Automatic Dual Axis Solar Tracking System

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Declaration

We do hereby solemnly declare that the work presented in this report entitled **"Automatic Dual Axis Solar Tracking and cleaning system"** has been carried out by us not been previously submitted to any other university, College or Organization for an academic qualification Certificate or diploma/degree.

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First, we started with in the name of almighty Allah. This thesis is accomplished under the supervisor of Md. Minhaz Uddin, Assistant Professor, Department of Mechanical Engineering, Sonargaon University. It is a great pleasure to acknowledge our profound gratitude and respect to our supervisor for this consistent guidance, encouragement, helpful suggestion, constructive criticism and endless patience through the progress of this work. The successful completion of this thesis would not have been possible without his persistence motivation and continuous guidance.

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Abstract

The Dual Axis Solar Tracking System (DASTS) is a cutting-edge technology designed to optimize solar energy capture by continuously orienting solar panels in two dimensions, azimuth and elevation, to follow the path of the sun throughout the day. This abstract provides an overview of the DASTS, highlighting its key features and benefits. The DASTS incorporates precision sensors, motors, and a control algorithm to accurately position solar panels for maximum exposure to sunlight. Unlike fixed solar installations, this dynamic system significantly enhances energy generation, increasing overall efficiency and reducing dependency on fossil fuels. By tracking the sun's movement from east to west and up and down the horizon, the DASTS maximizes energy capture, increasing overall energy output compared to static solar panels. Increased energy production leads to reduced electricity bills and a quicker return on investment for solar installations, making renewable energy more economically viable. The DASTS helps reduce greenhouse gas emissions and dependence on non-renewable energy sources, contributing to a more sustainable and environmentally friendly future. The DASTS is adaptable for various solar installations, from residential rooftops to large-scale solar farms, making it suitable for a wide range of applications. In summary, the Dual Axis Solar Tracking System represents a significant advancement in solar energy technology, offering a more efficient and environmentally friendly approach to harnessing solar power. Its ability to continuously track the sun's position ensures optimal energy generation, making it a promising solution for a sustainable energy future.

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CHAPTER 1

INTRODUCTION

1.1 Introduction

Finding energy sources to satisfy the world's growing demand is one of the foremost challenges for the next half century. Over the recent years, greenhouse effect has caused global warming and irregular climate changes. To generate electricity, few countries still depend on fossil fuels which produce greenhouse gases that can severely impact human and wildlife population. Environmental pollution and rising cost of the fossil fuels around the globe rouse individuals to concentrate on renewable energy sources. As per scientific predictions, the consumption of fossil fuels will decrease by 80% and of non-fossil fuels will increase by 50% within a period of 30 years. Statistics has shown that available fossil fuels will deplete by 2080. Thus, the primary energy source has to be non-convention sources [2].

The earth receives 16x1018 units of energy from the sun annually, which is 20,000 times the requirement of mankind on earth. On a sunny day, energy radiated from the sun is about 1 kW/m2. As mentioned in, "the International Energy Agency predicts that approximately one-quarter of the renewable power, or 11% of worldwide electricity, could be supplied from solar energy in 2050."

This paper, therefore, aims to optimize the harnessing of solar energy by designing and developing an automatic microcontroller-based solar tracker with a hybrid algorithm that can locate the precise sun's position. Experiments were conducted to evaluate the proposed solar tracker's performance under local climate. To facilitate timely monitoring of solar data, a webpage was also developed [4].

1.2 Method

PV solar trackers adjust the direction that a solar panel is facing according to the position of the Sun in the sky. By keeping the panel perpendicular to the Sun, more sunlight strikes the solar panel, less light is reflected, and more energy is absorbed. That energy can be converted into power.

There are two types of solar tracking systems: single-axis and dual-axis. A single-axis tracker moves your panels on one axis of movement, usually aligned with north and south.

These setups allow your panels to arc from east to west and track the sun as it rises and sets.

There are two main solar tracking systems types that depending on their movement degrees of freedoms are single axis solar tracking system and dual axis solar tracking system, which are addressed in the recent studies.

A single-axis tracker moves or adjusts the solar panels by rotating around one axis. Its movement is usually aligned in North and South directions. This device enables the PV panels to move in the direction of the sun as it rises and sets, i.e., from East to West.

