CHAPTER 01

INTRODUCTION

1.1 Background of Project

Arduino is the most commonly used industrial automation technology in the world used to refer to a company that manufactures a specific implementation of these boards and is typically also used to describe the community around compatible boards made by other people or companies which function in a similar way. For example, using the control of traffic lights and the real-time control system with programmable timings, pedestrian lighting, etc.

Through this task can be done by a human, Arduino is used to increasing the productivity of the company. It is because it can produce products speedily, reduce manpower and material costs and improve the quality of products. Here this project can help entrepreneurs of the small and medium industries to reduce the use of manpower thus it's the reduction of the overall product cost.

1.2 Objectives

The project is aimed to meet the following objectives:

1) To design a track solar system using Arduino and LDR sensors to follow the sun's movement.
2) To utilize the Automatic solar system for dual axis.
3) To maintain the quality of the product to be produced.
4) To apply the C program using Arduino Uno software.
5) To apply the Automatic Solar System that can be used to increase energy production.

1.3 Scopes

All projects have their own scope or limitation as a guideline throughout the competition of the project. The project scopes for implementing this project are:

1) The automatic solar tracker uses Arduino and LDR sensors to control the electrical and mechanical processes.
2) Arduino Uno acts as the main controller of the whole system, the light-dependent resistor is used as a light sensor to detect sunlight while the function of the servo motor is to rotate the solar panel to align with the sunlight.
3) C program is used to illustrate the control system of the programming activities of the project where Arduino Uno software is used for programming.

1.4 Problem statement

1) Lots of moving parts make it more likely for components to fail.
2) Lower lifespan and lower reliability.
3) Unreliable performance in cloudy or overcast weather.
4) Very costly. It can generate 40% more electricity compared to static panels but is also 100% more costly.

1.5 Methodology

The methodology is a part that will explain the project path from the beginning until it's completed. Every section and action that has been done while implementing the project must be explained in stages. The methodology must be done to make sure the project that consists of hardware and software development will be developed systematically. smoothly and successfully.

The project starts by collecting and gathering information from books and internet websites. The information collected is including Arduino, LDR sensor, and servo motor. Apart from that, asking for lectures and friends with the related topic can help to solve the problems in this project.

1.6 Project outline

Chapter 1- Introduction: The proposed system has been discussed in this chapter.

Chapter 2- Reviews and literature knowledge of Arduino and Solar Cell: This chapter explains theoretical reviews about Arduino and Solar Cells

Chapter 3- Design and construction of AUTOMATIC SOLAR TRACKER DUAL AXIS: This chapter explains the design and construction of automatic solar tracker criteria and discusses it. about the working principle of the circuit. The system design has been implemented in this project.

Chapter 4- Result and discussion: Describes the results and output of the system.

Chapter 5- Conclusions and recommendations: It gives the conclusions drawn from the paper and brief ideas about future development works that can be undertaken

CHAPTER 02

REVIEWS AND LITERATURE KNOWLEDGE OF ARDUINO AND SOLAR CELL

2.1 Introduction

Control engineering has evolved over time. In the past humans were the main method for controlling a system. More recently electricity has been used for control and early electrical control was based on relays. These relays allow power to be switched on and off without a mechanical switch. It is common to use relays to make simple logical control decisions. The development of low-cost computers has brought the most recent revolution, the Arduino. The advent of the Arduino began in the 2005s and has become the most common choice for manufacturing controls. Arduino has been gaining popularity on the factory floor and will probably remain predominant for some time to come. Most of this is because of the advantages they offer.

1. inexpensive.
2. open source in hardware.
3. don't need an external programmer (Burner)
4. programming ease.
5. open source in software.
6. IDE Software operates on any operating system.

2.2 What is Arduino

An open hardware development board that can be used by tinkerers, hobbyists, and makers to design and build devices that interact with the real world. While Arduino refers to a specific type of board design, it can also be used to refer to a company that manufactures a specific implementation of these boards and is typically also used to describe the community around compatible boards made by other people or companies which function in a similar way.

2.3 Features of Arduino

The main feature of Arduino

1. It is an easy USB interface. This allows interface with USB as this is like a serial device.
2. The chip on the board plugs straight into your USB port and supports your computer as a virtual serial port.
3. It is easy to find the microcontroller brain which is the ATmega328 chip.
4. A number of hardware features like timers, external and internal interrupts, PWM pins, and multiple sleep modes.

5. It is an open-source design.
6. A large community of people using and troubleshooting it.
7. Easy to help in debugging projects.
8. It is a 16 MHz clock which is fast enough for most applications and does not speed up the microcontroller.
9. It is very convenient to manage power inside it and it had a feature of built-in voltage regulation.

2.4 Application of Arduino

Arduino has also applications, that are-

1. Weighing Machines.
2. Traffic Light Count Down Timer.
3. Parking Lot Counter.
4. Embedded systems.
5. Home Automation.
6. Industrial Automation.
7. Medical Instrument.
8. Emergency Light for Railways.

2.5 Parts of Arduino Uno

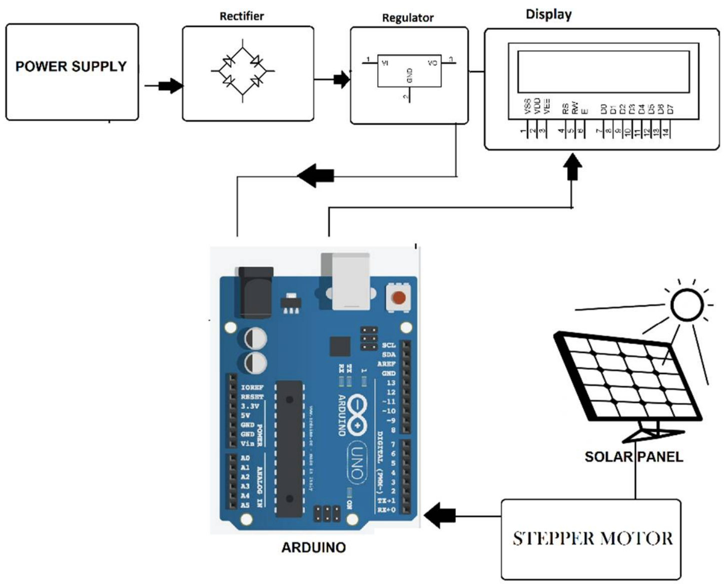

Figure 2.1: Arduino Uno Block Diagram

2.5.1 Central Processing Unit

The Central Processing Unit (CPU) is the control portion of the Arduino. It interprets the program commands retrieved from memory and acts on those commands present-day Arduino's this unit is a microprocessor-based system. The CPU is housed in the processor module of modularized systems. Memory in the system is generally of two types: ROM and RAM. The ROM memory contains the program information that allows us to interpret and act on the Ladder Logic program stored in the RAM memory.

2.5.2 Memory

ROM: Read Only Memory. We can read the data from this memory, but we cannot write (store) any data or instructions into this memory.

