CHAPTER ONE

INTRODUCTION

1.1 General

Automatic control system is situated among different aspect of applied branches of knowledge since it controls the production units in different industries and it control different types of vehicles and equipments. According to the development of the electronic science after the invention of transistor and integrated circuits, Electronic computer becomes very important in automatic control system and man could gain perfection in operation besides it has become more secured and it protect mankind from different accidents. This also leads to fewer burdens on human beings and difficult tasks have become easier for him.

Solar energy can play a vital role in providing most of the heating , cooling and electricity needs in the world and also has the potential to solve our environmental problems. The sun is infinite and clean energy source and it sends to earth more than the world's energy consumption.

1.2 Problem statement

A solar panel receives more sunlight when it is perpendicular or parallel to the sun . But the direction of the sunlight always changes depends on the movement of the sun in day.

1.3 Objectives

To study and understand solar energy ,To study main components such as arduino board and servo motor ,To build complete solar tracking system using proteus software ,To evaluate the performance of solar tracking system.

1.4 Methodology

Study and understand the previous works.

Contract the simulation model using proteus software.

Evaluate the performance of solar tracking system based on simulation results .

design a model based on the simulation result .

1.5 Research Outline

This research is presented in five chapter. The scope of each chapter is explained as follows:

Chapter one gives an introduction including general concepts, problem statement ,objectives and methodology .Chapter two introduces the solar tracking system. Chapter three presents literature review ,control system, the main components such as arduino board and servo motor .chapter four represents the components ,operation and project design . Various solar tracking system types are discussed .

CHAPTER TWO

SOLAR ENERGY AND SUN TRACKER

2.1 Introduction:

In today's climate of growing energy needs and increasing environmental concern, alternatives to the use of non-renewable and polluting fossil fuels have to be investigated. One such alternative is solar energy.

Solar energy is quite simply the energy produced directly by the sun and collected elsewhere, normally the Earth. The sun creates its energy through a thermonuclear process that converts about 650,000,000 tons of hydrogen to helium every second. The process creates heat and electromagnetic radiation. The heat remains in the sun and is instrumental in maintaining the thermonuclear reaction. The electromagnetic radiation (including visible light, infra-red light, and ultra-violet radiation) streams out into space in all directions.

Only a very small fraction of the total radiation produced reaches the Earth. The radiation that does reach the Earth is the indirect source of nearly every type of energy used today. The exceptions are geothermal energy, and nuclear fission and fusion. Even fossil fuels owe their origins to the sun; they were once living plants and animals whose life was dependent upon the sun.

Much of the world's required energy can be supplied directly by solar power. More still can be provided indirectly. The practicality of doing so will be examined, as well as the benefits and drawbacks. In addition, the uses solar energy is currently applied to will be noted.

Due to the nature of solar energy, two components are required to have a functional solar energy generator. These two components are a collector and a storage unit. The collector simply collects the radiation that falls on it and converts a fraction of it to other forms of energy (either electricity and heat or heat alone). The storage unit is required because of the non-constant nature of solar energy; at certain times only a very small amount of radiation will be received. At night or during heavy cloud cover, for example, the amount of energy produced by the collector will be quite small. The storage unit can hold the excess energy produced during the periods of maximum productivity, and release it when the productivity drops. In practice, a backup power supply is usually added, too, for the situations when the amount of energy required is greater than both what is being produced and what is stored in the container.

Methods of collecting and storing solar energy vary depending on the uses planned for the solar generator. In general, there are three types of collectors and many forms of storage units.

The two types of collectors are flat-plate collectors, focusing collectors, and passive collectors.

Flat-plate collectors are the more commonly used type of collector today. They are arrays of solar panels arranged in a simple plane. They can be of nearly any size, and have an output that is directly related to a few variables including size, facing, and cleanliness. These variables all affect the amount of radiation that falls on the collector. Often these collector panels have automated machinery that keeps them facing the sun. The additional energy they take in due to the correction of facing more than compensates for the energy needed to drive the extra machinery.

Focusing collectors are essentially flat-plane collectors with optical devices arranged to maximize the radiation falling on the focus of the collector. These are currently used only in a few scattered areas. Solar furnaces are examples of this type of collector. Although they can produce far greater amounts of energy at a single point than the flat-plane collectors can, they lose some of the radiation that the flat-plane panels do not. Radiation reflected off the ground will be used by flat-plane panels but usually will be ignored by focusing collectors (in snow covered regions, this reflected radiation can be significant). One other problem with focusing collectors in general is due to temperature. The fragile silicon components that absorb the incoming radiation lose efficiency at high temperatures, and if they get too hot they can even be permanently damaged. The focusing collectors by their very nature can create much higher temperatures and need more safeguards to protect their silicon components.

Of all the energy sources available, solar has perhaps the most promise. Numerically, it is capable of producing the raw power required to satisfy the entire planet's energy needs. Environmentally, it is one of the least destructive of all the sources of energy. Practically, it can be adjusted to power nearly everything except transportation with very little adjustment, and even transportation with some modest modifications to the current general system of travel. Clearly, solar energy is a resource of the future.

The power of the sun is what makes life on Earth possible. Efforts to harness solar energy in concentrated form have long been a human pursuit. Solar technology has existed since the 19th century and has received substantial government support since at least the 1970s. Despite vast amounts of subsidies, solar power comprises less than 1 percent of US electricity generation and should no longer be propped up by taxpayer dollars.

Initial Development of Solar Power. The development of solar cell technology, or photovoltaic (PV) technology, began during the Industrial Revolution when French physicist Alexander Edmond first demonstrated the photovoltaic effect, or the ability of a solar cell to convert sunlight into electricity, in 1839 .About four decades later, American inventor Charles Frits created the world’s first rooftop solar array in New York in 1883, one year after Thomas Edison opened the world’s first commercial coal plant Frits coated the panels with selenium to produce a very weak electric current. However, the process of how light produces electricity wasn’t understood until Albert Einstein wrote a paper explaining the photoelectric effect in 1905which won him the Nobel Prize in physics in 1921.