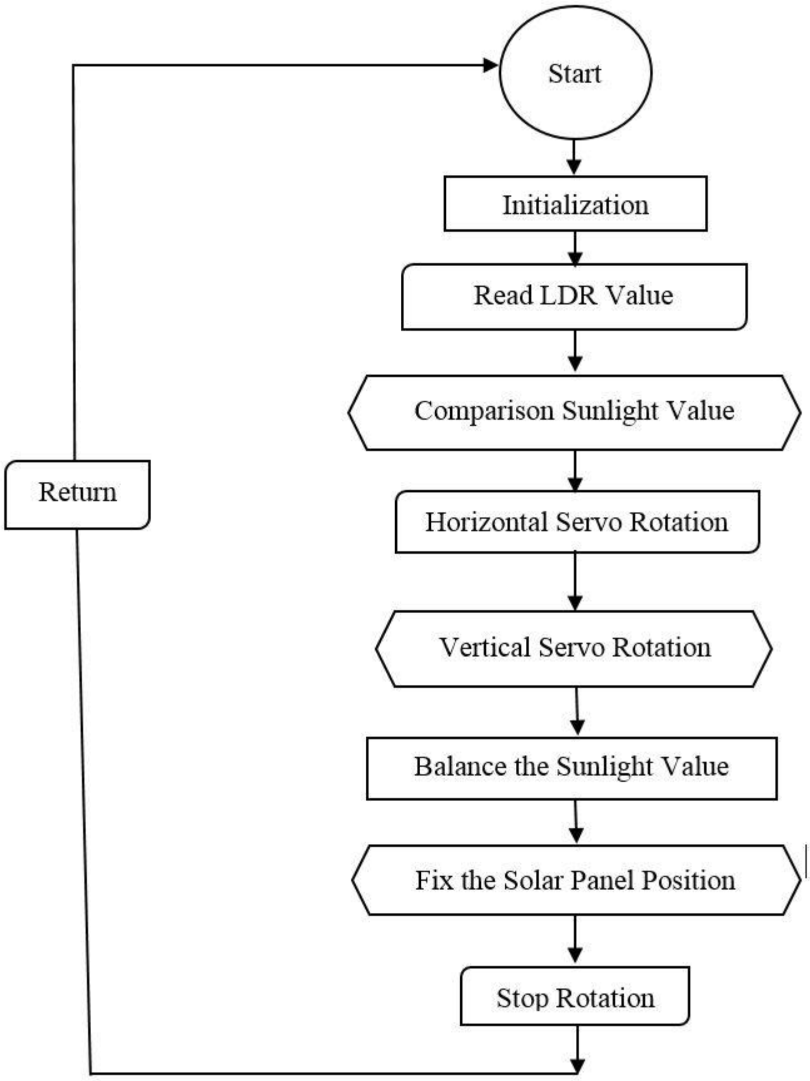

Figure 1.1: Flow Chart

1.3 Background

Early in the 21century, Nuwayhid et al. (2001) adopted the open-loop and closed-loop tracking methods into a parabolic concentrator attached in a polar tracking system In 2004, Abdallah and Nijmch designed a two axis sun tracking system, a programmable logic controller (PLC) was used to calculate the solar vector and to control the sun tracker so that it follows the sun's trajectory

In addition, Shanmugam & Christraj (2005) presented a computer program written a Visual Basic that is capable of determining the sun's position and thus drive a paraboloidal dish concentrator (PDS) along the east-west asis or north-south axis for receiving maximum solar radiation.

In 2007, Ali Al-Mohamad designed a Sun-tracking system, whereby the movement of a photovoltaic module was controlled to follow the Sun's radiation using a programmable logic-controller (PLC) unit

In 2008, Mohanad Alata, M.A. Al-Nimr and Yousef Qaush demonstrated the design and simulation of time controlled step son tracking systems

In Rajshahi University of engineering & Technology a project was done by Md. Rokunuzzaman whereby the movement of a photovoltaic module was controlled to follow the Sun's radiation using a CMOS logical circuit [6].

1.4 Objectives

The objectives of a dual-axis solar tracking system are to maximize the efficiency and energy output of solar panels by precisely orienting them to follow the sun's position throughout the day. This tracking system aims to achieve several goals:

Increased Energy Generation: By continuously adjusting the orientation of solar panels along both the horizontal (azimuth) and vertical (elevation) axes, a dual-axis tracking system ensures that the panels receive optimal sunlight exposure, resulting in higher energy production.

Maximizing Energy Harvesting: Dual-axis tracking allows solar panels to capture sunlight at near-perpendicular angles, reducing the angle of incidence and increasing the amount of energy harvested from the sun.

Seasonal and Daily Adaptation: This system accommodates changes in the sun's position throughout the day and across seasons, ensuring that panels are always aligned for collect proper sun ray.

CHAPTER 2

LITERATURE REVIEW

2.1 Introduction

The paucity of available resources has forced contemporary society to look for measures to consummate the demands of the latter. With the nurturing civilization, the depletion of conventional fuels, due to human practices has been an alarm to sustainable development issues. The scarcity of energy and its source guided us towards the optimistic approach of using the alternative resources bestowed to humankind–Solar, tidal etc.

The Sun has been looked upon as an imperative source of energy. Solar energy is an eco-friendly resource as compared to its counterparts. The advancement of technology has out-turn foster techniques to utilize this energy into its own good use. Be it as thermal energy, electricity, fuel production and many more. Photovoltaic or concentrated solar power (CSP) systems are operated to transfigure the solar power expropriated by the earth into electricity. Solar tracking device utilizes this expropriated solar power through the channel of photovoltaic arrays, an oriented scaffolding of photovoltaic/solar cells.

Solar cells, also known as photovoltaic cells are used to convert light energy into electricity. Photovoltaic cells work on the principle of the photovoltaic effect, which is similar to the photoelectric effect. Differences being that the electrons in photovoltaic are not emitted instead contained in the material around the surface, creating a voltage difference. Solar cells are forged with crystalline silicon. It is the most commonly used material in a solar cell. The use of silicon in the solar cell has been very efficient and low cost. Two forms of crystalline silicon can be used to make solar cells. Other than silicon, solar cells can be fabricated with cadmium telluride (CdTe), Copper indium gallium (di)selenide (CIGS) etc. the fabrication of solar cells with materials other silicon is slightly expensive, thus making silicon the best material to be used in solar tracking systems.

One of the finest and extensively used material, monocrystalline silicon has an efficiency of about 15-20%. While under high temperature the performance of the cell material drops by 10-15% of the initial [1].

Polycrystalline silicon is another form, cheaper than the latter but has the same band gap as that of monocrystalline silicon. Though it has the same band gap energy, it lags in efficiency, hence this material is used in low-cost products.

Amorphous silicon cells can work under extremely high temperatures, but the efficiency of these cells is comparatively lower than the other silicon forms.

The technologies which use CdTe, CIGS, Amorphous Thin-Film Silicon (a-Si, TF-Si) in the fabrication of solar cells are known as thin film photovoltaic modules. These thin-film solar cells are relatively cost-effective than the solar cells of crystalline silicon.

There are several other factors on which the efficiency of a solar cell depends.

- Cell temperature
- Energy Conversion Efficiency
- Maximum power point tracking

Solar panels are a cumulative orientation of photovoltaic cells. The PV cells are arranged in a solar panel or a PV array such that is serves the purpose of exciting the electron of the material consisting inside the solar cells using photons. The average amount of sunlight received by solar panels particular depends on the position of the sun.

Being a repository of energies, Sun witnessed to be the eminent and ever continuing source of emitting radiation from it. A part of this source of natural energy is received by the solar panel. Certain ways have been developed to utilize this energy source as an alternative to other nonrenewable sources. Considering its multitudinous flourishing ways in which it can be applied to bring about the change in conserving other resources, the manipulation of the energy source is encouraged.

Solar panels are hence used to utilize solar power in electrical means. They are aligned different arenas to collect maximum solar power. Though, solar panels can be used to absorb or collect solar power, there work is bounded to certain hours of the day and the sunlight pouring directly on them, i.e. the angle between the sunrays and the panel is orthogonal. While at other hours of the day, the angle of the sunrays is different, hence the amount of the solar power captured is very less.

To overcome such pitfalls, and encapsulate the maximum available of solar energy the solar tracking systems were introduced. A solar tracking system is designed with the intention of keeping the angle between the sunrays and the solar array 90°.

The solar tracking system have three different modules-

- The mechanism
- Driving motors
- The tracking controller.