RAM: Random Access Memory. We can read and write any data or instructions into this memory. If power fails then all data will be erased automatically.

PROM: Programmable Read Only Memory. By using a special program, we can write any data or instructions into this memory for only one time.

EPROM: Erasable PROM. By using ultraviolet rays, we can erase the contents of EPROM.

EEPROM: Electrically Erasable PROM. We can erase the contents of an EEPROM by a special electrical signal. EEPROM in Arduino is usually used to store a small amount of data like states of input or output devices so that it can be retained even if the Arduino loses power. I made a dedicated tutorial on Arduino EEPROM (both internal and external).

2.5.3 Power Supply

This system provides +5v and 1amps.

Figure 2.2: Power supply

Many types of inputs and outputs can be connected to an Arduino, and they can all be divided into two large groups analog (discrete) and digital. Digital inputs and outputs are those that operate due to a discrete or binary change - on / off, yes/no. Analog inputs and outputs change continuously over a variable range – pressure temperature and tensiometer. The standard Arduino module types and their descriptions are as follows:

2.6 Input control device

Input Device of Arduino are-

1. Light Dependent Resistor (LDR)
2. Pushbutton
3. Potentiometer
4. Temperature sensor
5. Fingerprint sensor
6. Smoke Sensor
7. Keypad
8. Sound detection sensor

2.7 Description of the input control device

Light Dependent Resistor (LDR)

The Light Dependent Resistor commonly known as a photoresistor or light sensor is one of the common input devices that can be used in different projects. These photoresistors are sensitive to light which can change their resistance depending on the falling light on them. They have several megaohms of resistance in the dark and when they are under light the resistance falls from megaohms to a few hundred ohms. The symbol of the photoresistor or LDR are:

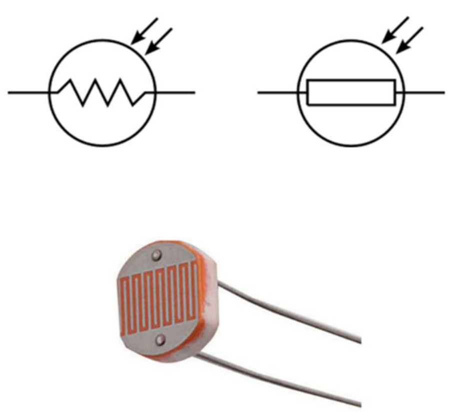

Figure 2.3: Light Dependent Resistor (LDR)

Pushbutton

The push button is another type of input device used for switching purposes. The pushbuttons are connected to the digital pins of Arduino because they have only two possible states either HIGH or LOW. The most common application of button in Arduino projects is switching and the symbol of a button is:

Figure 2.4: Pushbutton

Potentiometer

A potentiometer is an input device by which we can manually vary the resistance between zero to a specific value of the potentiometer. We can attach the potentiometer to the analog pins of Arduino and can take the resistance value of our choice. The potentiometer has three legs, one leg is connected to the five volts, the other is connected to the ground, and the middle leg is connected to the analog pin of the Arduino where we have to take input. The symbolic representation of the potentiometer is:

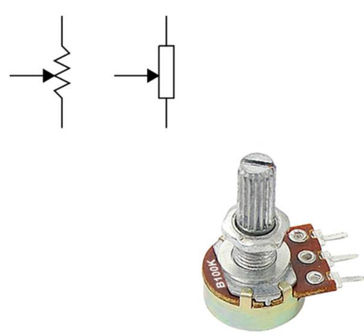

Figure 2.5: Potentiometer

Temperature Sensor

A temperature sensor is another input device that can be interfaced with Arduino to get the input values of the surrounding temperature. A temperature sensor has a resistor inside its construction, so when the surrounding temperature increases the value of resistance will start increasing, and if the surrounding temperature decreases, the value of resistance decreases.

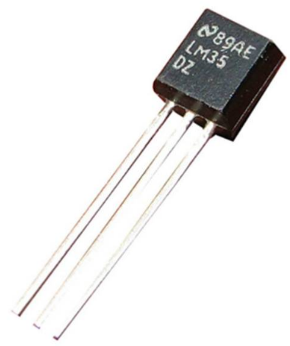

Figure 2.6: Temperature Sensor

Fingerprint Sensor

The fingerprint sensors are used to take the input of impressions of fingers and use it for security purposes. There are different types of fingerprint sensors, the most used fingerprint sensor is r503 which can be interfaced with Arduino. The fingerprint sensors are widely used where biometric impressions are required most common applications of fingerprint sensors are security and attendance devices:

Figure 2.7: Fingerprint Sensor

Smoke Sensor

The smoke sensor is another type of input device that can be interfaced with Arduino to detect the presence of smoke in its surroundings. It also changes the resistance to the concentration of the smoke if there is smoke in the surrounding, the concentration of the smoke increases which will increase the resistance of the sensor, and if there is no smoke in the surroundings, there will be no concentration of smoke, so the sensor will measure the less resistance.

Figure 2.8: Smoke Sensor

Keypad

The keypad modules are also considered as the input devices which can be interfaced with the Arduino boards. The keypad modules contain buttons just like a keyboard of a computer and can be used to insert different ASCII numbers. With the help of a keypad, we can take the input and perform a calculation. There are different types of keypads that can be interfaced with Arduino like 3×3 and 4×3 keypads:

Figure 2.9: Keypad

Sound Detection Sensor

The sound detection sensors are used to measure the loudness of the sound and are also a device that can be interfaced with Arduino to get input. The threshold of sound intensity can be adjusted by the potentiometer on the sensor module. There are different types of sound detection sensors among which KY-038 is the most commonly used sound detector.

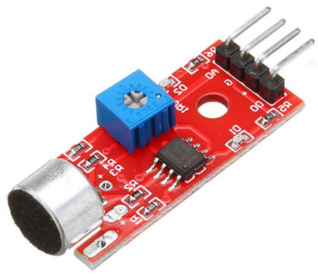

Figure 2.10: Sound detection sensor

2.8 Output control device

List of Arduino output devices

1. LEDs.
2. Motors.
3. Liquid crystal displays (LCDs)
4. Relays.
5. Seven segment displays.
6. Speaker and buzzer.

2.9 Explanation of output control device

Light Emitting Diode (LED)

The LEDs can be used as an output device with Arduino as they can serve various purposes in the projects, for example, the color of the LED can be associated with any type of indication. The indication can be for turning on an appliance or a circuit or it can be used to indicate if there is any fault in the circuit. Similarly, there are various types of indications that can be made using the LED, similarly, more than one LEDs can also be used for multiple indications in a project.

Figure 2.11: Light emitting diode

Motors

The Arduino boards can also be used to drive DC motors which in turn can run or control another device. For example, if water is to be pumped using Arduino the DC motor will be an output device. The device will run when the water level falls below the level given in the Arduino program. Similarly, motors can be used to drive fans as well in short to move any device we can use motors with Arduino.

