DUAL AXIS SOLAR TRACKING SYSTEM

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Declaration

It is declared hereby that this thesis paper or any part of it has not been submitted to anywhere else for the award of any degree.

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Certification

This is to certify that this project entitled "DUAL AXIS SOLAR TRACKING SYSTEM" is done by the following students under my direct supervision. This project work has been carried out by them in the laboratories of the Department of Mechanical Engineering under the Faculty of Engineering, Sonargaon University (SU) in partial fulfillment of the requirements for the degree of Bachelor of Science in Mechanical Engineering.

Supervisor

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Acknowledgement

The report titled as on “DUAL AXIS SOLAR TRACKING SYSTEM” has been prepared to fulfil the requirement of our practicum program. In the process of doing and preparing our practicum report, we would like to pay our gratitude to some persons for their enormous help and vast co-operation.

At first, we would like to show our gratitude to the University authority to permit us to do our practicum. Specially, we would like to thank to our honorable teacher **Nuruzzaman Rakib** Lecturer, Department of Mechanical Engineering, Sonargaon University (SU), Dhaka, for his valuable and patient advice, sympathetic assistance, co-operation, contribution of new idea. Deep theoretical and hardware knowledge & keen interest of our supervisor in this field influenced us to carry out this project. His endless patience, scholarly guidance, continual encouragement, constant and energetic supervision, constructive criticism, valuable advice, reading many inferior drafts and correcting them at all stage have made it possible to complete this project.

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Dedicated to

Our Parents

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List of Abbreviations

1	**LDR**	Light Dependent Resistor
2	**LCD**	Liquid Crystal Display
3	**DC**	Direct Current
4	**TXD**	Data Transfer
5	**RXD**	Data Receiver
6	**AC**	Alternating Current
7	**ADC**	Analog to Digital
8	**IC**	Integrated Circuit

ABSTRACT

This is a project of **DUAL AXIS SOLAR TRACKING SYSTEM**. The project is about making two axis solar panel tracker that can be working robotic system. The Solar Tracker is a device which follows the movement of the sun. we used four LDR (Light Dependent Resistor). They are light sensitive devices**.** They are also called as photo conductors. The working principle of an LDR is photo conductivity, that is nothing but an optical phenomenon. When the light is absorbed by the material then the conductivity of the material reduces. We use two servo motor. Servos are controlled by sending an electrical pulse of variable width. A servo motor can usually only turn 90° in either direction for a total of 180° movement. we use to PIC16F877 microcontroller. The microcontroller is there for controlling automatically. We use 7805 regulator IC, 10uF capacitor (6pcs), 100uF capacitor 1pcs. We use LCD (Liquid Crystal Display) display. The layers are made of liquid crystals which have the ability to change the direction of their polarization when a voltage is applied to them. This creates an area which looks dark. Different areas are controlled by voltages from whatever circuitry controls the device. We used solar panel, 1N4007 diode, 1N4007 diode. The microcontroller is there for programming language C++. The main objectives of this project are to investigate a newly

Chapter 1

Introduction

1. 1. Introduction:

Though in this era electricity is one of the most important parts 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 developing world. As people are much concerned with the fossil fuel exhaustion and the environmental problems caused by the conventional power generation, renewable energy sources and among them photovoltaic panels and wind-generators are now widely used. So Solar Energy is a good choice for electric power generation. The solar energy is directly converted into electrical energy by solar photovoltaic module. Photovoltaic sources are used today in many applications such as battery charging, water pumping, home power supply, satellite power systems etc. They have the advantage of being maintenance and pollution-free but their installation cost is high and in most applications; they require a power conditioner (dc/dc or dc/ac converter) for load interface. Since PV modules still have relatively low conversion efficiency, the overall system cost can be reduced using high efficiency power conditioners which, in addition, are designed to extract the maximum possible power from the PV module. In PV power systems maximum power point trackers (MPPTs) has an important role. It's minimizing the output power of a PV system and also the arrow efficiency as well as its cost is lower than the other power system. An important characteristic of solar panels is that the available maximum power is provided only in a single operating point given by a localized voltage and current known, called Maximum Power Point (MPP). 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. In this project we develop a Microcontroller based dedicated MPPT controller for solar PV module based on the incremental conductance method. [1-3]

1.2. Historical Background:

1839 – The Photovoltaic Effect**:** Edmond Becquerel, in 1839, discovered that when two electrodes were placed in an electrolyte (electricity-conducting solution), a voltage developed when light fell upon the electrolyte. The basic principles of solar power had been uncovered.

1876 – Electricity from Light**:** A King's College Professor, William Grylls Adams, and his student, Richard Evans Day, found in 1876 that selenium produced electricity when exposed to light. They attached platinum electrodes to selenium and observed a current in the electrodes when the selenium was exposed to light.

1883 – The First Working Solar Cell**:** American inventor Charles Fritts developed the first solar cell, applying selenium to a thin layer of gold. This method was only able to achieve 1% efficiency, making it impractical for general use.

1904 – Einstein's Paper on Light & Electrons**:** In the snappily titled "On a Heuristic Viewpoint Concerning the Production and Transformation of Light," 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.

Later in 1916, Robert Millikan would experimentally prove Einstein's theory of the photoelectric effect.

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

Late 1950s – Increasing Efficiency: Throughout the late 50s, Hoffman electronics developed increasingly efficient solar cells. It started out initially at an 8% efficient cell in 1957, before eventually increasing to a 14%-efficient, commercially available cell in 1960.

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 batteries. Since the voltage from the PV panels would be lower at high temperatures, the PV panels had to be over sized to ensure that the minimum voltage at high temperatures would be at least as high as the battery to be charged plus voltage headroom enough to force current into the battery. At any temperature lower than the maximum, the excess voltage from the PV panels would have to be discarded by the charge controllers. Because PV panels are the most expensive component of the system, the need for extra (or larger) PV panels negatively impacted the cost-effectiveness of such PV power systems. People 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 were 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 State University’s solar research center at Cape Canaveral was also involved in early trials of the product. [4-5]

1.2.2. Resent research:

Newer and more efficient charger controllers have emerged that provide a better match between the PV panels and their load. Their goal is to use all the power from the PV panel(s) regardless of the voltage and current at any amount of insolation or at any temperature. The newer charge controllers employ a DC-to-DC converter section that is adapted to dynamically charge the battery (or to directly power a load) at the exact voltage and current that is most appropriate for that battery (or load). Although the newer charge controllers provide improved system efficiencies relative to the older models, they too often suffer from several shortcomings. More particularly, the charge controllers are slow to adapt to changing conditions of the PV panel(s) over the course of any given day, including low light conditions in the morning, evening and during cloud cover and also temperature changes sometimes associated with the changes in insolation.