The mechanism is accountable to furnish with accurate movements, in the sake of following the footsteps of the sun throughout the day. The prototype of the device is made durable enough to withstand unfavorable weather condition. This mechanism of the solar tracking systems classifies themselves into two segments single axis tracker, dual axis tracker.

Single axis tracking can be considered as one of the handy systems or prime solution in terms of small-scale photovoltaic power plants. Single axis tracking can be done using three different arrangements, which are based on the different axes of tracking-

- Inclined shaft installation
- South-North axis horizontal installation
- East-West axis horizontal installation.

Single axis tracker tracks in a single cardinal direction. The tracker has a single row tracking configuration. The above maintained methods are the different arrangements in which single axis tracker can be implemented. The working mechanism of all the maintained methods is at par with each other. The angle of the sun with the surface of the collector is computed and examined, the collectors are thus charged to track down the movement of the sun to meet the expectations of captivating a greater percentage of solar radiance.

There are numerable other imposition of single axis tracking tracker, including-

- Horizontal Single Axis Tracker (HSAT)
- Horizontal Single Axis Tracker with Tilted Module (HTSAT)
- Vertical Single Axis Tracker (VSAT)
- Tilted Single Axis Tracker (TSAT)
- Polar Aligned Single Axis Tracker (PSAT)

The rotational axis in the dual axis tracker are orthogonal to each other. One of the axes is fixed in accordance with the ground level. This axis is known as the primary axis and the other axis is hence called the secondary axis. Dual axis trackers moved along two cardinal directions, horizontal and vertical. There are many applications of the dual axis tracker, the two most common being-

- Tip-Tilt Dual Axis Tracker

- Azimuthal Altitude Dual Axis Tracker.

The efficiency of these tracker is much more than any single axis tracker. It conventionally follows the movement of the un and hence captivates maximum solar energy.

On the basis of the driving mechanism solar trackers can again be of two kinds active solar trackers and passive solar trackers. The mechanism which makes use of electric motors such as DC motor, can be termed as active driving mechanism. The passive ones are simply controlled by the movement of the earth that is the gravitational forces.

Solar tracking controller can also categories solar trackers into two different module-

1. Open loop control- The approach followed requires microprocessor. This method has a inbuild prototype which is based upon the records of the movement of sun throughout the day. Hence, the microcontroller computes the time and determines the position of the sun at that particular hour. The control system is not affected by any geographical conditions.
2. Closed loop control/Feedback controllers- This control system utilizes photo sensor to compare the light intensity. These sensors are fixtures at the side of panel and helps in detection of the position of the sun.

The prototype used in this research, is that of a horizontal single axis tracker. The tracking system utilizes photosensitive sensors to track down the movement or the path of the sun. This type of tracking technique is classified as active solar tracking. It is based on feedback control system or closed loop controlling. The intensities of light in our system are compared and the solar panel is charged to move in the direction of maximum available intensity. Thus, the system works on the feedback of the weather condition

2.1.1 Effect of light intensity

Variation in the intensities of light plays a significant role in depicting the amount of power output. This change in intensities monitors all the technical criterions such as voltage, circuit current, efficiency, shunt resistance etc. As a result, higher the intensities of light, greater is the power output.

2.2 Summary

Here, we go over the specifics of how to use Automatic 360 Degree Solar Tracking and cleaning system. This method makes it simple to make sure. This device is simple and inexpensive to use. Each device's function is described below, along with what each device does before and after it.

CHAPTER 3

DESIGN

3.1 Required Components

Table I: Component List

S/L	Components Name	Quantity
01	Aurdiuno Nano	1
02	SMPS 5V-5A	1
03	Servo Motor (MG996r)	2
04	Solar Panel	1
05	Battery	3
07	Switch	1
09	LDR	4
10	Light	1

3.1.1 Arduino Nano

The Arduino Nano is a small, complete, and breadboard-friendly board based on the ATmega328P released in 2008. It offers the same connectivity and specs of the Arduino Uno board in a smaller form factor.

The Arduino Nano is equipped with 30 male I/O headers, in a DIP-30-like configuration, which can be programmed using the Arduino Software integrated development environment (IDE), which is common to all Arduino boards and running both online and offline. The board can be powered through a type-B mini-USB cable or from a 9 V battery.

In 2019, Arduino released the Arduino Nano Every, a pin-equivalent evolution of the Nano. It features a more powerful ATmega4809 processor and twice the RAM.

Figure 3.1: Aurdiuno Nano

Technical specifications

- Microcontroller: Microchip ATmega328P
- Operating voltage: 5 volts
- Input voltage: 5 to 20 volts
- Digital I/O pins: 14 (6 optional PWM outputs)
- Analog input pins: 8
- DC per I/O pin: 40 mA
- DC for 3.3 V pin: 50 mA
- Flash memory: 32 KB, of which 2 KB is used by boot loader
- SRAM: 2 KB
- EEPROM: 1 KB
- Clock speed: 16 MHz
- Length: 45 mm
- Width: 18 mm
- Mass: 7 g
- USB: Mini-USB Type-B
- ICSP Header: Yes
- DC Power Jack: No

Communication

The Arduino Nano has a number of facilities for communicating with a computer, another Arduino, or other microcontrollers. The ATmega328 provide UART TTL (5V) serial communication, which is available on digital pins 0 (RX) and 1 (TX). An FTDI FT232RL on the board channels this serial communication over USB and the FTDI drivers (included with the Arduino software) provide a virtual com port to software on the computer. The Arduino software includes a serial monitor which allows simple textual data to be sent to and from the Arduino board. The RX and TX LEDs on the board will flash when data is being transmitted via the FTDI chip and USB connection to the computer (but not for serial communication on pins 0 and 1). A SoftwareSerial library allows for serial communication on any of the Nano's digital pins. The ATmega328 also support I2C and SPI communication. The Arduino software includes a Wire library to simplify use of the I2C bus.

Automatic (software) reset

Rather than requiring a physical press of the reset button before an upload, the Arduino Nano is designed in a way that allows it to be reset by software running on a connected computer. One of the hardware flow control lines (DTR) of the FT232RL is connected to the reset line of the ATmega328 via a 100 nanofarad capacitor. When this line is asserted (taken low), the reset line drops long enough to reset the chip.

