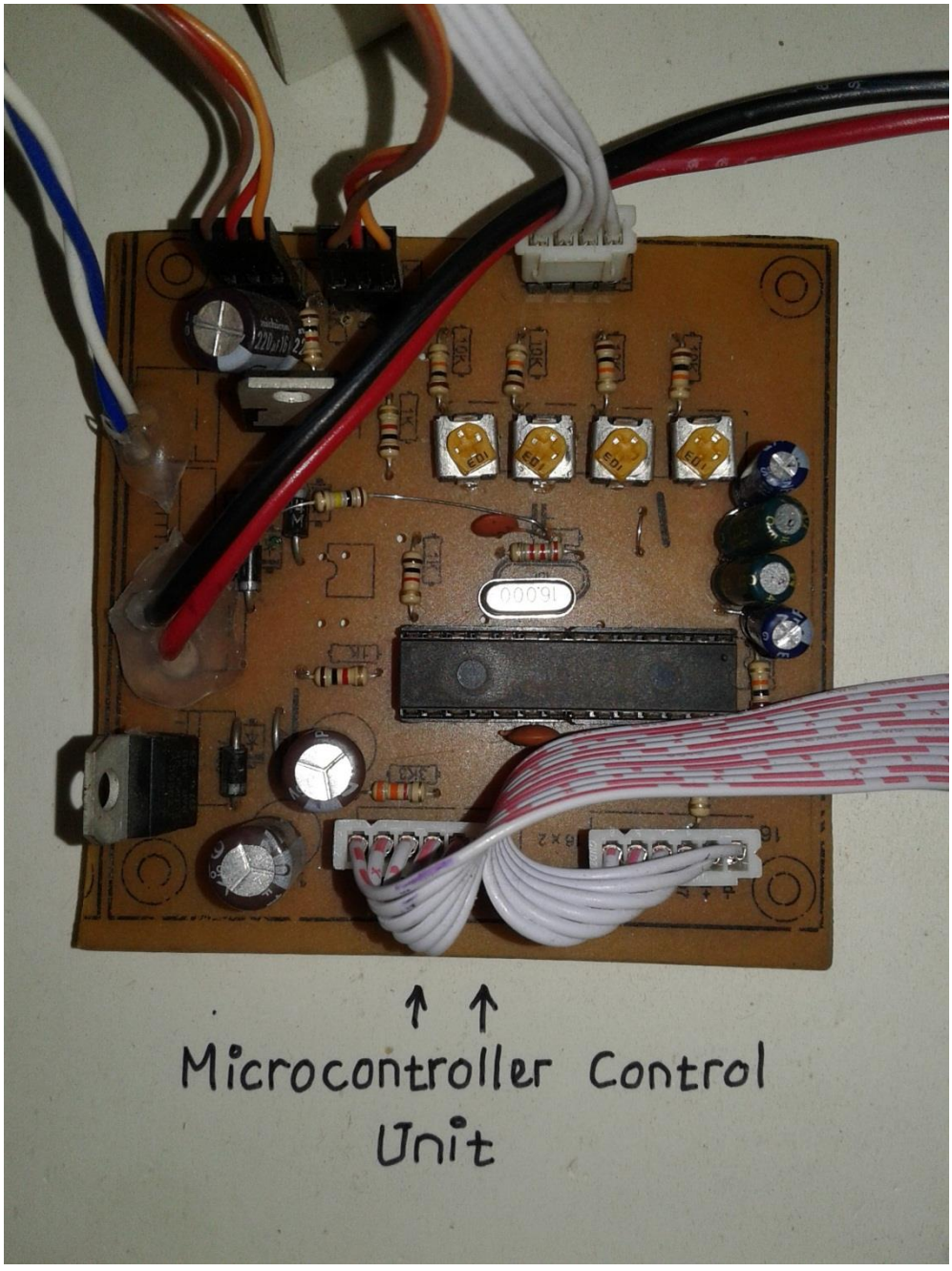

Fig 3.19: PIC16F72 development board

3.11. 2 Block Diagram

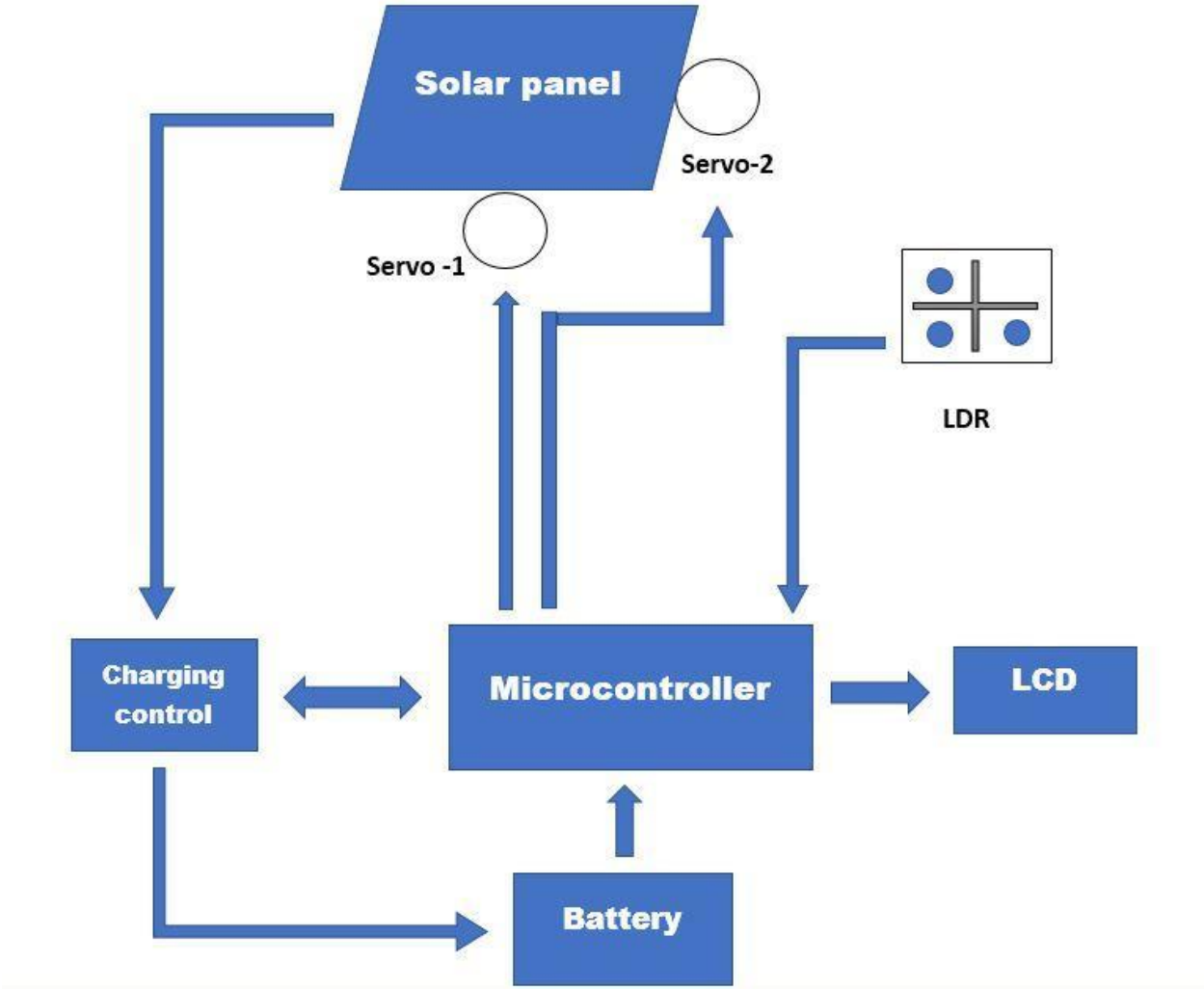

Fig 3.20: Block diagram of dual axis solar panel trackers

3.11.3. Proposed assembly for the automatic solar tracking trackers

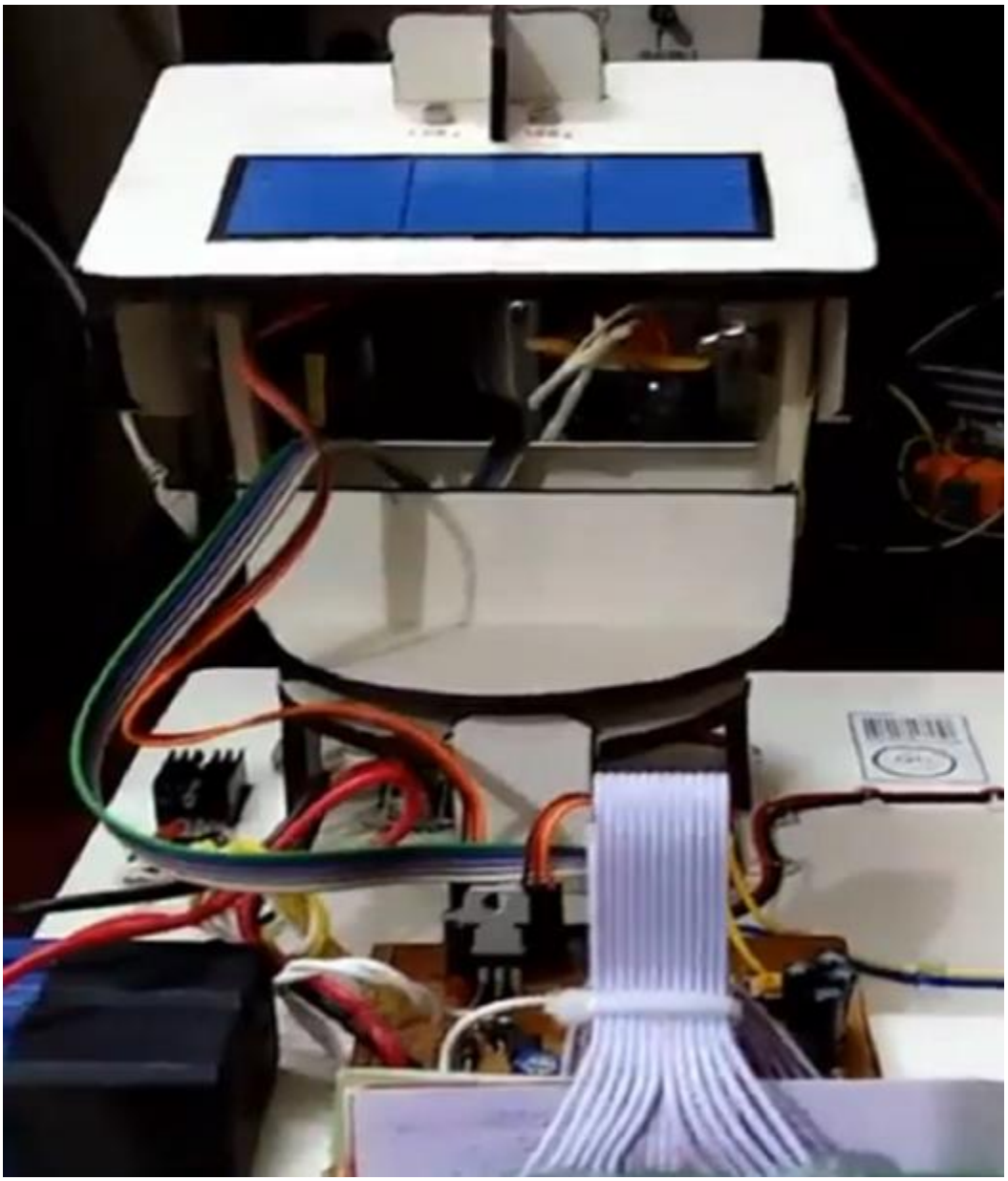

Fig 3.21: Dual axis solar panel trackers

3.11.4. Operating Principle

The positive terminal of the solar panel connected through a diode to the battery positive terminal. Diode is used because the battery voltage does no passed the panel. The negative terminal of the solar panel connect to the battery negative terminal by a n-channel MOSFET. This FET is used a switch and its gate voltage is comes from a optocoupler. When the gate voltage of the FET is high the switch is on and start charging. When charge is full gate voltage remain low and switch is remain closed. The positive terminal of the battery is connected a voltage regulator and its output is given pure 5V. This voltage is purify by a capacitor and pass this on the microcontroller. And another positive supply is given to the servo motor power supply as the same process. There are three LDRs use this system. LDRs gives analog output to the microcontroller and adc makes it digital and this values of the LDRs shown LED. Servo motor used as the vertical and horizontal movement of the solar panel. When LDR0 is gather then LDR1 servo motor duty cycle is ++ and when LDR0 is less than LDR1 servo motor duty cycle is --. Here LDR0 is used for X axis and LDR2 is used for Y axis and LDR1 is common. LDRs output is passed through a variable resistor to the microcontroller.

CHAPTER 4
RESULT AND DISCUSSION

4.1 Results

Thus we have tried to make an automated solar tracking system which will increase the efficiency of the solar panel system available. Although there is higher initial cost involved we have tried to make the system cost effective .This is just the beginning, we can add different enhancements to make the system more efficient so that it will work round the year.