Figure 2.12: Motor

Liquid Crystal Display (LCDs)

To display the output of the Arduino program digital displays are interfaced with Arduino. These displays come in multiple sizes/resolutions and the most common of them is 16×2. This size is the most commonly used size by the students in their different projects. The purpose of the LCD is to just display the output data coming from the Arduino board or the input data given by any input device to the Arduino board.

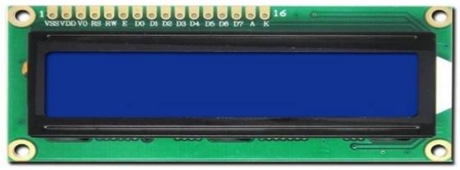

Figure 2.13: Liquid Crystal Display

Relays

Relays are normally used for the protection of the devices in the circuit as it isolates the faulty part of the circuit from the whole circuit. Another purpose of the relays is that we can use them for the purpose of switching from one device to another. The Arduino boards mostly use relays as an output device as they can switch from one device to another. For example, based on the load or time interval, or voltage level Arduino board can switch between two or three motors. Similarly, it can also be used to shift from the regular supply to the backup supply in case of power failure.

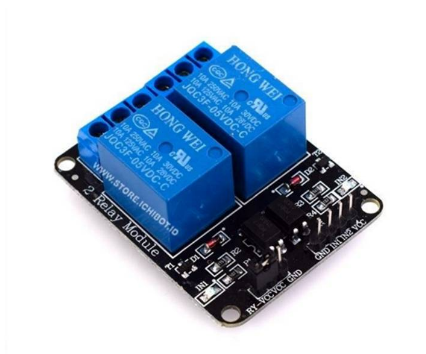

Figure 2.14: Relays

Seven segment displays

The seven-segment displays are used when the output of Arduino is only in the form of numbers, for example, in digital counters, clocks, or electronic meters. A single module of the seven segments can display numbers from 0 to 9. It comes in two configurations: a common anode and a common cathode.

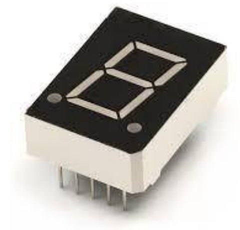

Figure 2.15: Seven-segment display

Speaker and buzzer

In Arduino projects, the speakers or buzzers are interfaced as an output device. These can be used for sounding an alarm or playing any melody on specific frequencies. Similarly, speakers can also be used for giving any voice commands in case of the occurrence of an event.

Figure 2.16: Speaker and buzzer

2.10 Solar Cell

2.10.1 Theoretical Framework

The solar panel is mainly made from semiconductor materials. Si is used as the major component of solar panels, which is a maximum of 24.5% efficient. Unless highly efficient solar panels are invented, the only way to enhance the performance of a solar panel is to increase the intensity of light falling on it. Three ways of increasing the efficiency of solar panels are through the increase of cell efficiency, maximizing the power output, and the use of a tracking system. MPPT technology will only offer maximum power which can be received from stationary arrays of solar panels at any given time. The technology cannot however increase the generation of power when the sun is not aligned with the system. Because the position of the sun changes during the course of the day and season over the year. So, the implementation of a solar tracker is the best solution to increase energy production. Solar tracking is a system that is mechanized to track the position of the sun and align perpendicular to increase power output by between 30%and 60% to systems that are stationary. It is a more cost-effective solution than the purchase of solar panels. Currently, there are two main types of solar trackers one axis and two axes.

Figure 2.17:(a) Schematic diagram of single axis solar tracker (b) Schematic diagram of double axis solar tracker

When seasons changes, the sun's path goes from low in the sky in winter too high in the sky in summer as shown in figure 2.18. So, in order to accurately follow the sun, two-axis tracking is required as solar azimuth angle as well as solar altitude angle of the sun varies (in two axes) all the time. This optimizes maximum power from the PV system over a day than a non-tracking system.

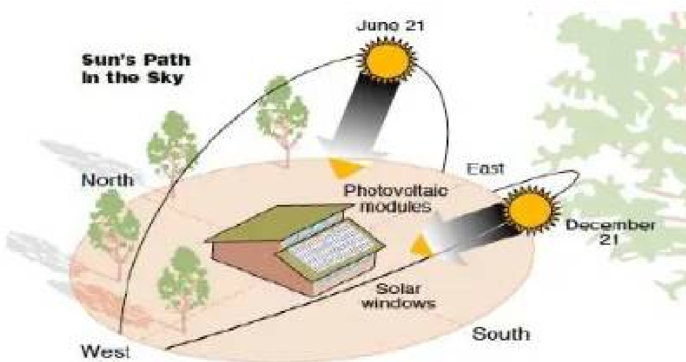

Figure 2.18: Variation of the trajectory of sun from winter to summer

2.10.2 Electrical Application of Solar Energy

Solar energy is the production of electricity with the help of PV cells or solar cells. Different types of solar cells are developed and developing to increase their efficiency. Different parameters regarding photovoltaic modules are described below:

1) PV CELLS

A solar cell is an electronic device that directly converts sunlight into electricity. Light shining on the solar cell produces both a current and a voltage to generate electric power. This process requires firstly, a material in which the absorption of light rises electron to a higher energy state, and secondly, the movement of this higher energy electron from the solar cell into an external circuit. The electron then dissipates its energy in the external circuit and returns to the solar cell. A variety of materials and processes can potentially satisfy the requirements for photovoltaic energy conversion, but in practice, nearly all photovoltaic energy conversion uses semiconductor materials in n the form of a p-n Junction. The basic working can be seen in figure 2.19

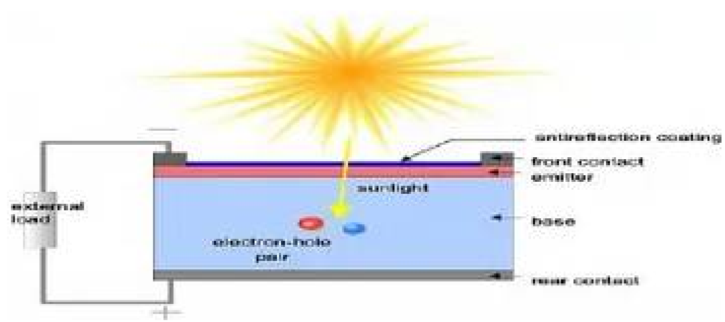

Figure 2.19: Photoelectric effect in PV Cell

2) I-V CURVE

The IV curve of a solar cell is the superposition of the IV curve of the solar cell diode in the dark with the light-generated current. The light has the effect of shifting the IV curve down into the fourth quadrant where power can be extracted from the diode. Illuminating a cell adds to the normal "dark" currents in the diode so that the diode law becomes:

$I = I_0[\exp(qV/nkT) -1] - I_L$

where IL = light generated current
Without illumination, a solar cell has the same electrical characteristics as a large diode. When the light shines on the cell, the I-V curve shifts as the cell begins to generate power. Fig 20 shows the IV curve of solar cells.