This setup has other implications. When the Nano is connected to a computer running Mac OS X or Linux, it resets each time a connection is made to it from software (via USB). For the following half-second or so, the bootloader is running on the Nano. While it is programmed to ignore malformed data (i.e. anything besides an upload of new code), it will intercept the first few bytes of data sent to the board after a connection is opened.

3.1.2 SMPS 5V

The use of switched mode power supplies eliminates the drawbacks of linear power supplies, including their poorer efficiency, necessity for large-value capacitors to prevent ripples, and bulky, expensive transformers, among others.

Figure 3.2: SMPS (5V, 5A)

It is simple to comprehend how SMPS works if you are aware that the transistor used in LPS is used to control the voltage drop while the transistor in SMPS is utilized as a controlled switch.

Working:

The working of SMPS can be understood by the following figure.

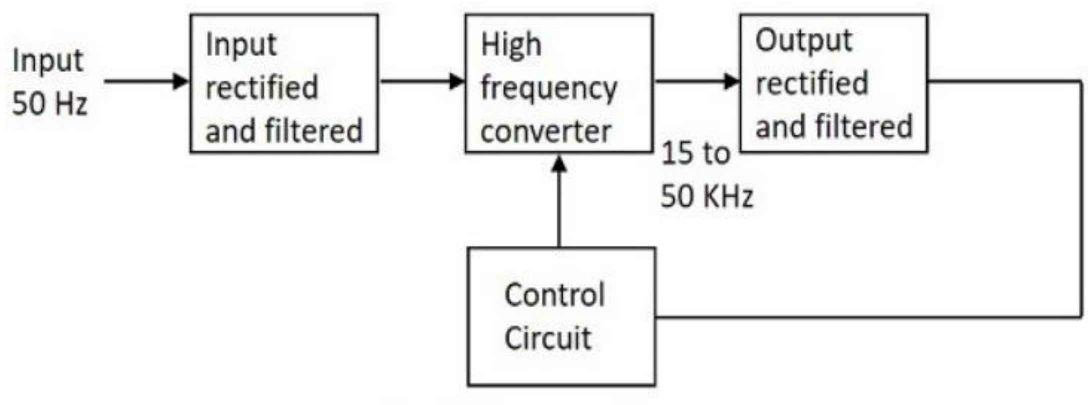

Figure 3.3: Working Procedure of SMPS (5V, 5A)

Let's attempt to comprehend what occurs at each phase of the SMPS circuit.

Input Stage

Without utilizing a transformer, the rectifier and filter circuit combination receives the 50 Hz AC input supply signal directly. The capacitor's capacitance value should be greater to withstand the input fluctuations because this output will exhibit a great deal of change. The primary switching component of the SMPS receives this unregulated dc supply.

Switching Section

A rapid switching device, like a MOSFET or power transistor, is utilized in this section. It responds to changes in voltage by turning ON and OFF, and its output is attached to the transformer's primary here. The transformer utilized here is substantially smaller and lighter than the ones used for 60 Hz supply. They are more efficient, which results in a better power conversion ratio.

Output Stage

The output signal from the switching part is once more rectified and filtered to provide the required DC voltage. This controlled output voltage is delivered to the feedback-based control circuit. The output is derived after accounting for the feedback signal.

Control Unit

This unit is the feedback circuit which has many sections. Let us have a clear understanding about this from the following figure.

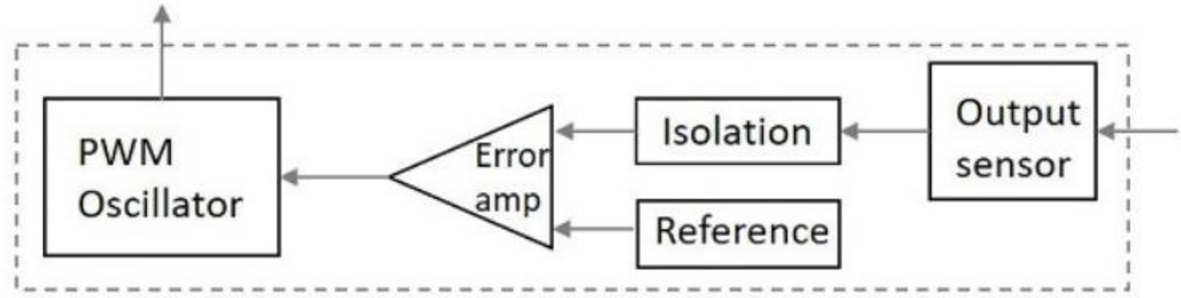

Figure 3.4: Control Unit

The internal components of a control unit are shown in the above figure. The signal is picked up by the output sensor, which connects it to the control system. Any rapid spikes shouldn't harm the circuitry because the signal is segregated from the other section. The signal and a reference voltage are both sent as one input to the error amplifier, a comparator that compares the incoming signal with the necessary signal level. The ultimate voltage level is maintained by adjusting the chopping frequency. The error amplifier's output, which determines whether to increase or reduce the chopping frequency, is used to control this. A fixed frequency standard PWM wave is generated by the PWM oscillator.

By taking a closer look at the following figure, we may gain a better understanding of how SMPS operates in its entirety.

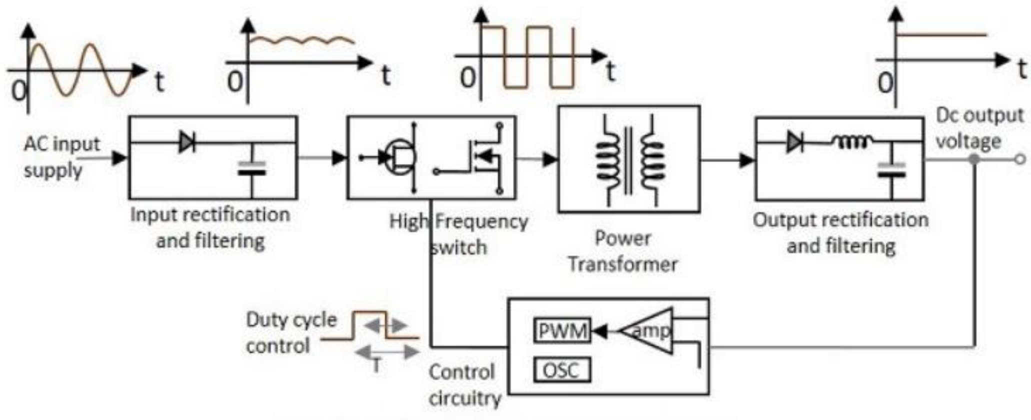

Figure 3.5: Functional Block Diagram of SMPS

The SMPS is typically utilized in situations where switching between voltages is not at all problematic and where system efficiency is crucial. There are a few things to keep in mind when it comes to SMPS. Those are

- Because the SMPS circuit is switched-operated, voltages continuously change.
- The switching device is used in cutoff or saturation mode.
- The feedback circuitry's switching period regulates the output voltage.
- By changing the duty cycle, switching time can be altered.
- The high efficiency of SMPS is due to the fact that it continuously changes its input to regulate the output rather than dissipating extra power as heat.