Becquerellar's and Einstein's research formed the basis of future developments in solar technology.

The modern photovoltaic (PV) cell was developed by Bell Labs in 1954and while solar power remained too costly for commercial use, the U.S. military funded research on PV technology's potential to power satellites in the 1950s. The U.S. Naval Research Laboratory launched Vanguard I, the first spacecraft to use solar panels, in 1958, and NASA launched the first satellite equipped with panels that tracked the Sun, Nimbus I, in 1964 . The U.S. government pioneered much of the early PV technology.

U.S. Government's First Push for Solar. The federal government's oil price controls of the early 1970s, followed by the Arab oil embargo of 1973, and the federal government's Emergency Petroleum Allocation Act of 1973 created an energy crisis in the United States. This energy crisis catalyzed the federal government's commitment to develop solar energy. Congress passed five energy bills in 1974, two of which cited solar power as a potential solution to the energy crisis. The "Solar Heating and Cooling Demonstration Act of 1974" ordered the installation of solar heating and cooling units in federal buildings by 1977 to acclimate the public to the new technology.

Essentially, Congress was attempting to turn federal buildings into billboards for solar energy, and it simultaneously passed additional legislation to mobilize several government agencies for research and logistical support to make solar technology affordable. Congress passed the "Solar Energy Research, Development and Demonstration Act of 1974" to create the Solar Energy Coordination and Management Project, an organization designed to direct agencies like NASA, the National Science Foundation, and the Department of Housing and Urban Development to improve solar energy technology and use it to heat and cool government-owned buildings . Theact also created a new federal office, The Solar Energy Research Institute, to conduct research and facilitate the industrial use of solar power. The Institute, which began operating in 1977, still exists today as the National Renewable Energy Laboratory.

Solar Power applications :

Solar power is used a number of different ways, of course. There are two very basic kinds of solar energy:

Solar thermal energy collects the sun's warmth through one of two means: in water or in an anti-freeze (glycol) mixture.

Solar photovoltaic energy converts the sun's radiation to usable electricity.

2.2 Solar-Cells

A solar cell also called a photovoltaic cell is an electrical device that converts the energy of light directly into electricity by the photovoltaic effect. It is a form of photoelectric cell, defined as a device whose electrical characteristics like current, voltage, or resistance vary when exposed to light; cells can be described as photovoltaic even when the light source is not necessarily sunlight like lamplight and artificial light. The solar cell shown in (figure 2.1).

Figure 2.1: Solar cell

2.2.1 solar panel

A solar panel is a set of solar photovoltaic modules electrically connected and mounted on a supporting structure. A photovoltaic module is a packaged, connected assembly of solar cells. The solar module can be used as a component of a larger photovoltaic system to generate and supply electricity in commercial and residential applications. Each module is rated by its DC output power under the standard test conditions, and typically ranges from 100 to 320 watts. The efficiency of a module determines the area of a module given the same rated output - an 8% efficient 230-watt module will have twice the area of a 16% efficient 230-watt module. A single solar module can produce only a limited amount of power; most installations contain multiple modules. A photovoltaic system typically includes a panel or an array of solar modules, an inverter, and sometimes a battery and/or solar tracker and interconnection wiring.

The three most practical and popular ways that solar energy is used:

a. Small portable solar photovoltaic systems. We see these used everywhere, from calculators to solar garden products. Portable units can be used for everything from RV appliances while single panel systems are used for traffic signs and remote monitoring stations.

b. Solar pool heating. Running water in direct circulation systems through a solar collector is a very practical way to heat water for your pool or hot tub.

c. Thermal glycol energy to heat water. In this method (indirect circulation), glycol is heated by the sun's rays and the heat is then transferred to water in a hot water tank.

Integrating solar photovoltaic energy into your home or business power. In many parts of the world, solar photovoltaic is an economically feasible way to supplement the power of your home. In Japan, photovoltaic are competitive with other forms of power. In the US, new incentive programs make this form of solar energy ever more viable in many states. An increasingly popular and practical way of integrating solar energy into the power of your home or business is through the use of building integrated solar photo voltages.

` Large independent photovoltaic systems. If you have enough sun power at your site, you may be able to go off grid. You may also integrate or hybridize your solar energy system with wind power or other forms of renewable energy to stay 'off the grid'.

2.2.2 The photovoltaic effect

The photovoltaic effect is the creation of voltage or electric current in a material upon exposure to light. The standard photovoltaic effect is directly related to the photoelectric effect, though they are different processes. When the sunlight or any other light is incident upon a material surface, the electrons present in the valence band absorb energy and, being excited, jump to the conduction band and become free. These highly excited, non-thermal electrons diffuse, and some reach a junction where they are accelerated into a different material by a built-in potential (Galvani potential). This generates an electromotive force, and thus some of the light energy is converted into electric energy. The photovoltaic effect can also occur when two photons are absorbed simultaneously in a process called two-photon photovoltaic effect.

2.3 Sun Track

It seems you can't walk down the street these days without coming across a solar panel. You can find them lighting up crosswalk signs, mobile power for construction, as well as simple little sidewalk path lights. Solar is easy to use, readily available, and inexpensive.

So why aren't we using it to power our homes?

For the most part our common every day solar cells run at an efficiency of 18-20%, meaning they convert 18-20% of the every they receive into electricity. While this is far better than the 3-6% efficiency that most green plants end up with, it doesn't quite meet our power needs. To bring in enough power we either need to improve the efficiency of our panels or find ways of getting more from our current solar panels.