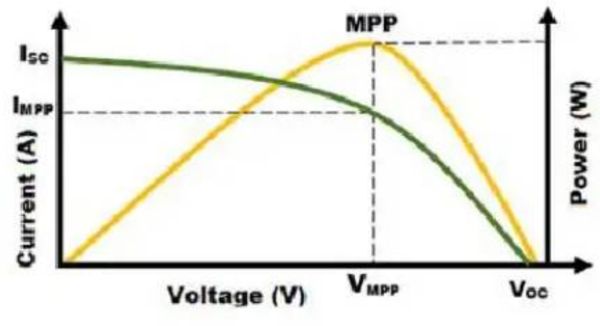

Figure 2.20: I-V curve of solar cells

Several important parameters which are used to characterize solar cells are discussed below:

i. Short-circuit current

The short-circuit current is the current through the solar cell when the voltage across the solar cell is zero. Usually written as I_{sc}, the short-circuit current. The short-circuit current is due to the generation and collection of light-generated carriers and it is the largest current that may be drawn from the solar cell.

ii. Open-circuit voltage

The open-circuit voltage, V_{oc}, is the maximum voltage available from a solar cell, and this occurs at zero current. The open-circuit voltage corresponds to the amount of forwarding bias on the solar cell due to the bias of the solar cell junction with the light-generated current. V_{oc} depends on the saturation current of the solar cell and the light-generated current.

iii. Maximum power point (P_m)

It is the maximum power that a solar cell produces under STC. The higher the Pm, the better the cell. It is measured in watts. A solar cell can operate at many current and voltage combinations, but a solar cell will produce maximum power only when operating at certain current and voltage.

$P_m = I_m \text{ X } V_m$

iv. Current at maximum power point (I_m)

This is the current that solar cells will produce when operating at the maximum power point. The I_m is always lesser than I_{sc}.

v. Voltage at maximum power point (V_m)

This is the voltage that a solar cell will produce when operating at the maximum power point. The V_m is always less than V_{oc}.

vi. Fill Factor (FF)

The "fill factor", more commonly known by its abbreviation "FF", is a parameter that, in conjunction with V_{oc} and I_{sc}, determines the maximum power from a solar cell. The FF is defined as the ratio of the maximum power from the solar cell to the product of V_{oc} and I_{sc}. Graphically, the FF is a measure of the "squareness" of the solar cell and is also the area of the largest rectangle that will fit in the IV curve. Mathematically,

$FF = (I_m x\ V_m / I_{sc} x V_{sc}) = (P_m / I_{sc} x V_{oc})$

vii. Solar cell efficiency

Efficiency is defined as the ratio of energy output from the solar cell to input energy from the sun. In addition to reflecting the performance of the solar cell itself, the efficiency depends on the spectrum and intensity of the incident sunlight and the temperature of the solar cell. Therefore, conditions under which efficiency is measured must be carefully controlled in order to compare the performance of one device to another. Terrestrial solar cells are measured under AM 1.5 conditions and at a temperature of 25°C. The efficiency of a solar cell is defined as:

$P_{max} = V_{oc} I_{sc} FF$

$\eta = V_{oc} I_{sc} FF/Pin$

Where:

V_{oc} is the open-circuit voltage

I_{sc} is the short-circuit current

FF is the fill factor and

η is the efficiency

3) A MODULE CIRCUIT DESIGN

A bulk silicon PV module consists of multiple individual solar cells connected, nearly always in series, to increase the power and voltage above that from a single solar cell The voltage of a PV module is usually chosen to be compatible with a 12V battery. An individual silicon solar cell has a voltage of just under 0.6V under 25 °C and AM1.5 illuminations. Taking into account an expected reduction in PV module voltage due to temperature and the fact that a battery may require voltages of 15V or more to charge, most modules contain 36 solar cells in series. The remaining excess voltage is included to account for voltage drops caused by other elements of the PV system, including operation away from the maximum power point and reductions in light intensity.

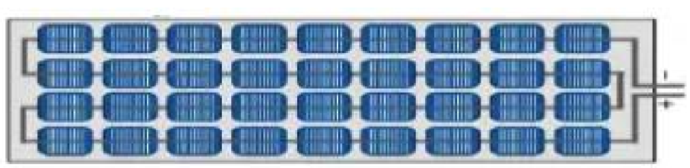

Figure 2.21: Pictorial view of PV panel

While the voltage from the PV module is determined by the number of solar cells, the current from the module depends primarily on the size of the solar cells and also on their efficiency. Also, we can connect cells in parallel for higher charging current.

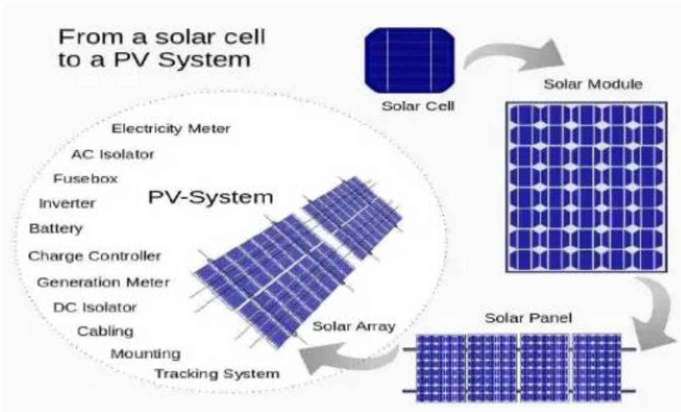

Figure 2.22: Pictorial representation from the solar cell to solar array

2.10.3 Types of Solar PV modules

Solar PV modules or panels are generally classified according to the cell technology used to produce or manufacture them. On this basis there are three types of PV modules:

a) Amorphous silicon (a-Si) PV module

The term amorphous literally means shapeless. The silicon used to make amorphous silicon cells is not structured or crystallized as in other types of PV modules The solar cells are made up of one or several layers of photovoltaic material deposited onto a substrate. These panels are cheap and have an appealing look. However, they are bigger in size and therefore require a lot of space.

b) Monocrystalline silicon PV module

The solar cells used in this module are made from uniform silicon lattice cut out of a single crystal. They have high-efficiency rates since they are made out of high-grade silicon. They are also smaller than amorphous silicon panels and therefore do not require a lot of space. However, they are the most expensive solar panels.

c) Polycrystalline silicon PV module

The solar cells used in this module are made from raw silicon, which is melted and poured into a square mould. Once cooled, it is cut into perfectly square wafers This process makes these modules simpler and cheaper to produce than those in a monocrystalline module. However, polycrystalline modules have lower space efficiency. That is, you need to cover a wider surface to produce the same electrical power that you would with solar panels made of monocrystalline silicon.

Figure 2.23: Types of solar cells

d) Hybrid Cell

These types of cells are simply PV cells that use two different types of PV technology. For example, a hybrid cell could be composed of a monocrystalline PV cell covered by a layer of amorphous silicon. These cells generally perform well at high temperatures and have efficiencies exceeding 18%. However, these cells can be very expensive.