The edges of clouds create particularly issues because they cause a rapid change in lighting which may be followed by a relatively rapid change in temperature. Because they do not quickly adapt to changing conditions, the charge controllers have limited efficiency, which results in the need for extra (or larger) PV panels to be used for a given power output and high costs. 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.

MPPT charge controllers are now commercially manufactured by several companies, such as outback power, Xantres XW-SCC, Blue Sky Energy, Apollo solar, Midnight solar, Morning star and a few others. [5]

1.2.3. State of art technology:

PV technology, PV panels produce current using solar energy. It depends on the amount of solar radiation hitting the cells of the panel.

Theoretically, the maximum amount of power from sun the earth surface is about 1KW per square meter at equator on a clear day. The batteries store the power and supply the power at night time for producing current. Depending on the nature of PV panel, it has a basic current vs voltage curve which changes with the change of temperature and the amount of sunlight on the angle which the 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:

Nearly everyone thinks that generating electricity via solar power is good for the environment. Renewable energy and solar in particular remain rather controversial in the public debate about energy policy. Demands of solar energy have been running high. What motivated us is the bewildering range of statements you have out there regarding the cost effectiveness of electricity based on solar PV. Given the range of opinions, that’s why we wanted to do our own analysis.

In a broad new assessment of the status and prospects of solar photovoltaic technology, MIT researchers say that it is “one of the few renewable, low-carbon resources with both the scalability and the technological maturity to meet ever-growing global demand for electricity.” 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, the MIT researchers look at possible constraints on materials availability, and propose a system for evaluating the many competing approaches to improved solar-cell performance.

1.3.1. Future scope:

In future, solar energy will be very important source. So, using MPPT solar charge controller can generate a huge amount of current successfully. In this way, the cost of the production can also be reduced. In a word, it can develop a high-power output MPPT system with a low cost. This complete system schematic includes the feature of maintenance free use, no requirement of fuel or lubricant, stainless steel hardware, built-in over-load, over-charge, low voltage protection, temperature compensated charging and low battery disconnect facility. Moreover, it ensures maximum continuous power at full load and simultaneously pollution free and noiseless maintenance. Furthermore, it has the ability to charge the battery in low voltage so it will get sufficient backup in case of power failure.

1.3.2. Recommendation:

Future studies into maximum power point tracking could include the use of a different DC/DC converter and also some different MPPT algorithm such as Current MPPT (CMPPT) for example, could be implemented. Another extension of this project could be to design the DC/DC converter in full. The converter design could be done to optimize the components and in turn increasing the power efficiency. By optimizing the DC/DC converter the MPPT algorithms would achieve improved efficiencies and power tracking capabilities. Finally, a future work can also improve the developed software in order to efficiently use the capabilities of the microcontroller. A final prototype could then be design and implemented in order to have a final portable prototype for the solar charger. The whole system into a single integrated.

1.4. Limitations of this study:

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

1.5. Advantage over traditional methods:

At first it is pollution free and reduces the waste of other using of MPPT algorithm increase the system's efficiency. The LCD Display helps the users to inform about the condition of charge. For microcontroller it's easy to use and ensures reliability the system.

1.6. Objective of this work:

The main aim of our project is to utilize the maximum solar energy through solar panel. 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 advantage of renewable energy. With more and more portable devices coming out all the time the need to use renewable energy is ever increasing. The development of this thesis is very important because nowadays there is a current need in the market for an alternative Energy device that can charge different types of batteries efficiently. The developed charging process is not very fast but can ensure an efficient loading and without any additional cost for the final user. 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:

Processes involved are:

To fabricate two servo motors control interference with proposed circuit and construct a model prototype solar cell movement system with a mechanical assembly to move the panel from east to west as well as the sun track maximum angle. Finally, to design an electronic circuit to sense the intensity of light and to control servo motors drive for the panel movement.

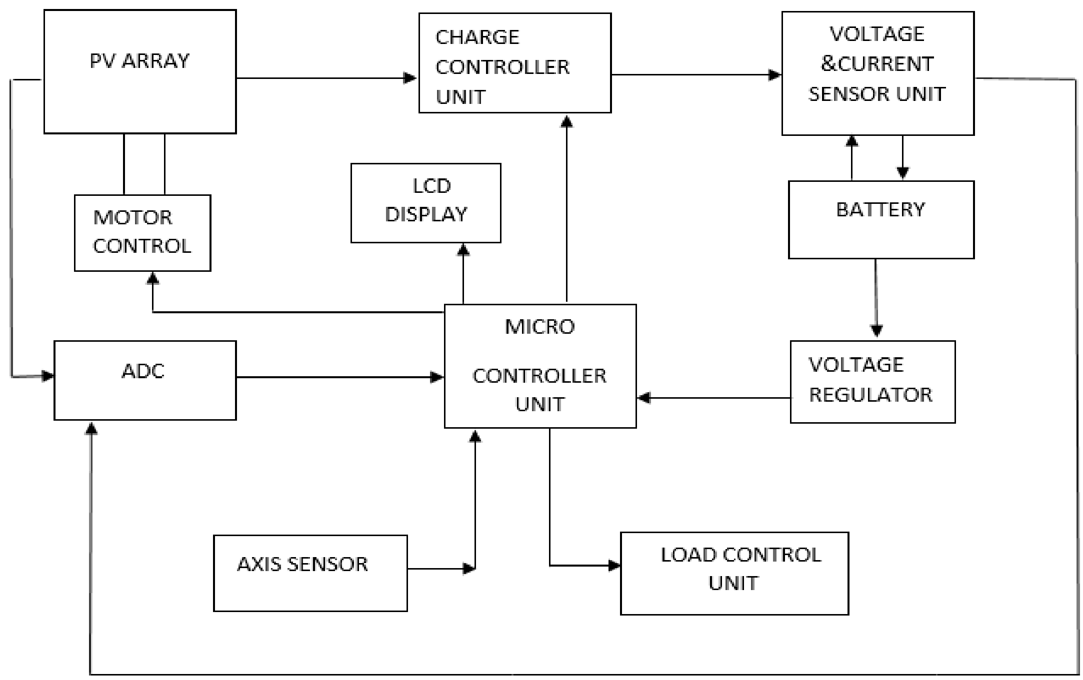
1.7. Introduction to the Project:

This is a Maximum Power Point tracking base solar charge controller which will controlled by microcontroller. Microcontroller wills co-ordinate the total system. This work presented a prototype board based in a small microcontroller that controls the battery charging process. The control algorithm executes the P&O maximum power point tracking function allowing, according to solar irradiance, the transfer of maximum energy generated by photovoltaic panel to the battery. This P&O algorithm increase the efficiency power transference in comparison to systems that have not a MPPT (direct connection), reducing the size and the cost of the PV panel. In this paper, we have focused how to increase the efficiency of a solar charge controller with a reduced cost the overall system. [7-12]