Every panel you see in your day to day life is in a fixed position, most likely facing south at a 45 degree angle. While this approach is extremely simple and meets the needs of most small applications, it isn't producing as much energy as it could be.

The single most simple way of getting more energy out of a solar panel is to have it track the sun. In fact solar panels that track the sun create around 30% more energy per day than a fixed panel. With that kind of power increase you'd think everyone would be doing it, but there are some good reasons why it's not overly common. First, the initial cost of setup is higher since it requires moving parts. Second, it also require maintenance and upkeep since they'd be exposed to outdoors conditions year round. Third, you'd need to power this equipment in order to keep it running and moving which then takes away from your output.

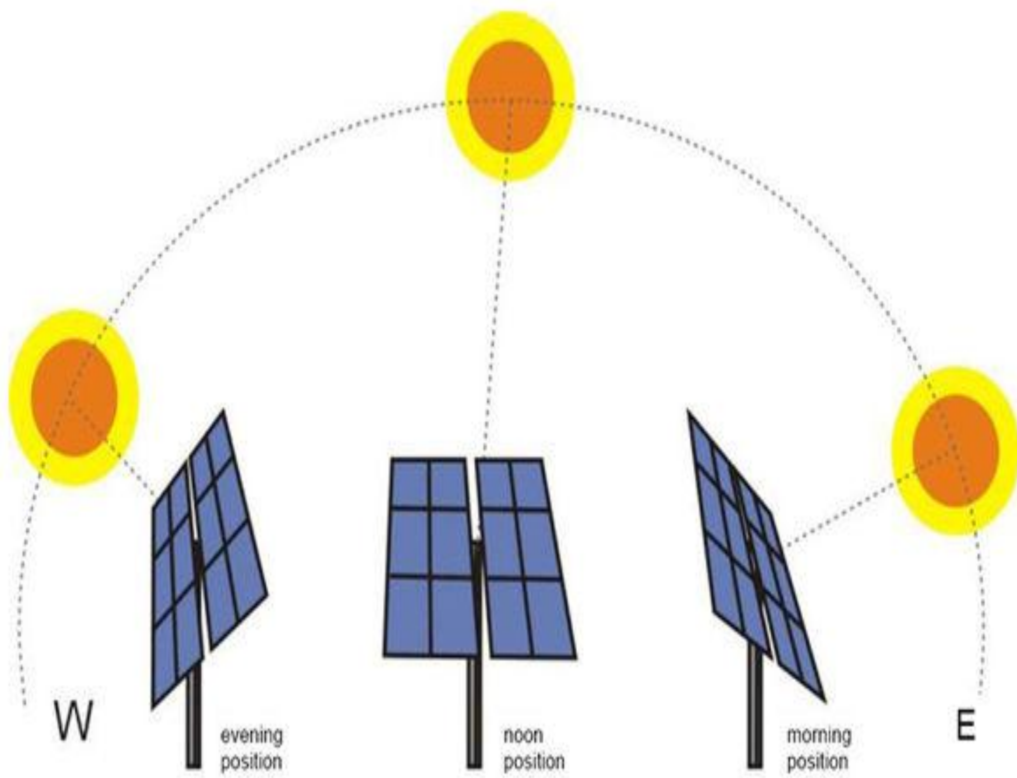

Figure 2.2 : Daily directional movement of dual-sun tracker

2.4 Types of Trackers

There are a couple different types of trackers as well as ways to track the sun.

Single Axis or Dual Axis

dual axis tracker, meaning it tracks in both X and Y. To put it into even more simple terms, it goes left, right, up, and down. This means once you have your tracker set up you will never need to change or adjust anything, since anywhere the sun moves your tracker will follow because you can have it track a flashlight around. This method gives the best results for power generation.

single axis tracker, one that does just X or Y. To put it in simple terms again, it'll do just left to right or just up and down. Typically people will make an X axis (left to right) tracker and then just set their panel at 45 degrees for Y. This still gives really high amounts of power generation while at the same time eliminating half the moving parts. You'll frequently find this approach being used in "dumb" trackers that are not computer controlled.

Active Tracking or Scheduled Tracking

Our tracker is an **active tracker** which is controlled by computer program (via an Arduino). This means that we use sensors to find the brightest source of light if you were to take a flashlight and shine it at the sensors the tracker would follow it around. While this is the most interactive and exciting kind of tracking you can. The sun is highly predictable. If you can easily look up the time of every sunrise and sunset for the next 100 years as well as use some simple math to figure out the angle of the sun relative to your location at any time of the year. With this in mind many people end up using a **scheduled tracker**. This system uses a computer program that changes the angle of the panel based on the date, time, and physical location. While not as fancy or exciting as an active tracker, it is in fact far more efficient provided everything is set up properly. You can be sure that your panel is at the mathematically most efficient spot possible even under heavy cloud coverage.