CHAPTER 03

DESIGN AND CONSTRUCTION OF ARDUINO

3.1 System implementation

In this chapter, we are going to explain the system design construction through hardware and the development of software. In addition, the chapter elaborates on the hardware and software step by step.

3.2 Block diagram of Arduino Uno

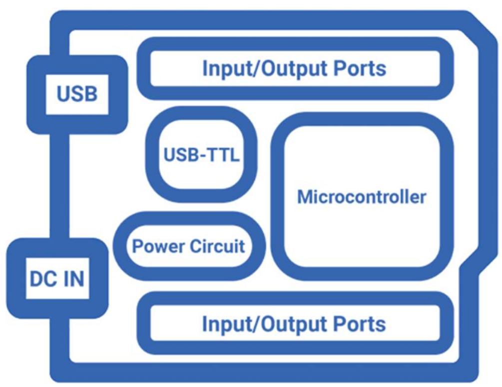

Figure 3.1: Block Diagram

3.3 Description of each block

3.3.1 Central processing unit

The processing unit is the main part of this project. The function CPU of the is to store I/O modules, the peripheral device, and run diagnostics. It is essentially the "brains" of this project.

3.3.1.1 Component used in the central processing unit

1) Arduino Uno
2) Arduino Cable
3) Power Supply DC 5v 1 Amp
4) Male Female jack

Component descriptions of the central processing unit are below-

1) Arduino Uno

The Arduino Uno is an open-source microcontroller board based on the Microchip ATmega328P microcontroller. The board is equipped with sets of digital and analog input/output pins that may be interfaced to various expansion boards and other circuits.

Figure 3.2: Arduino Uno

2) Arduino Cable

Arduino Cable UNO/MEGA (USB A to B)-1 foot, you can use it to connect “Arduino Uno”, “Arduino Mega 2560″, or any board with the USB female A port of your computer. Cable length is approximately 30 cm. Cable color and shape may vary slightly from an image as our stock rotates.

Figure 3.3: Arduino Cable

This is a standard-issue USB 2.0 cable. the kind that's usually used for printers, Arduino, etc. Compatible with most SFE-designed USB boards as well as USB Arduino boards like the Uno.

3) Power Supply

Electrical supply is used in bringing electrical energy to the central processing unit. Most of the Arduino boards can operate at 5 volts which can be provided to the board by the USB port. Similarly, power supplies can be used when Arduino is to operate in independent mode.

Most of the Arduino boards can operate at 5 volts and that can be provided to the board by the USB port. Similarly, power supplies can be used when Arduino is to operate in independent mode.

Figure 3.4: Power Supply

4) Male to Female HQ jumper

A male connector is commonly referred to as a plug and has a solid pin for a center conductor. A female connector is commonly referred to as a jack and has a center conductor with a hole in it to accept the male pin.

Figure 3.5: Male to Female Jack

3.3.2 Control unit

The Control unit is the controlling part of the project. All switching and input signals are provided in the control unit and control the output of this project. This unit consists of different types of components and materials on this project basis. It provides the controlling signal through the Arduino Uno.

3.3.2.1 Component used in the control unit

1) Battery
2) Digital Amp Volt meter
3) Capacitor
4) Diode
5) Resistor
6) Variable Resistor
7) Voltage Regulator IC LM7805
8) Timer IC 555
9) LED
10) Breadboard

Component descriptions of the control unit are below-

1) Battery

An electric battery is a source of electric power consisting of one or more electrochemical cells with external connections for powering electrical devices. When a battery is supplying power, its positive terminal is the cathode and its negative terminal is the anode.

Figure 3.6: Battery

2) Digital Amp Volt Meter

A digital ammeter is an instrument that measures the flow of an electrical current in a circuit. The measurements are given in amperes, the unit for measuring electrical current. Power Distribution Units (PDUs) distribute power to multiple devices through a single electrical source.

Figure 3.7: Digital Amp Volt Meter

3) Capacitor

A capacitor is a passive two-terminal electrical component that stores electrical energy in an electric field. The effect of a capacitor is known as capacitance. While capacitance exists between any two electrical conductors of a circuit in sufficiently close proximity, a capacitor is specifically designed to provide and enhance this effect for a variety of practical applications by considering of size, shape, and positioning of closely spaced conductors, and the intervening dielectric material. In this project, we use two capacitors one is rated by 1000 µF and another is .01 µF which offers high efficiency for buffer, bypass, and coupling applications.

Figure 3.8: Capacitor

4) Diode

The most common function of a diode is to allow an electric current to pass in one direction while blocking it in the opposite direction (the reverse direction). As such, the diode can be viewed as an electronic version of a check valve. This unidirectional behavior is called rectification and is used to convert alternating current (AC) to direct current (DC). In this project, we use two diodes. one is SR560 which is used in the power supply to convert A.C to D.C. Another diode which is IN4007 which is used for safety purposes for a voltage regulator.

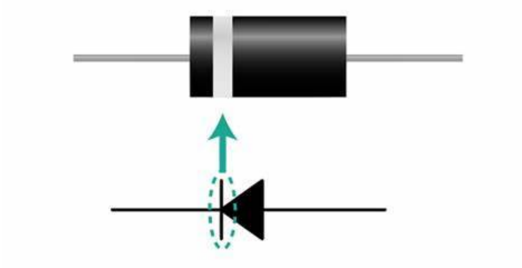

Figure 3.9: Diode

5) Resistor

A resistor is a passive two-terminal electrical component that implements electrical resistance as a circuit element. Resistors act to reduce current flow, and, at the same time, act to lower voltage levels within circuits. In electronic circuits, resistors are used to limit current flow, adjust signal levels, bias active elements, and terminate transmission lines among other uses. High-power resistors that can dissipate many watts of electrical power as heat may be used as part of motor controls, in power distribution systems, or as test loads for generators. In this project, we use a resistor rated by 560E 10K protection.

Figure 3.10: Resistor

6) Variable Resistor

A variable resistor is a resistor of which the electric resistance value can be adjusted. A variable resistor is in essence an electro-mechanical transducer and normally works by sliding a contact (wiper) over a resistive element. When a variable resistor is used as a potential divider by using 3 terminals it is called a potentiometer. When only two terminals are used, it functions as a variable resistance and is called a rheostat.

Figure 3.11: Variable Resistor

7) Voltage Regulator IC LM7805

A voltage regulator is designed to automatically maintain a constant voltage level. A voltage regulator may be a simple "feed-forward" design or may include negative feedback control loops. It may use an electromechanical mechanism or electronic components. Depending on the design, it may be used to regulate one or more AC or DC voltages. Electronic voltage regulators are found in devices such as computer power supplies where they stabilize the DC voltages used by the processor and other elements. There are common configurations for 78xx ICs, including 7805 (5 V) , 7806 (6 V) , 7808 (8 V) , 7809 (9 V) , 7810 (10 V) , 7812 12 V) , 7815 (15 V) , 7818 (18 V) , and 7824 (24 V) versions . In this project, we use IC LM 7805 to regulate voltage which provided the output of 5V.