Chapter 2

Literature Review

2.1. Block Diagram of This Proposed Project:



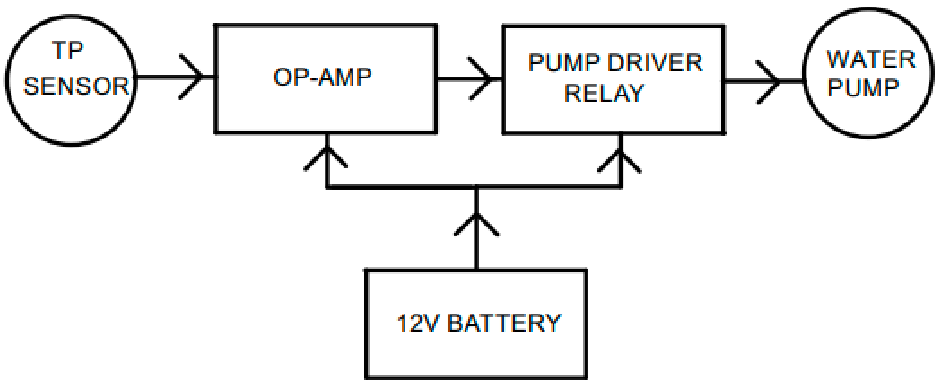


Fig2.1. Block Diagram of sun tracking system.

2.1.2. The Model of the Project:

The Proposed model of Dual Axis Solar Tracker Robot.

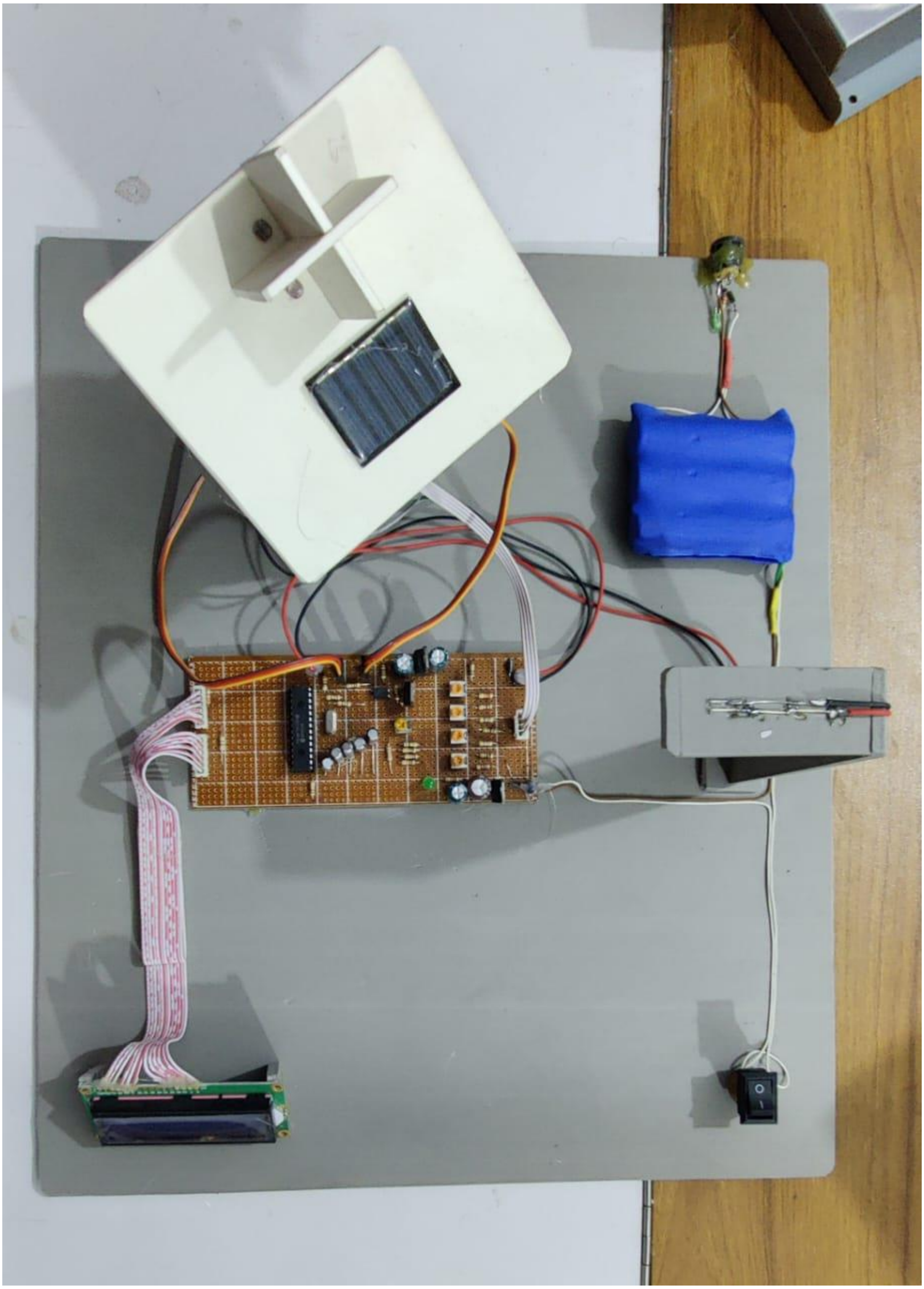


Fig2.1,2 Dual axis solar tracker Robot

2.2. Solar panel:

Solar panel is mainly designed as a panel which absorbed the sun’s rays and convert light into electricity. Most of the time the most powerful source of light available is the Sun, called Sol by astronomers. It is called photovoltaic which means, basically, "light-electricity."

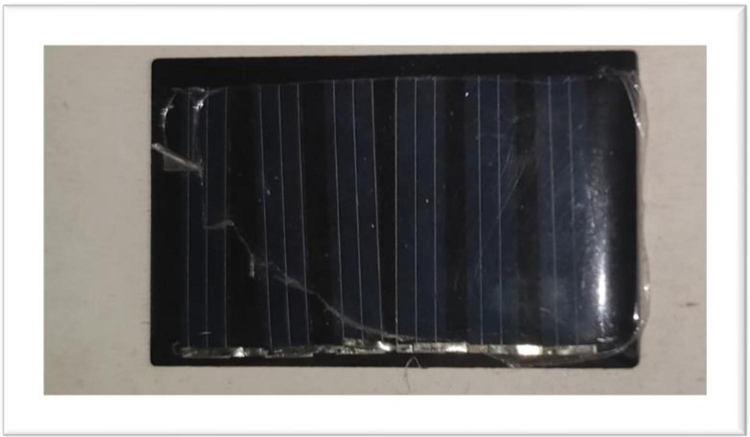


Fig 2.2 Solar panel Module

2.3. Photovoltaic cell model:

A simplest equivalent circuit of a solar cell is a current source in parallel with a diode. The output of the current source is directly proportional to the solar energy (photons) that hits on the solar cell. During darkness, the solar cell is not an active device; it works as a diode, i.e. A p-n junction. It produces neither a current nor a voltage. The diode determines the IV characteristics of the cell.