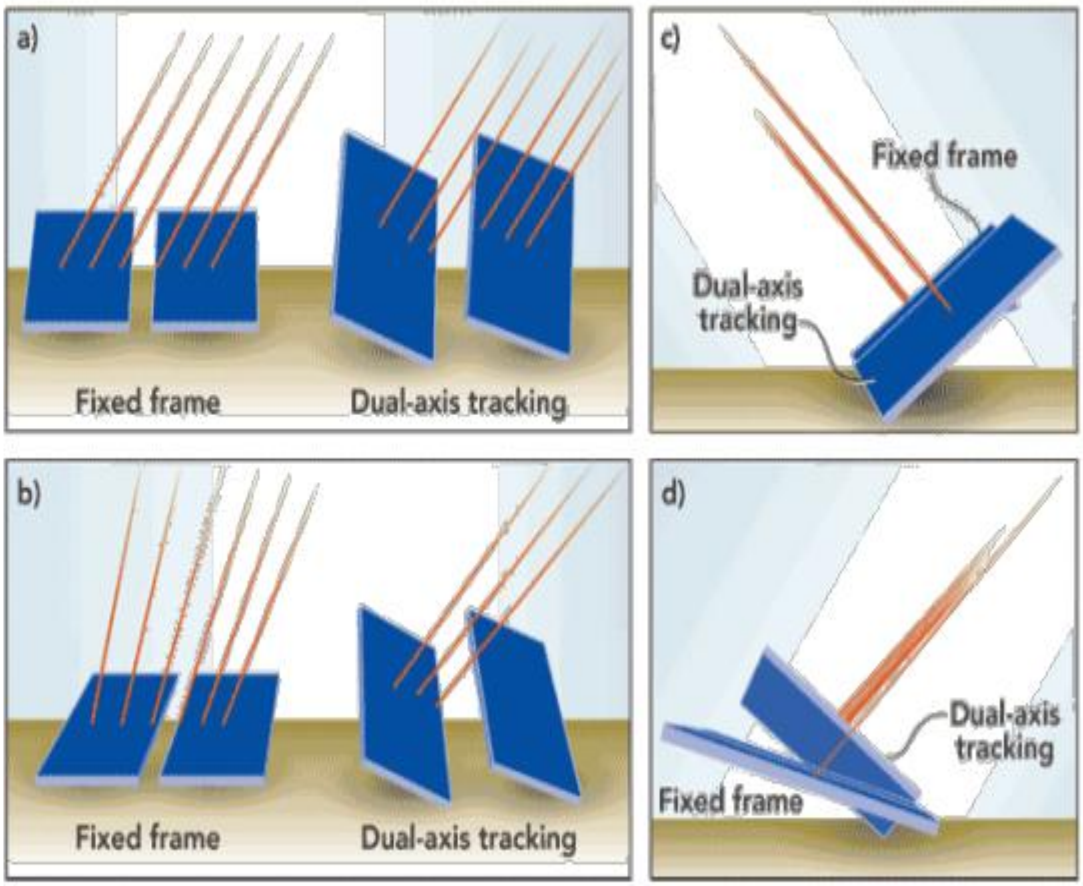

Figure 2.3 : The difference between fixed frame and dual-axis tracker

CHAPTER THREE

LITERATURE REVIEW

3.1 Introduction

Control engineering is based on the foundation of feedback theory and linear system analysis, and it generates the concepts of network theory and communication theory. Accordingly, control engineering is not limited to any engineering discipline but is applicable to foundation provided by linear system, which assumes a cause effect relationship for the components of a system . A component or process to be controlled can be represented by a block as shown in figure.

An open-loop control system utilizes a controller or control actuator to obtain the desired response as shown in figure the open-loop control system utilizes an actuating device to control the process directly without using device. An example of an open-loop control system is an electric toaster.

A closed-loop control system utilizes an additional measure of the actual output to compare the actual output with the desired output response, The measure of the output is called the feedback signal. A feedback control system is a control system that tends to maintain a relationship of one system variable to another by comparing functions of these variables becoming more complex, the inter relationship of many controlled variables may be considered in the control scheme. An example of closed-loop control system is a person steering automobile by looking at the auto's location on the road and making the appropriate adjustments.

3.2 Types of control theory

The main type of control are:

***Conventional Theory**

The conventional theory depends on representing the control system by Laplace variable ,and also depends on the relation between input and output only by transfer function and it's exposed to the internal variables of the system (state variables).This is considered as limitation and short coming in the conventional theory besides another limitation and short coming which is initial condition that equal zero, it can be applied in the design bas limitation and short coming in the conventional theory besides another limitation and short coming which is initial condition that equal zero, it can be applied in the design by the root locus or frequency response on the input, output systems only, and the way of the design by the trial and error.

***Modern control theory**

The modern control theory is considered as the most suitable entry to the multi input and output control systems. It dose consist of a large number of variables and it can be used in all the liner systems of single input and single output and the multi input and multi output system. The modern control theory is suitable also for non-linear systems. The conventional theory verses the control system theory. The control operation in the conventional theory depends only on the feedback of the input without considering the internal variables of the system, this limitation and short coming can be avoided in the modern control theory where the controlled by the feedback of the output and the internal variables in the same time, this guarantee that it doesn't change these system variables according to the targeted aims during the control operation.

3.3 Role of control theory

To design a controller that makes a system behave in a desirable manner, we need a way to predict the behavior of quantities of interest over time, specifically how they change in response to different inputs. Mathematical models are most often used to predict future behavior, and control system design methodologies are based on such models. Understanding control theory requires engineers to be well versed in basic mathematical concepts and skills, such as solving differential equations and using Laplace transform. The role of control theory is to help us gain insight on how and why feedback control systems work and how to systematically deal with various design and analysis issues. Specifically, the following issues are of both practical importance and theoretical interest:

1-Stability and stability margins of closed-loop systems.

2-How fast and smooth the error between the output and the set points in driven zero.

3-How well the control system handles unexpected external disturbance, sensors, and internal dynamic changes.

In the following, modeling and analysis are first introduced, followed by an overview of the classical design methods for single-input single-output plants, design evaluation methods, and implementation issues. Alternative design methods are then briefly presented. Finally, For the sake of simplicity and briefly, the discussion is restricted to linear, time invariant systems. Results may be found in the literature for the cases of linear, time-varying systems, and also for nonlinear systems, systems with delays, systems described by partial differential equations, and so on; these results however, tend to be more restricted and case dependent.

Arduino already contains all components which allow it to operate and stand alone, and it has been designed in particular for monitoring and/or control tasks. In consequence, in addition to the process it includes memory, various interface controllers, one or more timers, an interrupt controller , and last but definitely not least general purpose Input/output(I/O) pins which allow it to direct interface to its environment. arduino also includes bit operations which allow to change one bit within a byte without touching the other bits.