4.2 Project Cost

Name	Model / Value	Quantity	Cost
Microcontroller (IC)	PIC16F72	1	190/=
Servo Motor	SG-90	2	250 /=
7805 Regulator IC	PNP	1	15/=
Light Dependent		4	120=
IC Base	28pin	1	10/=
Capacitor	10Uf	6	60/=
Capacitor	100Uf	1	15/=
Crystal	16MHz	1	30/=
LCD Display	(2x16)	1	160/=
Solar Panel	5watt(0v-18v)	1	550/=
Resistor	100E, 1k, 2.2k, 10k, 33k, 100k	12	20/=
Battery	+ 8V	2	100/=
Switch		1	10/=
Printed Circuit Board		1	50/=
Diode	1N4007	3	12/=
Others			230/=
Total cost	-	-	1592/=

Table 4.1: Project cost

4.3 Discussions

A microcontroller is use to controlled. An optimized and effective technique that has been proposed considering the discussed drawbacks. efficiency of the PV systems and reduces low power loss and system cost. This method protects the MPPT effects from environmental variations and leads us to proper direction to the tracker which makes it independent of environmental changes (particularly irradiation and temperature).

The method has been modified based on the incremental conductance and the simulated result offers high efficiency during stable conditions as well as fast changing conditions and hence it maintains the advantage of the existing methods. was to investigate and verify the transformer less so that it can comply with the standard requirements, safety of human interaction and mitigation of unwanted losses. [13-14

CHAPTER 5
CONCLUSIONS

5.1 Conclusions

The rapid increase in energy demand cannot be resolved easily until there is an alternative way to meet the demand.The micro grid can undertake to solve this sort of situation in future. Solar, wind and biomassenergy is the main source of energy used for optimizing the overall systems and hence to make it efficient. So the user will become less compulsive on the convenient fossil fuel energy.The stored energy also play a significant role to avoid the imbalance of the power system.

5.2 Suggestion of future work

The main destination of this project is to achieve the highest performance a solar panel charge controller using MPPT system.

5.2.2 Development of MPPT system & PV panels

The PV panel that are being used for tests of the diagnostic methods in this project. New kind of topologies or control strategies can be introduced which can handle the elimination or minimization of the dc part in the injected ac current. Besides this only real power output for AC is analyzed here. Development of a high power output MPPT system. [15]

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APPENDIX

Programming Code for Whole System:

```
#include <16F72.h>
#use delay (clock = 16000000)
#include <flex2_lcd.c>
////////////////////////////////////////////////////////////////////////////////
void main()
{ lcd_gotoxy(1,1
);
printf(lcd_putc, " WELCOME TO     ");
lcd_gotoxy(1,2);
printf(lcd_putc, "        DIU     ");
delay_ms(3000);

lcd_gotoxy(1,1);
printf(lcd_putc, " SUBMITTED TO: ");
lcd_gotoxy(1,2);
printf(lcd_putc, " Dr. M. SHAMSUL
ALAM");
delay_ms(3000);

lcd_gotoxy(1,1);
printf(lcd_putc, " SUBMITTED BY: ");
lcd_gotoxy(1,2);
printf(lcd_putc, "        ");
delay_ms(1000);

lcd_gotoxy(1,1);
printf(lcd_putc, " ESANUR RAHMAN ");
lcd_gotoxy(1,2);
printf(lcd_putc, "MD.REZAUL KARIM");
delay_ms(3000)
```

```
while(1)
{
lcd_gotoxy(1,1);
printf(lcd_putc, " LDR0, LDR1, LDR2, B:,BV V");
lcd_gotoxy(1,2);
printf(lcd_putc, "PLEASE WAIT...");

SURVO_CTRL();
set_adc_channel( 0 );
delay_ms(1);
LDR0 = read_adc();

set_adc_channel( 1 );
delay_ms(1);
LDR1 = read_adc();

set_adc_channel( 2 );
delay_ms(1);
LDR2 = read_adc();

set_adc_channel( 3 );
delay_ms(1);
BV = read_adc();

} // end main()
```

```
void SURVO_CTRL(void)
{
//////////////////////  SURVO-1 CONTROL   //////////////////////

if( LDR0 > LDR1 )
s1ds++;
if( LDR0 < LDR1 )
s1ds--;
//////////////////////   SURVO-2 CONTROL   //////////////////////

if( LDR0 > LDR2 )
s2ds++;
if( LDR0 < LDR2 )
s2ds--;
}

}
```