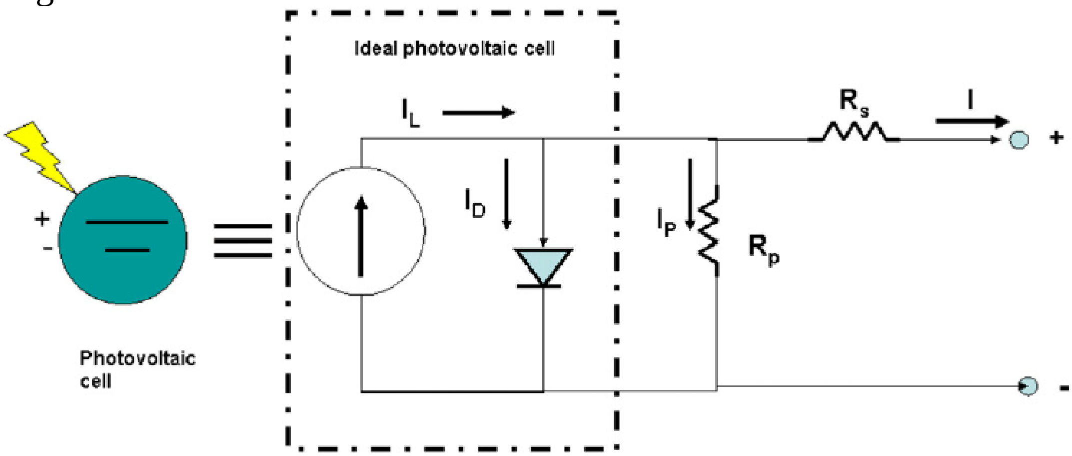


Fig 2.4 Circuit diagram of a PV cell

2.4 Maximum Power Point Tracking (MPPT):

Maximum Power Point Tracking (MPPT) is an electronic system that operates the Photovoltaic (PV) modules that allows the modules to produce all the power they are capable of.

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 reaches 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 rotated the panel according with rays. There are two types of tracker system and they are single axis solar tracker and dual axis solar tracker.

2.5.1. Dual axis solar tracker:

Dual axis tracking system uses the solar panel to track the sun from east to west and north to south. Dual axis solar tracker has two axis of freedom that act as axes of rotation. These axes are fixed with respect to the ground axis consider as a primary axis. But this one is also costly and complicated then single axis solar tracker. Dual axis solar tracker will be reliable and accurate and it is maximizing the output to static and single axis tracking system. This system uses four LDR's, two motors and a controller. The four LDR placed on at four different directions. The controller detects the signal from the LDR's and commands the motor to rotate the panel in respective direction.

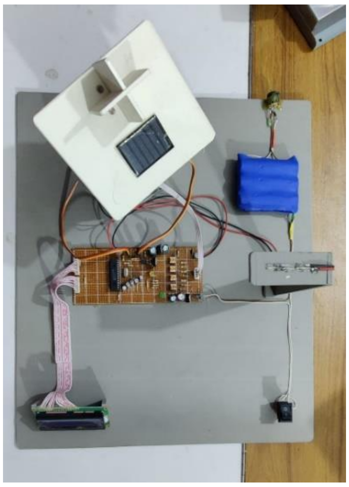


Fig 2.6.1 Dual axis solar tracking

2.6. Advantages & Disadvantages of solar energy:

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

2.6.1. Advantages:

- Solar energy is a clean and renewable energy source.
- It is pollution free.
- 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.
- Once a solar panel is installed, the energy is produced at reduced costs.

2.6.2. 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.
- Solar panels can be costly to install resulting in a time lag of many years for savings on energy bills to match initial investments.

Chapter 3

Components, Design & Implementation

3.1. LDR (Light Dependent Resistor):

LDR (Light Dependent Resistor) is called as light detecting sensor to build solar track which has included phototransistors, photodiodes and LDR. It is a made up of semiconductor materials which has high resistance. It is utilizing the light sensor circuit for automatic switch OFF the loads based on daylight's intensity by helping of a light sensor. In daylight the rays of sun fall on the photovoltaic panel and photo resistor and when the light falls on the resistor, then the resistance changes. Intrinsic Photo Resistors are made up of pure semiconductor devices like silicon or germanium.

Fig 3.1 Light Dependent Resistor

3.1.1. Working Principle of LDR:

Photo Conductivity is the main principle of the light depended resistor. Photo conductivity is an optical method, which the material's conductivity is increased when light is absorbed by the materials. When the light (photon) falls on the materials, the electrons in the valence band of the semiconductor material are excited to the conduction band. These photons in the incident light should have energy greater than the band gap of the semiconductor material to make the electrons jump from the valence band to the conduction band. The result of this process is more and more current starts flowing through the device when the circuit is closed and hence it is said that the resistance of the device has been decreased. This causes the free electrons or holes to conduct electricity and thus dropping the resistance (< 1 Kilo ohm). This is the working principle of light dependent resistor. The equation to show the relation between resistance and illumination can be written as:

3.1.2 The Design and implementation of using Four LDRs:

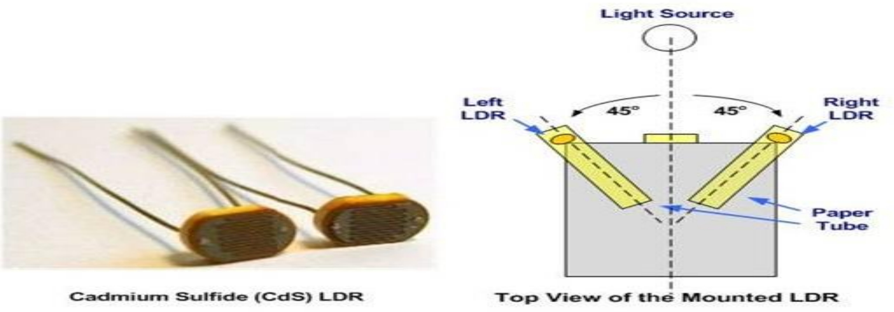


Fig 3.2 quadrant wise LDR positioning

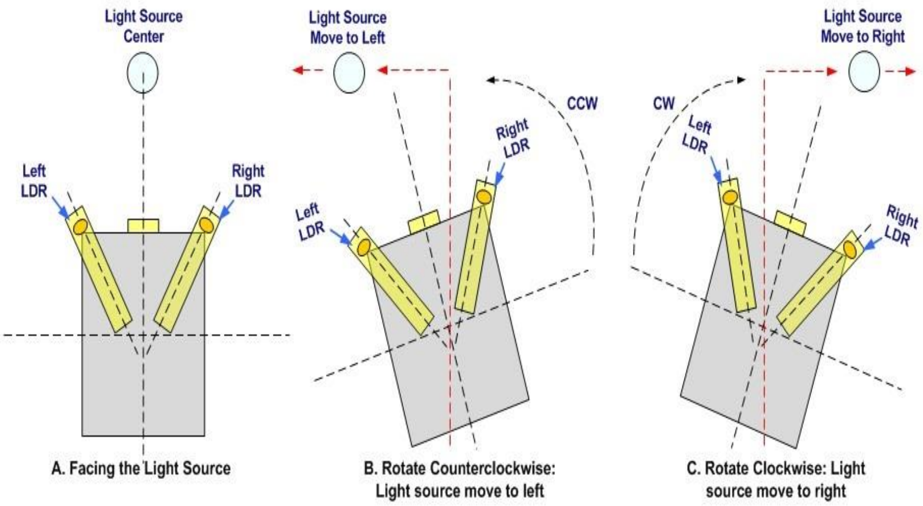


Fig 3.3 the Sensing Element and Signal Processing

There are several methods was proposed and used to track the position of sun light. We used four LDRs to track our module properly. A Light Dependent Resistor separated by a small plate to act as a shield to sunlight, as shown in the next figures. The two LDRs are connected to a bridge and the output of the bridge is connected to a comparator (the analog comparator of the microcontroller is used).

When LDR1 has higher light intensity than LDR2 then the resistance of LDR1 is smaller than that of LDR2 then voltage at AIN0 is higher than that of AIN1 and the output of comparator is high.

When LDR2 has higher light intensity than LDR1 then the resistance of LDR1 is larger than that of LDR2 then voltage at AIN0 is smaller than that of AIN1 and the output of comparator is low. Then the output of the comparator is used in the UC program to control the stepper motor RV1 variable resistor is used to balance the bridge when the two LDRs having the same light intensities (due to the mismatch between the two LDRs).

Similarly, we used the process for LdR3 and LDR4 using Dark and Bright Fringes.

3.2. LCD (2 Line 16 Carriers):

"LCD" short form of “Liquid Crystal display”. screen is an electronic display module. A 16x2 LCD display is very basic module and is very commonly used in various devices and circuits. These modules are preferred over seven segments and other multi segment LEDs. The reasons being: LCDs are economical; easily programmable; have no limitation of displaying special & even custom characters (unlike in seven segments), animations and so on.

A 16x2 LCD means it can display 16 characters per line and there are 2 such lines.

Fig 3.2 LCD (2*16) Pin

3.2.1. Pin Features:

- 5*8 Dots with cursor
- 16 Characters *2-line display
- 4-bit or 8-bit MPU interfaces
- Display mode & Backlight Variations
- ROHS Compliant

3.2.2. Pin Description:

16 pin LCD description given bellow:

Pin No.	Function	Name
1	Ground(0V)	Ground
2	Supply voltage; 5V (4.7V-5.3V)	Vcc
3	Contrast Adjustment; though a variable Resistor	VEE
4	Selects Command register When Low; And Data Resister When High	R-select
5	Low to write to the register; High to read from the register	Read/Write
6	Sends data to data pins when a high to low pulse is given	Enable
7	8-Bit Data Pins	DB0
8		DB1
9		DB2
10		DB3
11		DB4
12		DB5
13		DB6
14		DB7
15	Backlight Vcc (5V)	LED+
16	Backlight Ground (0V)	LED-

3.3. Servo Motor:

Servo motor is a self-contained electric devices and simple electrical motor, which is controlled with the help of servomechanism. It is a motor which has an output shaft and can be moved to a specific angular position by sending it a coded signal. The servo motor will maintain the position of the shaft. When we changed the coded signal, the angular position of the shaft will be changed. Servo motors are used for various applications. They are normally small in size and have good energy efficiency.

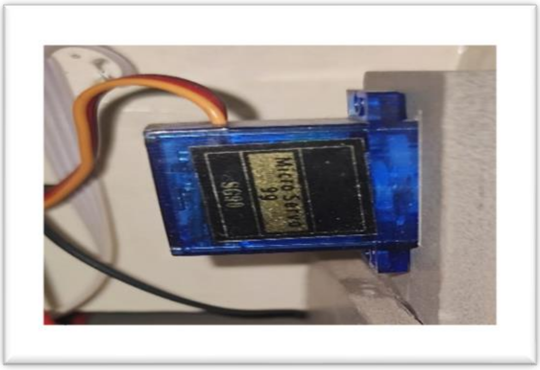



FIg3.3 Standard Servo Motor SG-90

The motor is controlled with an electric signal that determines the amount of shaft movement.

SERVO MOTOR SG-90:

It is tiny and lightweight with high output power. This servo can rotate approximately 150 degrees and it works just like the standard kinds

Specifications:

- Weight: 9 gm
- Dimension: 22.2 x 11.8 x 31 mm approx.
- Stall torque: 1.8 kgf cm
- Operating speed: 0.1 s/60 degree
- Operating voltage: 4.8 V (~5V)
- Dead band width: 10 µs
- Temperature range: 0 ºC – 55 ºC

3.3.5.Advantages & Disadvantages 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 motors also maintain torque at high speed, up to 90%.
- 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.
- Servo motor has poor motor cooling. Servo motor design more mechanically complex.
- Servo motor maintenance requirements will also increase.

3.4. Microcontroller:

A microcontroller is a single chip micro-computer on a single integrated circuit containing a processor core, memory, and programmable input/output peripherals. Basically, microcontrollers are used in automatically controlled products and devices, such as automobile engine control systems, implantable medical devices, remote controls, office machines, appliances, power tools, toys and other embedded systems. A microcontroller is available in different word lengths like microprocessors (4bit,8bit,16bit,32bit,64bit and 128-bit microcontrollers are available today). Here we use PIC16F72-I/SP microcontrollers.