3.4 Arduino

Arduino, sold as Genuine, due to a trademark dispute, outside the U.S. and U.K., is a hardware and software company, project, and user community that designs and manufactures computer open-source hardware, open-source software, and microcontroller-based kits for building digital devices and interactive objects that can sense and control physical devices.

The project is based on microcontroller board designs, produced by several vendors, using various microcontrollers. These systems provide sets of digital and analog input/output (I/O) pins that can interface to various expansion boards (termed shields) and other circuits. The boards feature serial communication interfaces, including Universal Serial Bus (USB) on some models, for loading programs from personal computers. For programming the microcontrollers, the Arduino project provides an integrated development environment (IDE) based on a programming language named Processing, which also supports the languages C and C++.

The first Arduino was introduced in 2005, aiming to provide a low cost, easy way for novices and professionals to create devices that interact with their environment using sensors and actuators. Common examples of such devices intended for beginner hobbyists include simple robots, thermostats, and motion detectors.

Arduino boards are available commercially in preassembled form, or as do-it-yourself kits. The hardware design specifications are openly available, allowing the Arduino boards to be produced by anyone. Ad fruit Industries estimated in mid-2011 that over 300,000 official Arduinos had been commercially produced, and in 2013 that 700,000 official boards were in users' hands

3.4.1 Adruino architecture

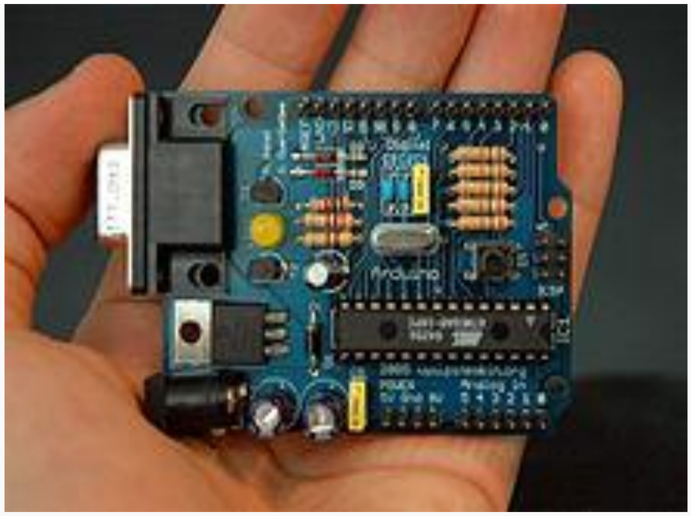

Figure 3.1: Arduino architecture

An early Arduino board with anRS-232 serial interface (upper left) and an Atmel ATmega8 microcontroller chip (black, lower right); the 14 digital I/O pins are at the top, the 6 analog input pins at the lower right, and the power connector at the lower left.

An Arduino board historically consists of an Atmel 8-, 16- or 32-bit AVR microcontroller (although since 2015 other makers' microcontrollers have been used) with complementary components that facilitate programming and incorporation into other circuits. An important aspect of the Arduino is its standard connectors, which let users connect the CPU board to a variety of interchangeable add-on modules termed shields. Some shields communicate with the Arduino board directly over various pins, but many shields are individually addressable via an I²C serial bus—so many shields can be stacked and used in parallel. Before 2015, Official Arduinos had used the Atmel megaAVR series of chips, specifically the ATmega8, ATmega168, ATmega328, ATmega1280, and ATmega2560. In 2015, units by other producers were added. A handful of other processors have also been used by Arduino compatible devices. Most boards include a 5 V linear regulator and a 16 MHz crystal oscillator (or ceramic resonator in some variants), although some designs such as the Lily Pad run at 8 MHz and dispense with the onboard voltage regulator due to specific form-factor restrictions. An Arduino's microcontroller is also pre-programmed with a boot loader that simplifies uploading of programs to the on-chip flash memory, compared with other devices that typically need an external chip programmer. This makes using an Arduino more straightforward by allowing the use of an ordinary computer as the programmer. Currently, opti boot loader is the default boot loader installed on Arduino UNO.

At a conceptual level, when using the Arduino integrated development environment, all boards are programmed over a serial connection. Its implementation varies with the hardware version. Some serial Arduino boards contain a level shifter circuit to convert between RS-232 logic levels and transistor–transistor logic (TTL) level signals. Current Arduino boards are programmed via Universal Serial Bus (USB), implemented using USB-to-serial adapter chips such as the FTDI FT232. Some boards, such as later-model Uno boards, substitute the FTDI chip with a separate AVR chip containing USB-to-serial firmware, which is reprogrammable via its own ICSP header. Other variants, such as the Arduino Mini and the unofficial Boarduino, use a detachable USB-to-serial adapter board or cable ,Bluetooth or other methods, when used with traditional microcontroller tools instead of the Arduino IDE, standard AVR in-system programming (ISP) programming is used.