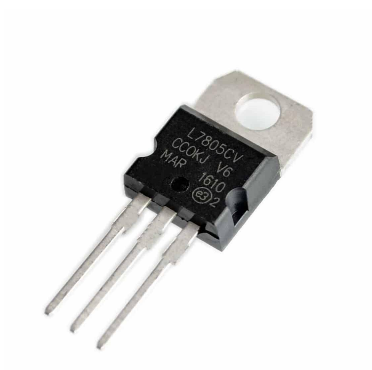

Figure 3.12: Voltage Regulator IC

8) Timer IC 555

The 555 timer IC is an integrated circuit (chip) used in a variety of timer, delay, pulse generation, and oscillator applications. Derivatives provide two (556) or four (558) timing circuits in one package. act as either a simple timer to generate single pulses or long-time delays or as a relaxation oscillator producing a string of stabilized waveforms of varying duty cycles from 50 to 100%.

Figure 3.13: Timer IC

9) LED

A light-emitting diode (LED) is a two-lead semiconductor light source. It is a p - n junction diode, which emits light when activated. When a suitable voltage is applied to the leads, electrons are able to recombine with electron holes within the device, releasing energy in the form of photons. This effect is called electroluminescence, and the color of the light (corresponding to the energy of the photon) is determined by the energy band gap of the semiconductor. An LED is often small in area (less than 1 mm2) and integrated optical components may be used to shape its radiation pattern.

Figure 3.14: LED

10) Breadboard

A breadboard (sometimes called a plug block) is used for building temporary circuits. It is useful to designers because it allows components to be removed and replaced easily. It is useful to the person who wants to build a circuit to demonstrate its action, then reuse the components in another circuit.

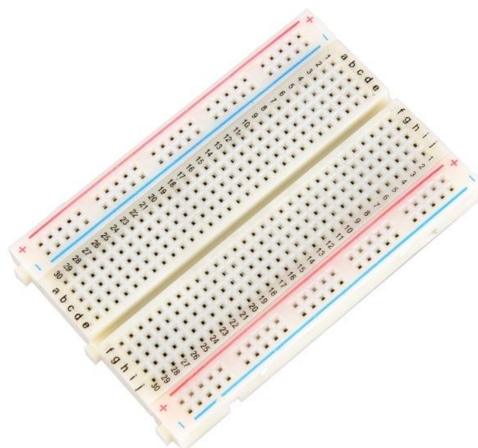

Figure 3.15: Breadboard

3.3.3 Solar unit

Solar units convert sunlight into electrical energy either through photovoltaic (PV) modules or through mirrors that concentrate solar radiation. In remote areas, the sun is a cheap source of electricity because instead of hydraulic generators it uses solar cells to produce electricity. The Sun tracking solar panel consists of two LDRs, a solar panel, a servo motor, and an ATmega328 Microcontroller.

3.3.3.1 Component use in solar unit

1) Solar
2) LDR
3) Servo motor
4) Plastic Sheet
5) Connecting Wire
6) Nut-Bolt

Component descriptions of the solar unit are below-

1) Solar

Solar technologies convert sunlight into electrical energy either through photovoltaic (PV) panels or through mirrors that concentrate solar radiation. This energy can be used to generate electricity or be stored in batteries or thermal storage.

Figure 3.16: Solar

2) LDR

Light Dependent Resistors (LDR), are light-sensitive devices most often used to indicate the presence or absence of light or to measure the light intensity. In the dark, their resistance is very high, sometimes up to 1 MΩ, but when the LDR sensor is exposed to light, the resistance drops dramatically, even down to a few ohms, depending on the light intensity. LDRs have a sensitivity that varies with the wavelength of the light applied and are nonlinear devices.

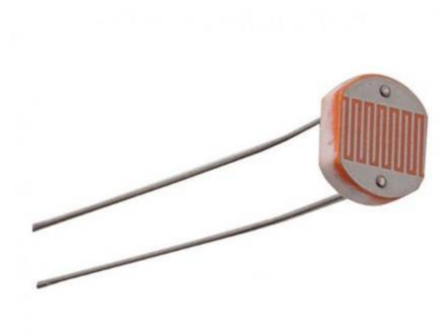

Figure 3.17: LDR

3) Servo Motor

A servomotor is a rotary actuator or linear actuator that allows for precise control of angular or linear position, velocity, and acceleration. It consists of a suitable motor coupled to a sensor for position feedback. It also requires a relatively sophisticated controller, often a dedicated module designed specifically for use with servomotors.

Figure 3.18: Servo Motor

4) Plastic Sheet

In this project, we used a plastic sheet to carry the pump motor and provided protection from insects and water.

Figure 3.19: Plastic Sheet

5) Nut-Bolt

The bolt consists of a head and a cylindrical body with screw threads along a portion of its length. The nut is the female member of the pair, having internal threads to match those of the bolt.

Figure 3.20: Nut-Bolt

6) Connecting Wire

Connecting wires allows an electrical current to travel from one point on a circuit to another because electricity needs a medium through which it can move. Most of the connecting wires are made up of copper or aluminum.

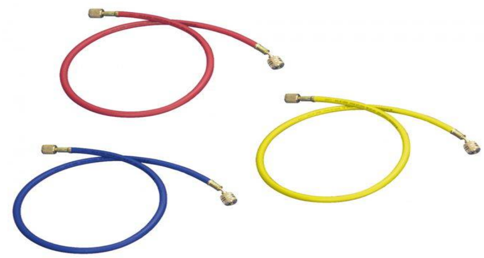

Figure 3.21: Connecting Wire

3.4 Hardware Design

The solar tracking system is done by first receiving analog input values from LDRs. Input values received from the sensors are then processed by the Arduino UNO R3 microcontroller, which it will convert the analog values into digital signals using an internal Analog to Digital converter. The digital PWM pulse is applied to move the servo motor and it will change the direction of the solar panel to the position of LDR which captured maximum light intensity. The position of LDR is divided into four positions, which are top-left, top-right, bottom-left, and bottom-right. Figure 1 shows the block diagram for the solar tracking system.