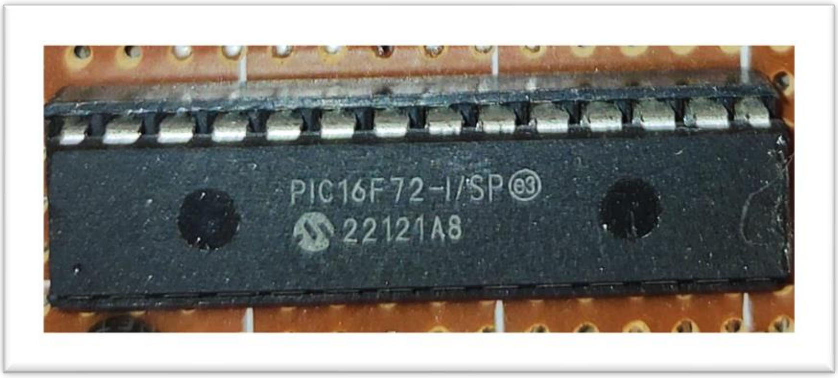
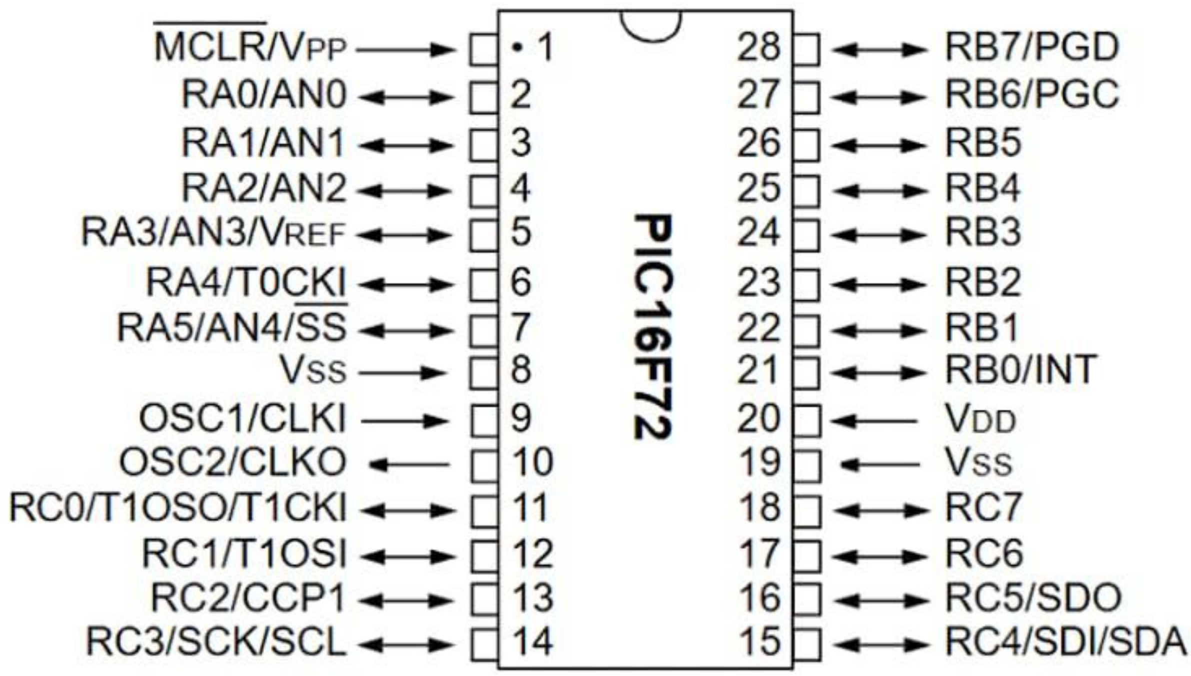


Fig3.4 PIC16F72-I/SP Microcontroller

A microcontroller contains one or more of the following components:

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

3.4.1. Pin and their functions:



3.4.2. PIC16F877 Development Board:

The immensely popular PIC16F877 development board for the PIC16F877 enables easy development and testing of various solutions. PIC16F877 is already included together with power supply components and crystals.

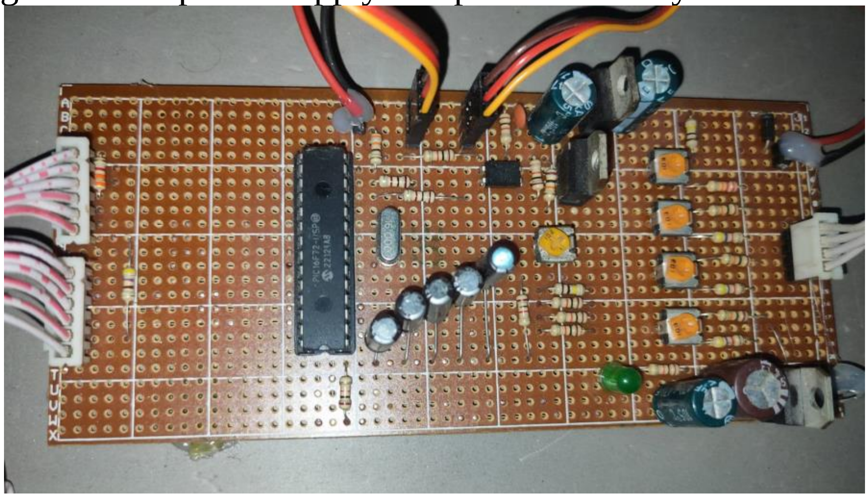


Fig3.4.2 Pic16F877 development board

3.5. Voltage regulator:

A voltage regulator generates a fixed output voltage of changes to its input voltage or load conditions. The voltage regulator must be stable with its condition. Here we use IC 7805 voltage Regulator. IC 7805 is a 5V Voltage Regulator that restricts the voltage output to 5V and draws 5V regulated power supply. The voltage source in a circuit may have fluctuations and would not give the fixed voltage output. The voltage regulator IC maintains the output voltage at a constant value.