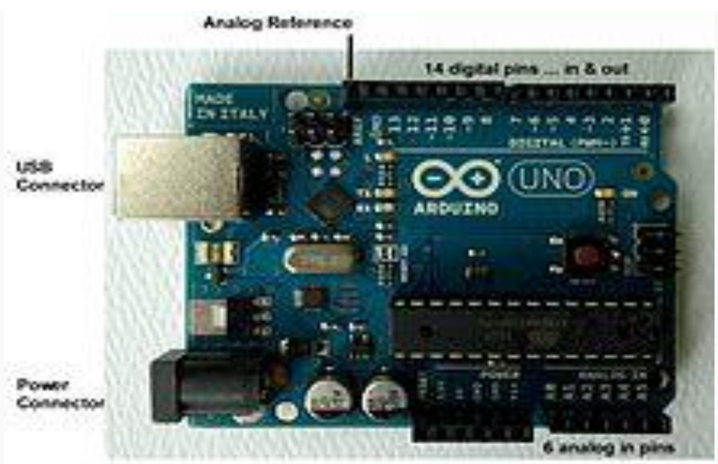

Figure 3.2: Arduino plug-in

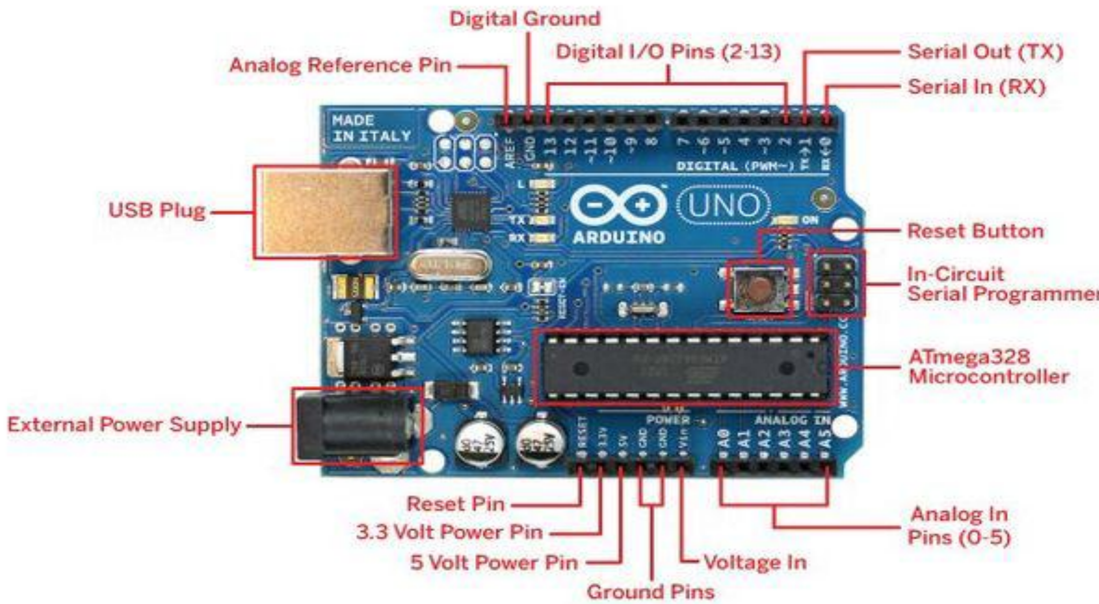

figure 3.3 : arduino uno components

The Arduino board exposes most of the microcontroller's I/O pins for use by other circuits. The Decimal, Due milanove, and current Uno provide 14 digital I/O pins, six of which can produce pulse-width modulated signals, and six analog inputs, which can also be used as six digital I/O pins. These pins are on the top of the board, via female 0.1-inch (2.54 mm) headers. Several plug-in application shields are also commercially available. The Arduino Nano, and Arduino-compatible Bare Bones Board and Boarduino boards may provide male header pins on the underside of the board that can plug into solder less breadboards.

Many Arduino-compatible and Arduino-derived boards exist. Some are functionally equivalent to an Arduino and can be used interchangeably. Many enhance the basic Arduino by adding output driv.ers, often for use in school-level education, to simplify making buggies and small robots. Others are electrically equivalent but change the form factor, sometimes retaining compatibility with shields, sometimes not. Some variants use different processors, of varying compatibility.

The Arduino project provides the Arduino integrated development environment (IDE), which is a cross-platform application written in the programming language Java. It originated from the IDE for the languages Processing and Wiring. It is designed to introduce programming to artists and other newcomers unfamiliar with software development. It includes a code editor with features such as syntax high lighting, brace matching, and automatic indentation, and provides simple one-click mechanism to compile and load programs to an Arduino board. A program written with the IDE for Arduino is called a "sketch".

The Arduino IDE supports the languages C and C++ using special rules to organize code. The Arduino IDE supplies a software library called Wiring from the Wiring project, which provides many common input and output procedures. A typical Arduino C/C++ sketch consist of two functions that are compiled and linked with a program stub main() into an executable cyclic executive program:

- setup(): a function that runs once at the start of a program and that can initialize settings.
- loop(): a function called repeatedly until the board powers off.

After compiling and linking with the GNU tool chain, also included with the IDE distribution, the Arduino IDE employs the program avrdude to convert the executable code into a text file in hexadecimal coding that is loaded into the Arduino board by a loader program in the board's firmware.

3.4.2 Arduino Applications

Xoscillo, an open-source oscilloscope .

Scientific equipment such as the Chemduino .

Arduinome, a MIDI controller device that mimics the Monome .

OBDuino, a trip computer that uses the on-board diagnostics interface found in most modern cars .

Ardupilot, drone software and hardware

Arduino Phone, a do-it-yourself cell phone.
GertDuino, an Arduino mate for the Raspberry Pi.
Water quality testing platform.
Homemade CNC using Arduino and DC motors with close loop. control by Homofaciens.
DC motor control using Arduino and H-Bridge.

3.5 Servo motor

"A servomotor (servo) is an electromechanical device in which an electrical input determines the position of the armature of a motor,"

Dc Servomotors:

These motors are separately-excited or permanent-magnet. The speed of dc servomotor is normally controlled by varying the armature voltage. Their armature is deliberately designed to have large resistance so that torque-speed characteristics are linear and have a large negative slope serves the purpose of providing the various damping for the servo driving system.