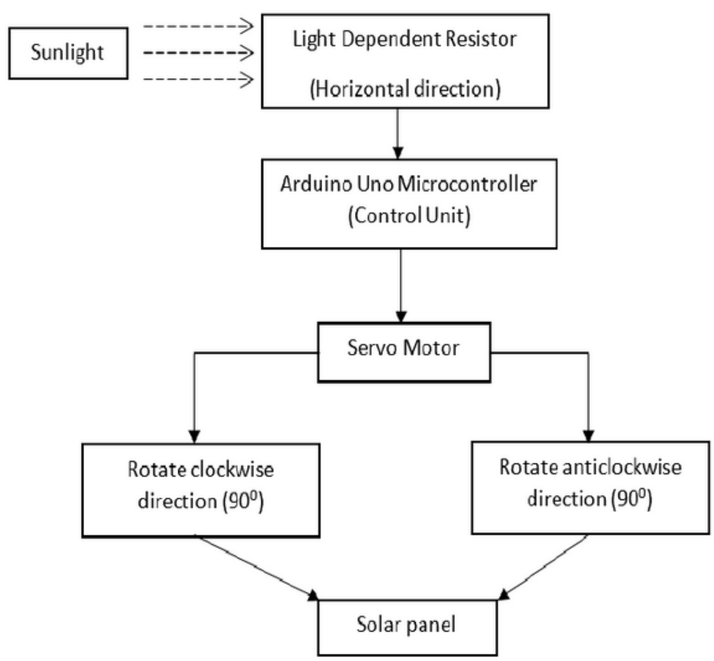

Figure 3.22: Blok diagram of solar tracking system

3.5 Software Implementation

After the completion of hardware design, this project proceeds with software implementation. This section explained the circuit design of the solar tracking system by using LDR inputs to control the rotation of the servo motor. As mentioned earlier, this circuit consists of an Arduino UNO R3 microcontroller, 4 units of LDR, 4 units of 10 kΩ resistors, and 2 servo motors.

3.6 Algorithm of solar tracking system

The algorithm is constructed using Arduino programming. After the microcontroller receives the digital signals from ADC, then it will proceed to compute the average voltage of the corresponding LDR pairs.
The average value computed is used to determine what control signal send to the servo motor. Equations 1 and 4 show the average method that needs to be utilized.

$$\text{The average value of the top part, Avg1} = \frac{Top\ left + Top\ right}{2}$$

$$\text{The average value of the bottom part, Avg2} = \frac{Bottom\ left + Bottom\ right}{2}$$

$$\text{The average value of the left part, Avg3} = \frac{Top\ left + Bottom\ left}{2}$$

$$\text{The average value of the right part, Avg4} = \frac{Top\ right + Bottom\ right}{2}$$

3.7 Program

```
#include <Servo.h>

//defining Servos

Servo servohori;

int servoh = 0;

int servohLimitHigh = 160;

int servohLimitLow = 20;


Servo servoverti;

int servov = 0;

int servovLimitHigh = 160;

int servovLimitLow = 20;

//Assigning LDRs

int ldrtopl = 2; //top left LDR green

int ldrtopr = 1; //top right LDR yellow
```

```
int ldrbotl = 3; // bottom left LDR blue
int ldrbotr = 0; // bottom right LDR orange

 void setup ()
 {
  servohori.attach(10);
  servohori.write(0);
  servoverti.attach(9);
  servoverti.write(0);
  delay (500);
 }
void loop ()
{
  servoh = servohori.read();
  servov = servoverti.read();
  //capturing analog values of each LDR
  int topl = analogRead(ldrtopl);
  int topr = analogRead(ldrtopr);
  int botl = analogRead(ldrbotl);
  int botr = analogRead(ldrbotr);
  // calculating average
  int avgtop = (topl + topr) / 2; //average of top LDRs
  int avgbot = (botl + botr) / 2; //average of bottom LDRs
  int avgleft = (topl + botl) / 2; //average of left LDRs
  int avgright = (topr + botr) / 2; //average of right LDRs

  if (avgtop < avgbot)
  {
    servoverti.write(servov -1);
    if (servov > servovLimitHigh)
     {
      servov = servovLimitHigh;
```

```
   }
  delay (10);
}
else if (avgbot < avgtop)
{
  servoverti.write(servov +1);
  if (servov < servovLimitLow)
{
  servov = servovLimitLow;
}
  delay(10);
}
else
{
  servoverti.write(servov);
}

if (avgleft > avgright)
{
  servohori.write(servoh +1);
  if (servoh > servohLimitHigh)
   {
  servoh = servohLimitHigh;
   }
  delay (10);
}
else if (avgright > avgleft)
{
  servohori.write(servoh -1);
  if (servoh < servohLimitLow)
    {
   servoh = servohLimitLow;
```

```
    }
   delay (10);
  }
  else
  {
   servohori.write(servoh);
  }
  delay (50);
}
```

CHAPTER 04

RESULT AND DISCUSSION

4.1 Arduino Uno interfacing

After uploading the program, the Arduino need to be interfacing after interfacing with a computer with the Arduino device displaying the following image. It means that the uploading program is successful.

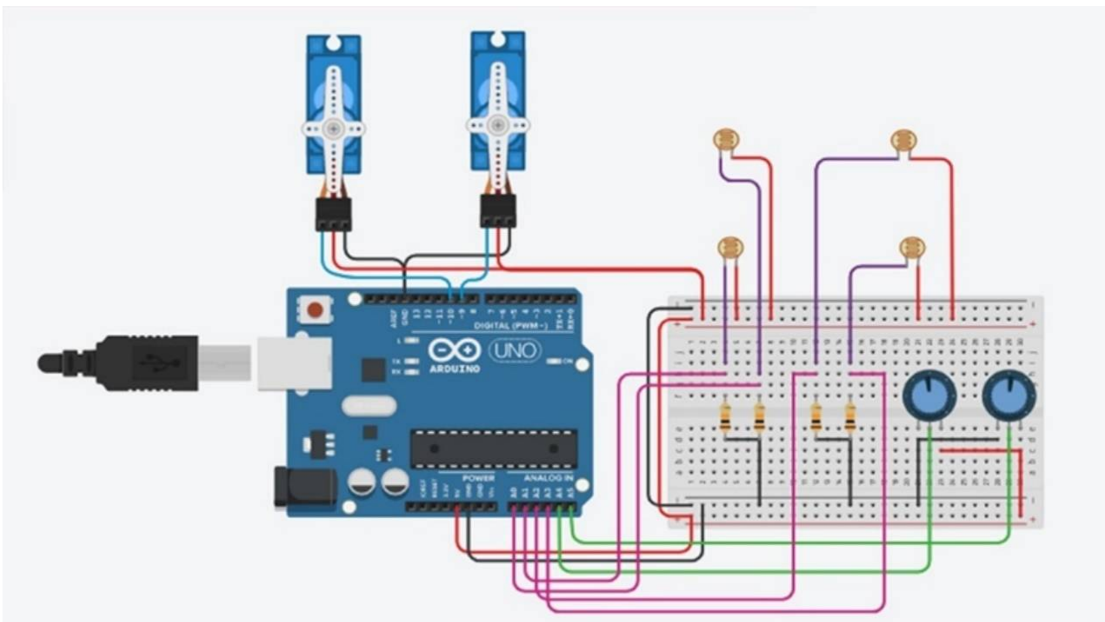

Figure 4.1: Interfacing Arduino Uno

4.2 Project Overview

This is the basement of the total system fig 4.1. There is a servo motor in this basement that controls the soar’s left-right movement.