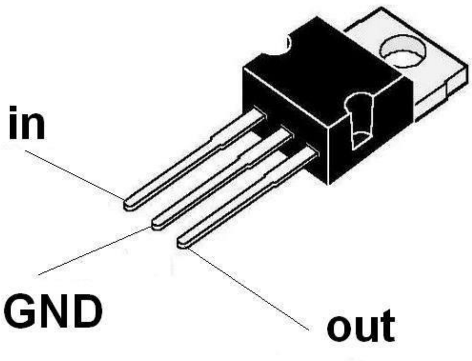


Fig 3.5 Voltage Regulator

3.5.1. Pin Description:

Pin no.	Function	Name
1	Input voltage (5V-18V)	Input
2	Ground (0V)	Ground
3	Regulated output; 5V (4.8V-5.2V)	Output

3.6. Capacitor:

Capacitor is an essential component of our project. We can use the capacitor in different many applications. Using capacitor in a microcontroller its must because of the microcontroller is a digital device with fast switching edges which uses a large amount of current for a very short period of time at each transition. The capacitors supply the large amount of current needed so that the power supply doesn't sag during that time creating noise. The main function of a capacitor is storing electric charge. A charged capacitor could be used as a voltage source. It is always best to use a variety of capacitors on the power supply pins of the microcontroller to provide a low impedance wideband supply. In our work we used variable value of capacitors and they are 10 μF (6 Pcs) & 100μF (1Pc). Capacitors are used for several purposes like timing, smoothing power supply, coupling, filtering, tuning for radio system, storing energy etc.

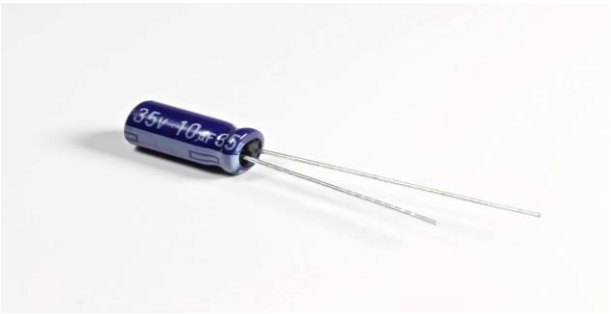


Fig 3.6 100μF & 10μF Capacitors

3.7. 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:

3.7.1. CCS C Compiler:

CCS stands for Custom Computer Services, a Microchip PIC Microcontroller Tool Solutions company. CCS C are the best compilers for beginners as they include a lot of built-in libraries which enable us to program a PIC Microcontroller without the deep knowledge of its internal architecture. I think CCS C is the best High-Level Language Compiler for PIC Microcontroller as it is almost hardware independent.

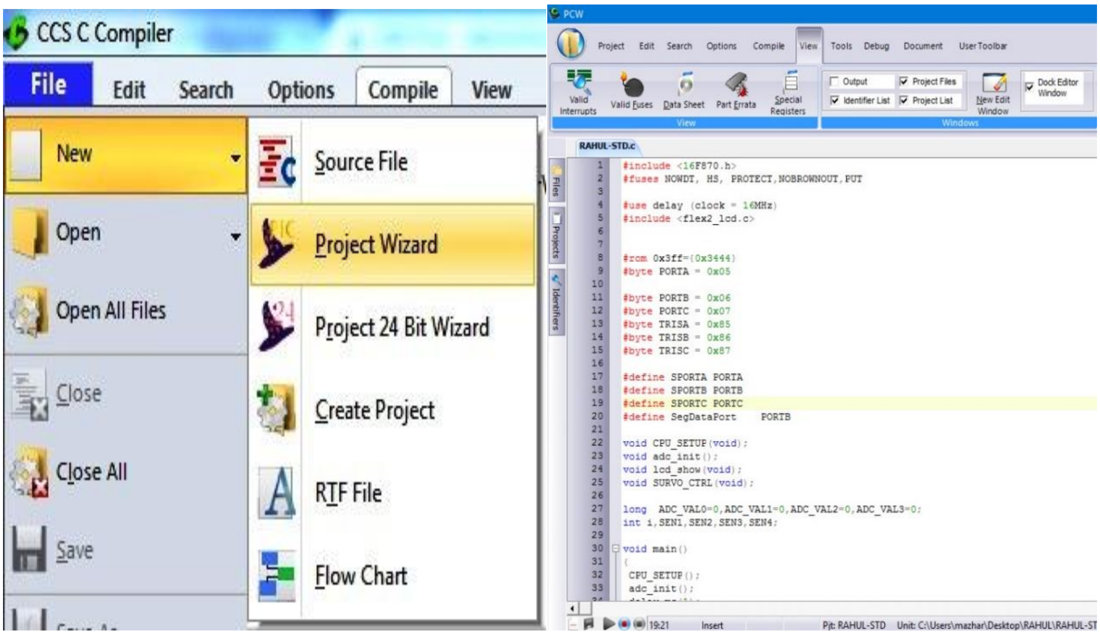


Fig 3.7.1 CCS C Compiler

Key Compiler Features:

- Easily migrate between all Microchip PIC MCUs devices.
- Minimize development time with: peripheral drivers and standard C constructs.
- C++ style input/output streams with full data formatting to any device or for strings.
- Use CCS libraries and object code royalty free

- The integral one-bit type permits the compiler to generate very efficient Bit-oriented code
- Easily define, set-up and manage interrupts.

3.7.2 Proteus Design Suite:

Proteus is a software package for computer-aided design, simulation and design of electronic circuits. It consists of two main parts, the ISIS, the circuit design environment that even the simulator VSM includes, and the ARES, the PCB – Designer. Proteus Virtual System Modeling (VSM) has mixed mode SPICE circuit simulation, animated components and microprocessor models to ease co-simulation of complete microcontroller-based designs.

It offers a range of design features including:

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

3.8. Soldering wire:

Solder is basically metal wire with a "low" melting point, where low for our purposes means low enough to be melted with a soldering iron. For electronics, it is traditionally a mix of tin and lead. When the soldering wire cooled off an electrical connection will conduct. This is getting a good mechanical connection 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 3.8 Soldering two wires

3.9. Crystal:

Crystal oscillators are electronic oscillator circuits that use inverse piezoelectric effect. With this effect, when electric field is applied across certain materials, they will produce mechanical deformation. Therefore, a crystal uses mechanical resonance of a vibrating crystal of piezoelectric material so that there is creation of an electric signal with precise frequency. They have high stability, are low cost and quality factor which makes them superior over such resonators as LC circuits, ceramic resonators and turning forks.

The crystal action can be represented by an equivalent electrical resonant circuit. The optimal values of the capacitors depend on whether a quartz crystal or ceramic resonator is being used. It will also depend on application-specific requirements on start-up time and frequency tolerance. Crystal oscillators are not built into ICs because they cannot be easily fabricated with IC processes and the size is physically larger than IC circuits. The internal oscillators of microcontrollers are RC oscillators. The reason why crystal oscillators are used is because the quality factor is on the order of 100000 while that of RC oscillators is on the order of 100. Therefore, the crystal oscillator has lower phase noise and lower variation in output frequency.