AC Servomotors

Most of the ac servomotors are of the two-phase squirrel cage induction type and are used for low power applications**.**

Normally run on 60 or 400 Hz (for airborne systems). The stator has two distributed windings which are displaced from each other by 90^{o} (electrical). The main winding (also called the reference or fixed phase) is supplied from a constant voltage source.

$$Vm0\angle^{o}$$

where : Vm = maximum voltage

^{o} = theta = the stepping angle

the other winding (also called the control phase) is supplied with a variable voltage source of the same frequency as the reference winding but is phase displaced by 90^{o}(electrical) . Since the rotor bars have high resistance, the torque speed characteristics for various armature voltages are almost linear over a wide speed range particularly near the zero speed. The motor speed can be controlled by varying the voltage of the main phase while keeping that of the reference phase constant.

The characteristics equation is given as:

$$\boldsymbol{T = -Kw \times W + KV \times Va}$$

W = No load speed (ω0 ….rad/S): the rotational speed when the motor runs at no load.

T =Starting torque (Tst ….N.m) : torque developed at starting (maximum)

Kv = Slope of torque speed line

Va = the voltage across the control circuit

We used servo motor due to :

- it provide high torque at low speed
- not expensive
- no encoder required
- simple system

3.6 Light sensors

A Light Sensor generates an output signal indicating the intensity of light by measuring the radiant energy that exists in a very narrow range of frequencies basically called "light", and which ranges in frequency from "Infrared" to "Visible" up to "Ultraviolet" light spectrum. The light sensor is a passive device that convert this "light energy" whether visible or in the infrared parts of the spectrum into an electrical signal output. Light sensors are more commonly known as "Photoelectric Devices" or "Photo Sensors" because the convert light energy (photons) into electricity (electrons). Often used in auto dimming, darkness or twilight detection for turning the street lights "ON" and "OFF", and for photographic exposure meter type applications.

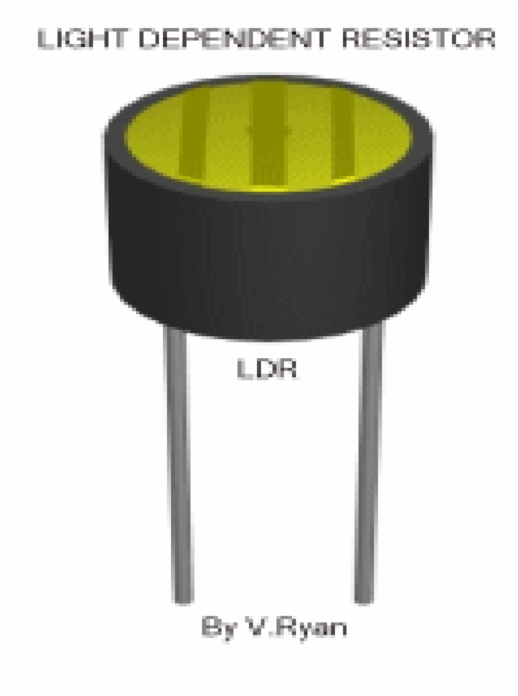

FIGURE 3.4 : light dependent resistor

CHAPTER FOUR
SIMULATION AND DESIGN

4.1 Introduction

In this project we will make the solar panel track the sun position depended on electric circuits that control the movement of the solar panel using special type of motors called servo motor. The servo motor is controlled arduino board to reach the desired response of the system. In this chapter we will observe how tracking system work.

4.2 List of Components

To complete this project we used the following tools and parts, as well as access to a laser cutter.

Component	Use
Arduino Uno + USB Cable	Programmed the movement of solar panel.
2 x 9g Metal Gear Servos	For movement in dual axis.
1 x 5 Port Terminal Block	Connection.
4 x 10K Ohm Resistors	Commutate the voltage the LDRs.
4 x Light Detecting Resistors	Detect the sun light.
Jumper wires	Connection
Power supply(5v)	Supplies the circuit to energize.

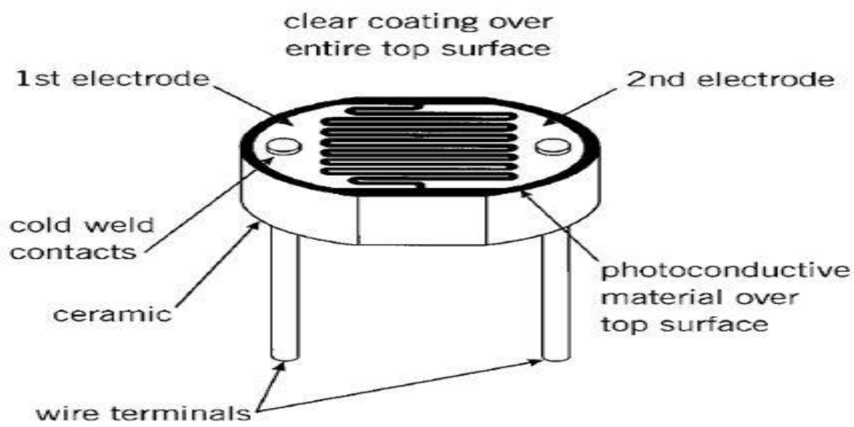

Figure 4.1 : Light Detecting Resistors (LDR)