Disadvantages

There are few disadvantages in SMPS, such as

- Due to high frequency switching, there is noise.
- The circuit is intricate.
- Electromagnetic interference is produced.

Advantages

The advantages of SMPS include,

- The effectiveness is between 80 and 90%.
- Less power is wasted and less heat is produced.
- Less harmonic feedback entering the power supply mains.
- The apparatus is small and portable.

- The price of production is decreased.
- A provision for supplying the necessary quantity of voltages.

Applications

The SMPS has a wide range of uses. Computer motherboards, cell phone chargers, HVDC measurements, battery charges, central power distribution, automobiles, consumer electronics, laptops, security systems, space stations, etc. all use them.

Types of SMPS

The Switched Mode Power Supply (SMPS) circuit is made to convert an unregulated DC or AC voltage into a regulated DC output voltage. SMPS come in four main categories, including:

- DC to DC Converter
- AC to DC Converter
- Fly back Converter
- Forward Converter

The input section's AC to DC conversion component distinguishes between a DC to DC converter and an AC to DC converter. Low power applications make advantage of the flyback converter. Additionally, there are two converters—Buck and Boost—among the SMPS types that can change the output voltage in response to demands. Self-oscillating fly-back converters, Buck-boost converters, Cuk, Sepic, etc. are examples of the other type of SMPS.

3.1.3 Servo Motor (MG996R)

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. Servomotors are not a specific class of motor, although the term servomotor is often used to refer to a motor suitable for use in a closed-loop control system.

A servo motor is an electromechanical device that produces torque and velocity based on the supplied current and voltage. A servo motor works as part of a closed loop system providing torque and velocity as commanded from a servo controller utilizing a feedback device to close the loop.

Figure 3.6: Servo motor

The feedback device supplies information such as current, velocity, or position to the servo controller, which adjusts the motor action depending on the commanded parameters. A servo consists of a Motor (DC or AC), a potentiometer, gear assembly, and a controlling circuit. First of all, we use gear assembly to reduce RPM and to increase torque of the motor. Say at initial position of servo motor shaft, the position of the potentiometer knob is such that there is no electrical signal generated at the output port of the potentiometer. Now an electrical signal is given to another input terminal of the error detector amplifier. Now the difference between these two signals, one comes from the potentiometer and another comes from other sources, will be processed in a feedback mechanism and output will be provided in terms of error signal. This error signal acts as the input for motor and motor starts rotating. Now motor shaft is connected with the potentiometer and as the motor rotates so the potentiometer and it will generate a signal.

3.1.4 Solar Panel

The Mon crystalline solar panels get their name from how they are made. Each of the individual solar cells contains a silicon wafer that is made of a single crystal of silicon. The single crystal is formed using the Czochralski method, in which a 'seed' crystal is placed into a vat of molten pure silicon at a high temperature. The seed is then drawn up and the molten silicon forms around it, creating one crystal. The large crystal, also called an ingot, is then sliced into thin wafers that are used to make the solar cells. Usually, a monocrystalline panel will contain either 60 or 72 solar cells, depending on the size of the panel. Most residential installations use 60-cell monocrystalline silicon panels [7].

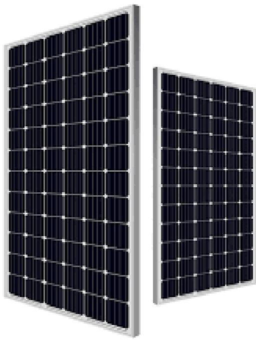

Figure 3.7: Mon crystalline solar panel

Mon crystalline solar panels usually have the highest efficiency and power capacity out of all types of solar panels. Mon crystalline panel efficiencies can range from 17% to 22%. Because monocrystalline solar cells are made out of a single crystal of silicon, electrons are able to flow easier through the cell, which makes the PV cell efficiency higher than other types of solar panels. The higher efficiency of monocrystalline solar panels means that they require less space to reach a given power capacity. So, monocrystalline solar panels will usually have a higher power output rating than either polycrystalline or thin film modules.

3.1.5 Battery 4V

The 3.7v lithium battery is a lithium battery with a nominal voltage of 3.7v and a full-charge voltage of 4.2v. Its capacity ranges from several hundred to several thousand mAh.
This Standard 18650 3800mAh 3.7v Rechargeable Li-Ion Battery is a single cell compact and powerful battery cell with 3800 mAh capacity. This Li-ion battery is very convenient to install in your project where 3.7 Volt with high capacity is needed.
For the model LP963450 (3.7V/1800mAh), it is a single cell, and your following understanding is correct. For the battery pack, it is consisting of the cells connected in series or in parallel.
Voltage: 3.7 V. Current Rating: 3000mAh. Charging environment temperature range: 32° to 113° F. In use temperature range: -4° to 140° F.

Figure 3.8: 4 Volt Battery

3.1.6 LDR

A Light dependent resistor (LDR) is resistor whose resistance decreases with increasing incident light intensity; in other words, it exhibits photoconductivity. We are using LDR as another input to the controller. A photo-resistor is made of a high resistance semiconductor. If light falling on the device is of high enough frequency, photons absorbed by the semiconductor give bound electrons enough energy to jump into the conduction band. The resulting free electron (and its hole partner) conduct electricity, thereby lowering resistance.

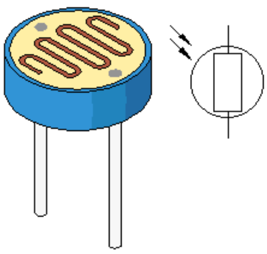

Figure 3.9: Light dependent resistor.