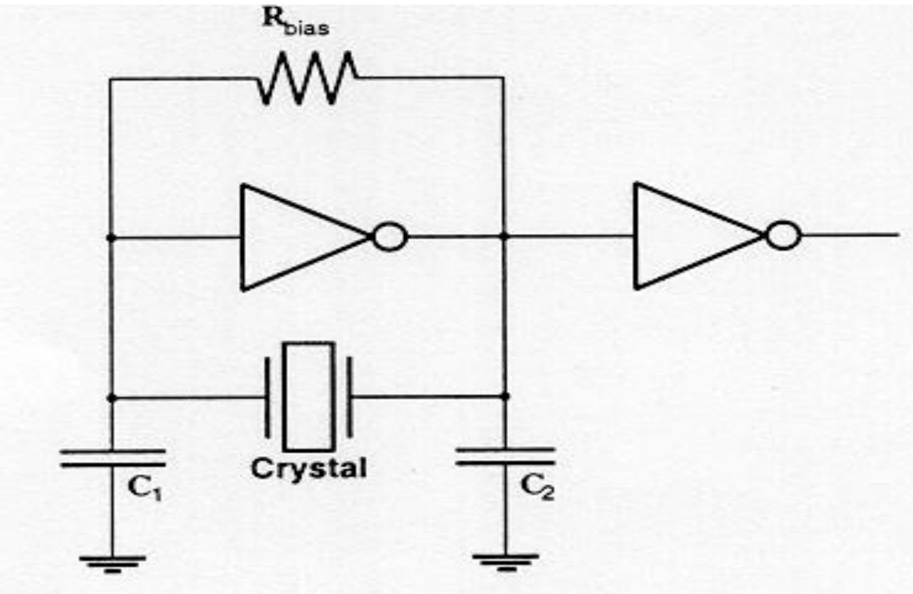


Fig3.21. Crystal

Chapter 4

Discussions and Conclusions

4.1. Discussion:

In this work, a MPPT charge controller is presented. A microcontroller is used to control the maximum power point tracking algorithm, which is used in PV systems to maximize the photovoltaic array o/p power.

An optimized and effective technique has been proposed considering the discussed drawbacks. The proposed system was simulated and constructed, and the functionality of the suggested control concept was proven. The proposed system was simulated and constructed, and the functionality of the suggested control concept was proven. From the results acquired during the simulations and hardware experiments, it was confirmed that, with a well-designed system including a proper converter and selecting an efficient and proven algorithm, the implementation of MPPT is simple and can be easily constructed to achieve an acceptable efficiency level of the PV modules. The results also indicate that the proposed control system is capable of tracking the PV array maximum power and thus improves the efficiency of the PV system 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.

The work executed in this project deals with analyzing and modeling of transformer less PV systems related to the leakage current phenomenon that can degrade solar panel performance and pose human. Additionally, leakage current is an unwanted loss especially when it comes to distributed generation system. One of the major tasks of this research was to investigate and verify the transformer less topologies and control strategies that would minimize the leakage current of PV inverter topologies so that it can comply with the standard requirements, safety of human interaction and mitigation of unwanted losses. [13-14]

4.2. Suggestion for Future work:

The main objective of this project is to achieve the highest performance a solar charge controller using MPPT system. This system successfully uses MPPT algorithm to reach our goal. Reaching a stable, true MPP at steady state instead of oscillating around this point would improve the system's efficiency and improve reliability.

4.2.1. Development of microcontroller:

Development of different Microcontroller based dedicated MPPT controller for solar PV module based on the different algorithm such as observe & perturbation, computational method etc. This can be a low-cost embedded controller. Or to incorporate the power supply into the system that draws energy from the solar panel or an energy storage element that is in turn charged by the solar panel. This extension would allow the system to be deployed to remote locations. Converting the whole system into a single Integrated Circuit.

4.2.2. Development of MPPT system & PV panels:

The PV panels that are being used for tests of the diagnostic methods in this thesis can be considered as a small-scale representation of a photovoltaic array. A full-scale residential PV system should be also considered for field testing. 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]

4.3. Conclusion:

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 biomass energy are the main source of energy used for optimizing the overall system and hence to make it efficient. So, the user will become less compulsive on the convenient fossil fuel energy. The stored energy also plays a significant role to avoid the imbalance of the power system. To ensure the photovoltaic generator operating its maximum power point, MPPT controllers are often used. These controllers are intended for MPP tracking and to thus minimize the error between the operating power and the reference maximum power which is variable according to the load and of the weather conditions. The MPPT based charge controllers are best suitable for wind and solar systems as they track the maximum power in case of power fluctuations at the input side due to environmental condition variation. Hence it is recommended to use the MPPT based charge controllers. Use of microcontroller-based systems provides huge computational capability and reduction in the hardware. The MPPT charge controller operates with high efficiency (90% or even higher) as compared to existing charge controllers. [10]

Appendix

```
#include <16F73.h>
#Use delay (clock = 16000000)       // HEADER FILES

INT V, A, W;
////////////////////////////////////////////////////
void main ()
{

 lcd_gotoxy(1,1);
 printf(lcd_putc, "   WELCOME      ");
 lcd_gotoxy(1,2);
 printf(lcd_putc, "     L.H.S      ");
 delay_ms(1000);

 lcd_gotoxy(1,1);
 printf(lcd_putc, "SUBMITTED BY:   ");
 lcd_gotoxy(1,2);
 printf(lcd_putc, "   MD. SOBUZ HOSSAIN                              ");
 delay_ms(1500);
 lcd_gotoxy(1,1);
 printf(lcd_putc, "   EMRAN ALI       ");
 lcd_gotoxy(1,2);
 printf(lcd_putc, "  MD. AMITE HASAN                                  ");
 delay_ms(2500);
 lcd_gotoxy(1,1);
 printf(lcd_putc, ");
 lcd_gotoxy(1,2);
delay_ms(2500);
```

```
}
 while (1)
 {
   lcd_gotoxy (1,1);
   printf(lcd_putc, "B:BV LDR1 LDR2 LDR3 ");
   lcd_gotoxy (1,2);
   printf(lcd_putc, "I:A      P:W      ");

   SURVO_CTRL ();

 /////////////////////////
   set_adc_channel(0 );
   LDR1 = read_adc();

   set_adc_channel(1 );
   LDR2 = read_adc();

   set_adc_channel(2 );
   LDR3 = read_adc();

   set_adc_channel(3 );
   V = read_adc();

   set_adc_channel(4 );
   A = read_adc();

   W=(V*I);
 ////////////////////////
 }
```

```
} // end main ()
////////////////////////////////////////////////////////////////////////////

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

        if (LDR0 > LDR1)
         s1ds++;
        if (LDR0 < LDR1)
         s1ds--;

  //////////////////////////   SUUURVO-2 CONTROL   ///////////////////////

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

  ////////////////////////   LOAD CONTROL      ///////////////////////////}
```

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