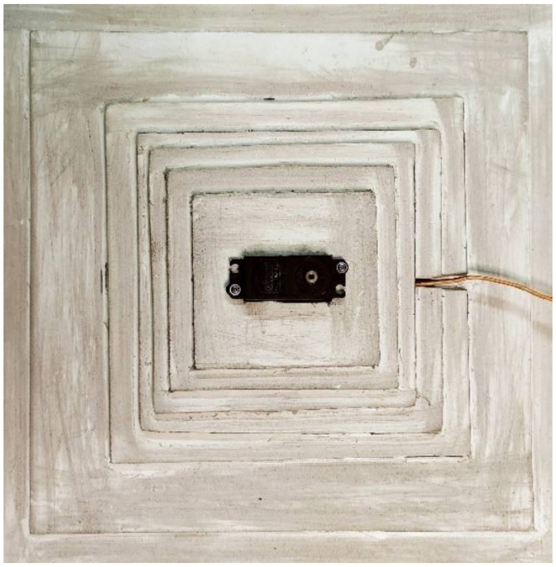

Figure 4.2: Basement with servo motor

This Frame controls the soar’s up-down movement figure 4.2

Figure 4.3: Solar Rotate Frame

The solar panel absorb the sunlight energy fig 4.4

Figure 4.3: Solar panel

This is the overview of the project figure 4.5. The whole project divided with three parts-control unit, processing unit, and solar unit.

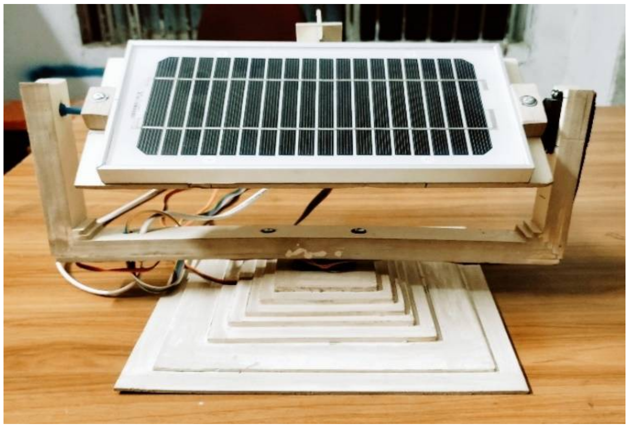

Figure 4.5: Project Overview

4.3 Result of this project

Time (Hours)	Static Solar Panel			Solar Panel with a tracking mechanism		
	Voltage (v)	Current (I)	Power (p)	Voltage (v)	Current (I)	Power (p)
9.00 am	4.40	0.63	2.8	4.90	0.65	3.2
10.00 am	5.00	0.66	3.3	5.60	0.67	3.8
11.00 am	5.47	0.73	4	6.12	0.65	4.0
12.00 pm	6.52	0.64	4.2	6.52	0.66	4.3
1.00 pm	6.83	0.64	4.4	6.83	0.65	4.4
2.00 pm	6.52	0.62	4.1	6.54	0.64	4.3
3.00 pm	5.29	0.60	3.2	6.03	0.62	3.7
4.00 pm	4.21	0.64	2.71	5.72	0.59	3.4
5.00 pm	4.03	0.29	1.2	4.85	0.52	2.5
Total Power = 29.91 Average Power = 3.32				Total Power = 33.6 Average Power = 3.73		

Table 41: Comparison of output values between the static solar panel and solar panel with a tracking mechanism

4.4 Cost Analysis

To carry out this project, some things were put into consideration. Among those things include the cost of components used for the construction was the priority. The following table shows that, the components that are used in the project construction, the quantity, and also the price of each component.

Table: 4.2: Price List

Name	Quantity	Price (BD)
Solar	1p	700/-
Battery	1p	700/-
Arduino Uno	1p	1100/-
Servo motor	2p	750/-
Digital Amp Volt meter	1p	300/-
LDR	4p	60/-
Capacitor-1000 µF -50V	1p	25/-
Capacitor-0.1 µF -25V	1p	05/-
Diode-1N4007-1000V-1A	2p	05/-
Resistor-10k	4p	05/-
Resistor-8k	1p	05/-
Resistor-560E	1p	05/-
Variable Resistor	1p	30/-
LED	6p	10/-
IC LM7805	1p	20/-
Timer IC 555	1p	40/-
Glue Stick	1p	75/-
Plastic Sheet	12 sq ft	450/-
Breadboard	1p	250/-
Nut-Bolt	10p	36/-
super strong	5p	125/-
Soldering lead	50 g	60/-
Switch	1p	20/-
male female connector	14p	50/-
Connecting wire	5 ft	45/-
Others		500/-
	Total cost	5371/-

4.5 Feasibility Study

Currently, PV module costs are manageable for investment. Sun tracking and cooling of PV modules could be applied to decrease investment costs. For that, we could reduce the number of man manpower though it is an expensive system to effort some business industries it reduces production cost to make a product. So, it is also helpful for our industrial economics.

CHAPTER 05

CONCLUSION AND RECOMMENDATION

5.1 Conclusion

The Sun Follower supports impoverished communities in meeting their need for both electricity and clean water. Using the weight displacement of water passing through the filter, a Sun Follower rotates solar panels throughout the day, to optimize energy by up to 40 percent. Now a family that struggled with limited electricity and insufficient clean water has both. From the design of experimental setup with Solar tracking system using a dead weight. If we compare tracking using mass imbalance with a fixed solar panel system, we predicted that the efficiency of the solar tracking system is improved by 30- 40% and it was found that all the parts of the experimental setup are given good results. Moreover, this tracking system does track the sun in a continuous manner. And this system is more efficient and low-cost effective in long run.

From the result, it is found that, with the automatic tracking system, there is a 30% gain in increased efficiency when compared with the non-tracking system. Even purification of water can be achieved.

5.2 Limitation of the work

A drastic environmental change cannot be tolerated by the equipment. Due to a lack of money, we use a small motor with a small torque value for the panel size.

5.3 Future scope

The goals of this project were purposely kept within what was believed to be attainable within the allotted timeline. As such, many advanced improvements can be made up to the initial design of the solar tracker. It is felt this design represents a functioning scale model which could be replicated on a much larger scale. The following recommendations are provided as ideas for the future expansion of this project.

- We can use wood and other locally available materials instead of Mild steel and thus reduce the cost further.
- A spring of appropriate stiffness could be designed to avoid sudden jerks.
- Provisions for the safety of solar panels from rain.
- More accuracy can be achieved by providing measures against wind vibrations

5.4 Recommendation

I recommend that government should set up industries for the production of basic electronic components locally and establish research centers in each university to enable students to have good sound practical knowledge of electronics and their operation.

References:

[1] **www.google.com**

[2] **https://www.arduino.cc/en/Guide/ArduinoUno**

[3] **https://create.arduino.cc/projecthub/336271/arduino-solar-tracker-41ef82**

[4] **https://theiotprojects.com/dual-axis-solar-tracker-arduino-project-using-ldr-servo-motors/**

[5] **https://en.wikipedia.org/wiki/Solar_tracker**

[6] **https://create.arduino.cc/projecthub/DemetrisEng/solar-tracker-35w-with-dc-motors-1b5ac6**