A photoelectric device can be either intrinsic or extrinsic. An intrinsic semiconductor has its own charge carriers and is not an efficient semiconductor, for example, silicon. In intrinsic devices the only available electrons are in the valence band, and hence the photon must have enough energy to excite the electron across the entire band gap. Extrinsic devices have impurities, also called do pants, and added whose ground state energy is closer to the conduction band; since the electrons do not have as far to jump, lower energy photons (that is, longer wavelengths and lower frequencies) are sufficient to trigger the device. If a sample of silicon has some of its atoms replaced by phosphorus atoms (impurities), there will be extra electrons available for conduction. This is an example of an extrinsic semiconductor.

3.2 System Block Diagram

This is the block diagram of our system. We use here an AC 220V power supply and then we convert this AC voltage to DC Voltage by using a SMPS Converter. This SMPS take 230V AC and produce only 5V DC to our System. Here we use an Arduino Nano as microcontroller. Arduino Nano will control the rotation of solar panel vertically and horizontally.

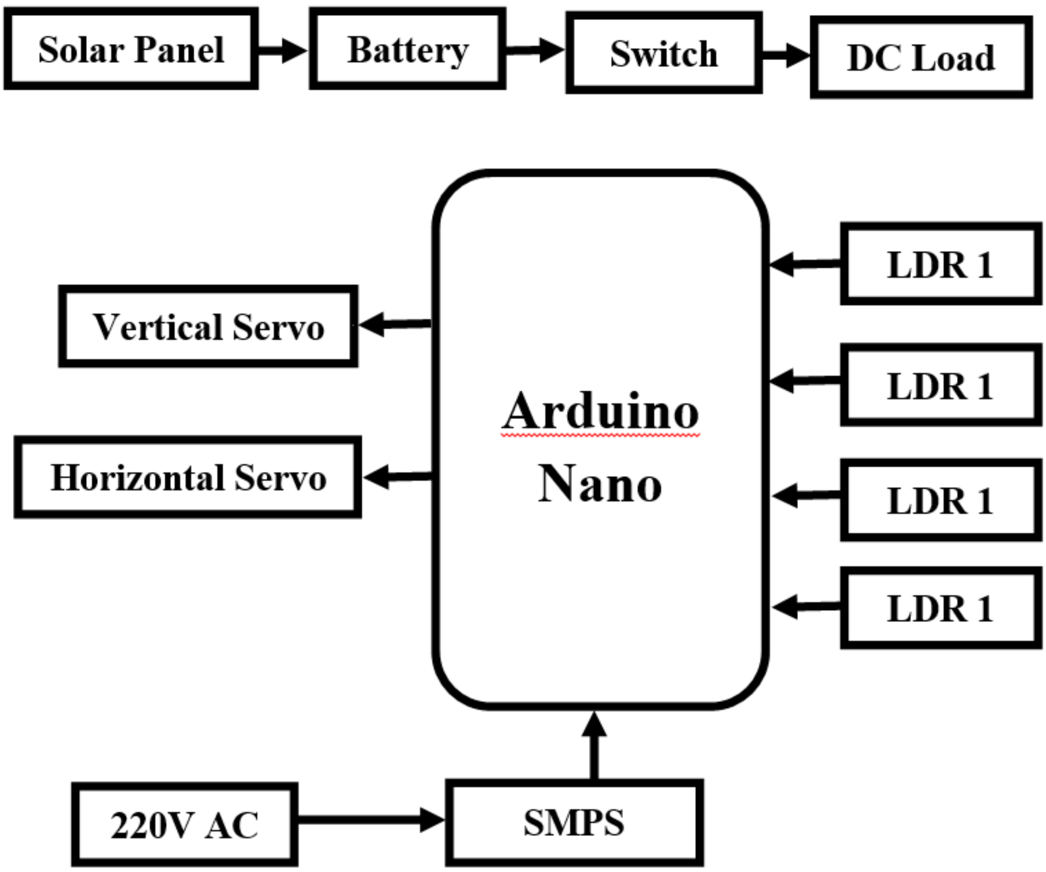

Figure 3.10: Block diagram of proposed system

We use here a Solar panel to produce power from sunray. Here four LDR is used here for find the exact rotation path for solar system. Two LDR is used here for make sure the solar movement for vertically and another Two LDR is used here for make sure the movement in horizontally. Here we used a DC 12V Battery for store the generated power from solar panel. We can control our DC Load manually by using a Switch.

3.3 Complete Circuit

This is the complete circuit diagram of our system. This is the block diagram of our system. We use here an AC 220V power supply and then we convert this AC voltage to DC Voltage by using a SMPS Converter. This SMPS take 230V AC and produce only 5V DC to our System. Here we use an Arduino Nano as microcontroller. Arduino Nano will control the rotation of solar panel vertically and horizontally.

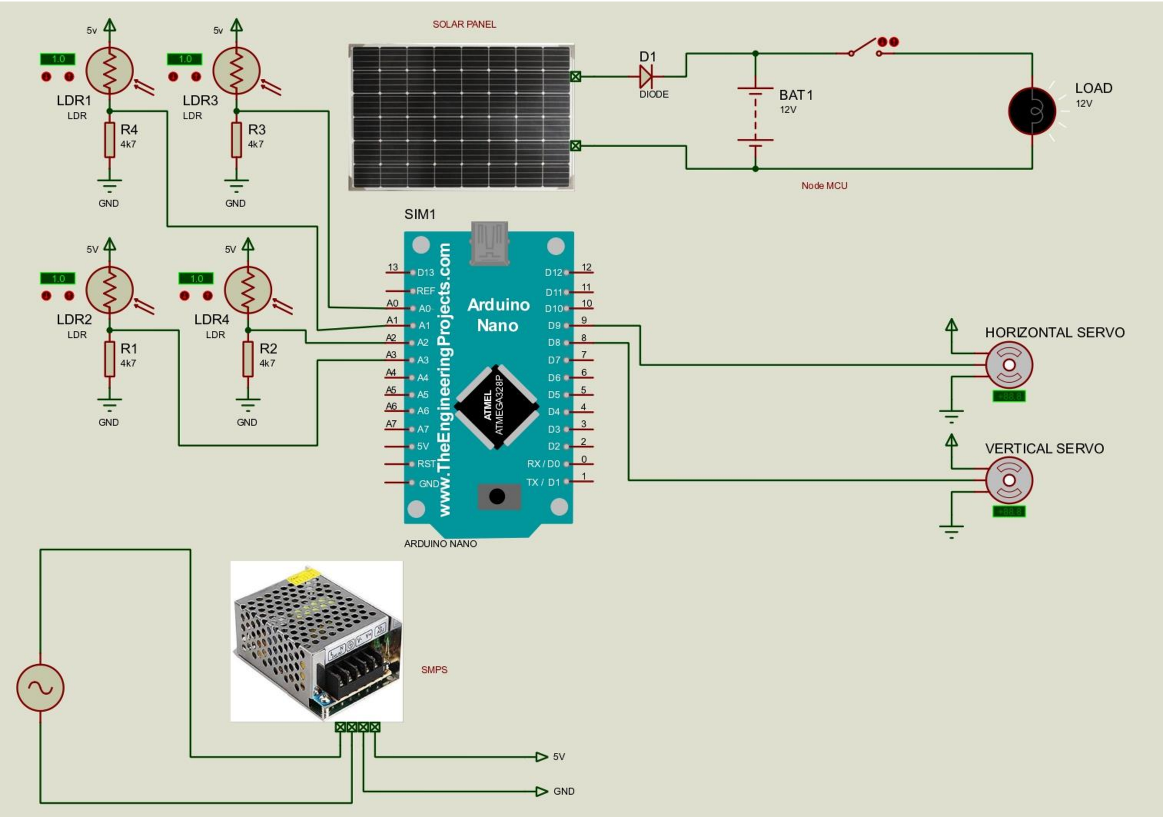

Figure 3.11: Complete circuit diagram of proposed system

We use here a Solar panel to produce power from sunray. Here four LED is used here for find the exact rotation path for solar system. Two LDR is used here for make sure the solar movement for vertically and another Two LDE is used here for make sure the movement in horizontally. Here we used a DC 12V Battery for store the generated power from solar panel. We can control our DC Load manually by using a Switch.

3.4 Project Overview

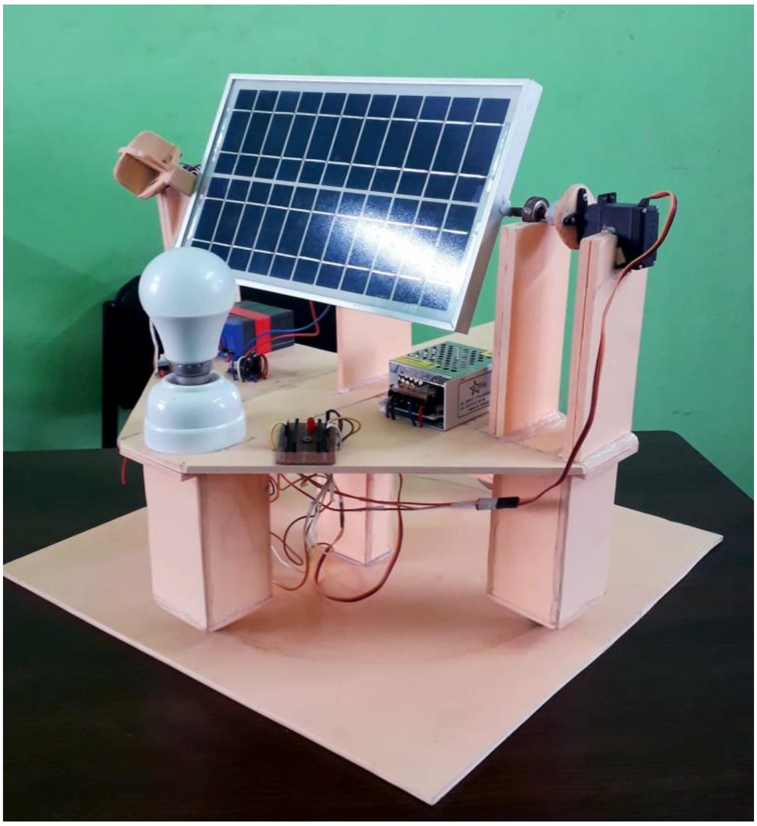

Figure 3.12: Left Side View of Proposed System

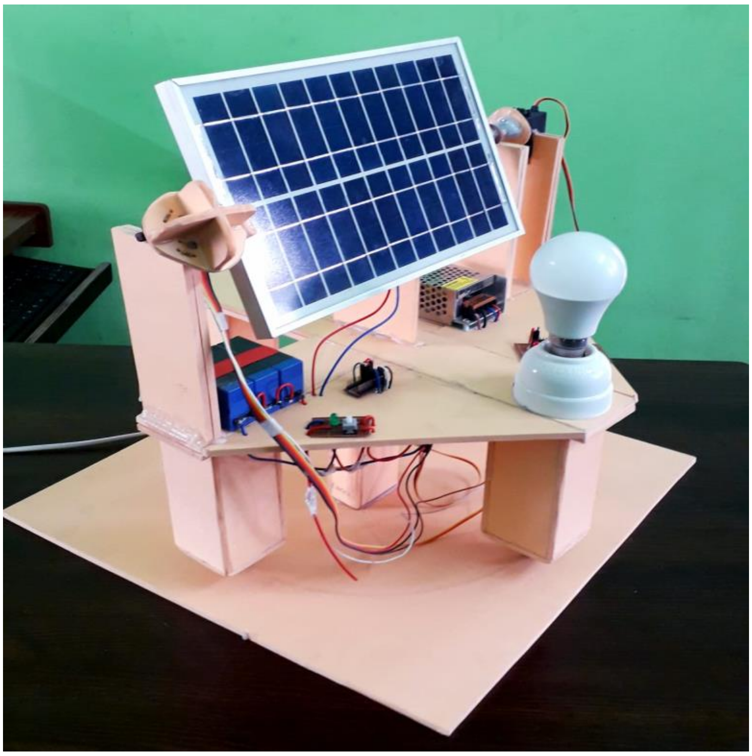

Figure 3.13: Right Side View of Proposed System

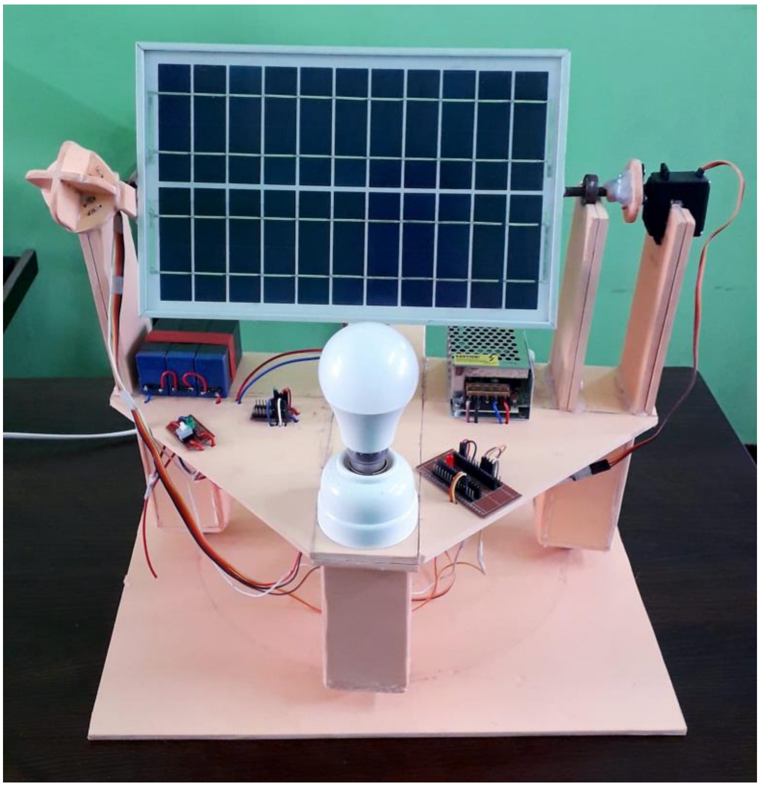

Figure 3.14: Front Side View of Proposed System

CHAPTER 4

RESULT AND DISCUSSION

4.1 Produced Power Comparison

Efficiency of single axis tracking system over fixed amount:

Time (hr)	Output			Input
	Volt (v)	Current (I) I=P/V	Power(w) P=VI	Input power (w)
8.00 am	09.55	1.70	15.55	3
10.00 am	09.45	1.99	18.80	3
12.00 pm	10.20	2.70	27.54	3
3.00 pm	10.25	2.85	29.21	3
6.00 pm	08.75	1.65	14.43	3
Average Power			21.10	3

Efficiency=output/input =21.10/3=7.03%

Efficiency of dual axis tracking system over fixed amount:

Time(hr)	Output			Input
	Volt (v)	Current (I) I=P/V	Power (w) P=VI	Input power (w)
8.00 am	10.15	2.93	29.73	3
10.00 am	10.45	3.00	31.35	3
12.00 pm	10.65	3.20	34.08	3
3.00 pm	10.35	3.29	34.02	3
6.00 pm	10.20	2.82	28.76	3
Average Power			31.58	3

Efficiency=output/input =30.58/3=10.52%

Here we show the comparison between single and dual axis solar tracking system.

CHAPTER 5

CONCLUSION

5.1 Discussion

The main theme of this project is to generate electricity using sun light efficiently by developing an advance dual axis solar tracking system. Proposed dual axis solar tracking system is more efficient than dual axis & static panels and also cheaper than the other trackers available in market.

Uses of four LDR's enable the tracker to keep the panel exactly perpendicular to the sun throughout the day. It enables the panel to grab energy throughout the day, which increase the efficiency of solar panel. Average power gain of the solar panel with proposed dual axis tracking system is up to 40-50% over normal stationary arrangement and 15-20% over 360 degree solar tracking system.

Basically, this project is a miniature model for large scale electrical generating system. According to this implementation in future it can be implemented in large scale in perspective of Bangladesh. A considerable amount of power could be obtained if it is implemented as a large project with comparing of fossil fuel resources

5.2 Advantages

There are certainly many advantages of our project and some of the major ones have been given below:

Solar tracking systems continually orient photovoltaic panels towards the sun and can help maximize your investment in your PV system.

- One time investment, which provides higher efficiency & flexibility on dependency over other sources.
- Tracking systems can help reducing emissions and can contribute against global warming.
- Bulk implementations of tracking systems help reduced consumption of power by other sources.

It enhances the clean and emission free power production.

5.3 Disadvantages

It has more costly.

It require more time for installing.

It may be require extra power supply for motor.

It require more maintains.

5.4 Applications

These panels can be used to power the traffic lights and streetlights

✓These can be used in home to power the appliances using solar power.

✓These can be used in industries as more energy can be saved by rotating the panel.

5.5 Conclusion

- ✓ The invention of Solar Tracking System helps us improve the performance of PV solar system in a simple way
- ✓ Used relative method of sunlight strength.
- ✓ Established a model of automatic tracking system to keep vertical contact between solar panels and sunlight.
- ✓ Improved the utilization rate of solar energy and efficiency of photovoltaic power generation system.

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APPENDIX

Uploaded Program for this project:

```
#include <Servo.h>
Servo myservo1, myservo2;
int LDR1 = A0, LDR2 = A1, LDR3 = A2, LDR4 = A3;
int rRDL1 = 0, rRDL2 = 0, rRDL3 = 0, rRDL4 = 0;
int max1=0, max2=0, max3=0;
int ser1 = 80, ser2=0;




void setup() {

  myservo1.attach(9);
  myservo2.attach(8);

  Serial.begin(9600);
  myservo1.write(ser1);
  myservo2.write(100);
}

void loop() {

  rRDL1 = analogRead(LDR1) / 100;
  rRDL2 = analogRead(LDR2) / 100;
  rRDL3 = analogRead(LDR3) / 100;
  rRDL4 = analogRead(LDR4) / 100;

  max1 = max(rRDL1, rRDL2);
  max2 = max(rRDL3, rRDL4);
  max3 = max(max1, max2);
```

```
  //Serial.println(String(max3));
  //Serial.println(String(rRDL1) +", "+String(rRDL2) +", "+String(rRDL3) +",
"+String(rRDL4));


  if(rRDL1<max3 && rRDL2<max3)
  {
    if(ser1<140)
      ser1+=1;
    myservo1.write(ser1);
  }
  if(rRDL3<max3 && rRDL4<max3)
  {
    if(ser1>0)
      ser1-=1;
    myservo1.write(ser1);
  }

  if(rRDL2<max3 && rRDL3<max3)
  {
    Serial.println("servo2 +" + String(ser2));
    if(ser2<180)
      ser2+=1;
    myservo2.write(ser2);
  }
  if(rRDL1<max3 && rRDL4<max3)
  {
    Serial.println("servo2 -" + String(ser2));
    if(ser2>0)
      ser2-=1;
    myservo2.write(ser2);

  }
```

```
  delay(15);


}
```