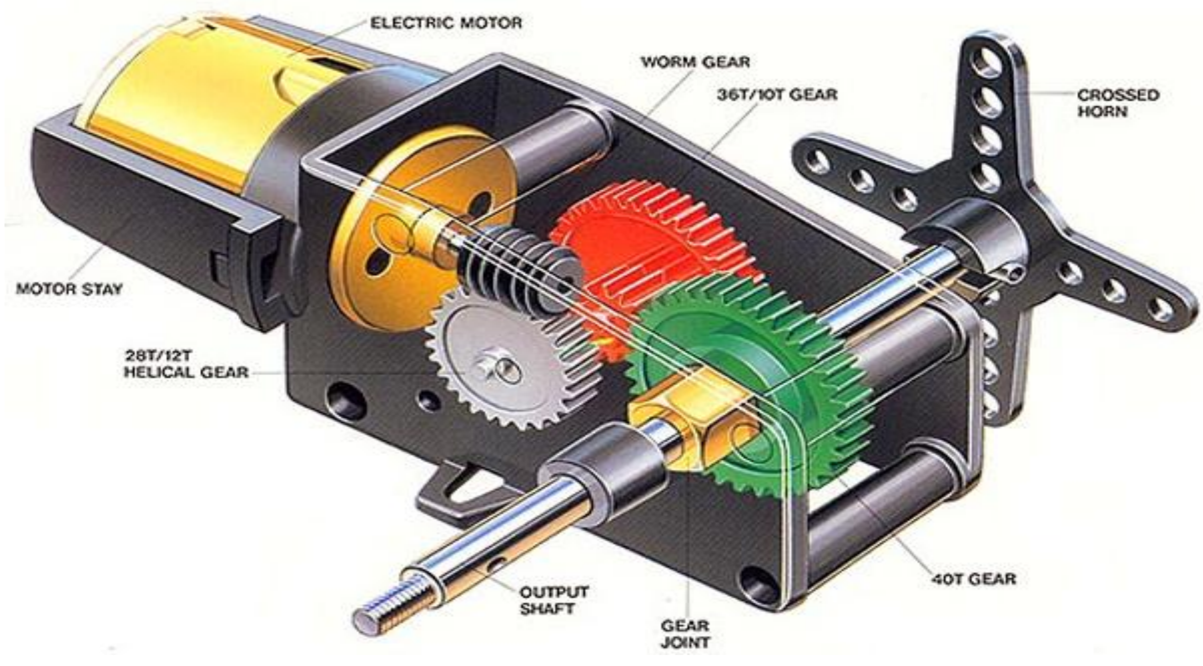

Figure 4.2 : servo motor components

4.3 Electrical circuit

LDR1 has two conjunctions the first one is connected to +Vcc and the other connected to the ground (Gnd) through a resistor and to pin A0 in arduino ,LDR2,LDR3 and LDR4 same as LDR1 are connected to +vcc and to the ground (Gnd) through another three resistors but also connected to pinA1,pinA2 and pin A3 respectively in arduino.

We used two servo motors , the first servo motor Servo1 has three conjunctions ,the first one is connected to the Gnd , the second to the negative part of the source and the third conjunction connected to Pin9 . Servo 2 same as Servo1 but the third conjunction connected to Pin10 .

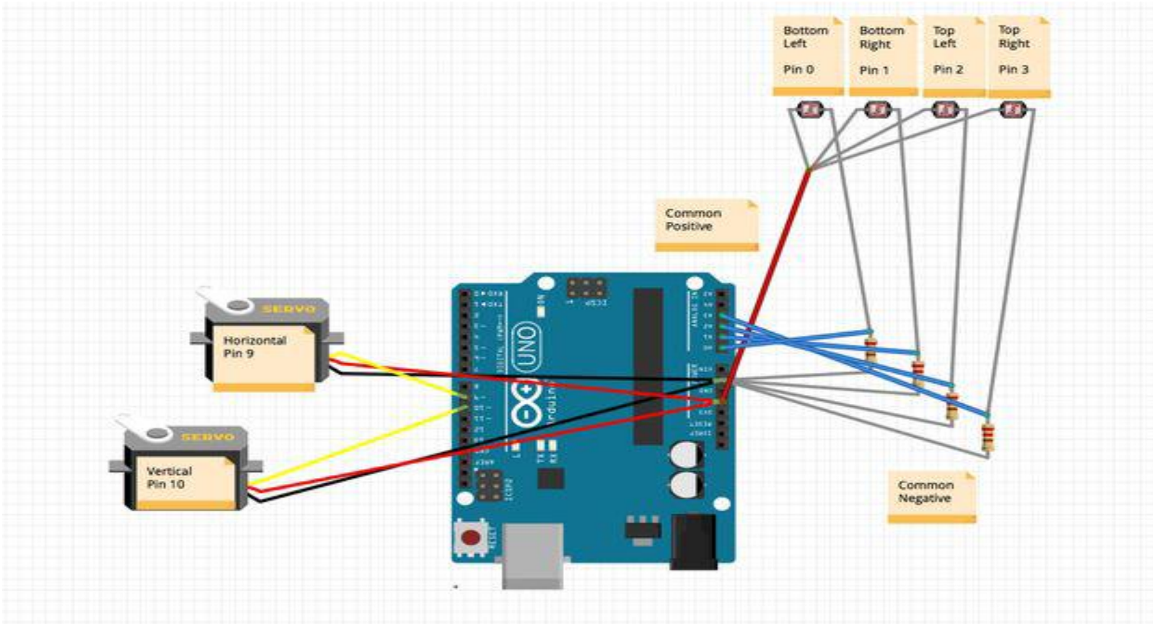

Figure 4.3 : Connection diagram

4.4 Operation of tracking system

operation the solar panel position is controlled automatically depending on the reading of the four LDR's two of them for north and south axis, the other two for east-west axis. The arduino receives the signals from LDR's in voltage signal form and after processing decide the suitable action that makes the panel in vertical position with the sun light as far as possible. The motion mechanism of concerned servo motor is done when one of LDR reading is more than the average of the all LDR's in the same axis, until all the readings of the same axis is equaled then the motor will stop. generally, for any reason. When auxiliary LDR's signal reach to the microcontroller the servo motor moves depending of the LDR signal until receiving signal from the top LDR's.

4.5 Movement and positioning conditions

4.5.1 Case 1 : Both Servo off-mode

In this case both servo 1 and 2 are off , so the solar panel will stand in the fixed position.

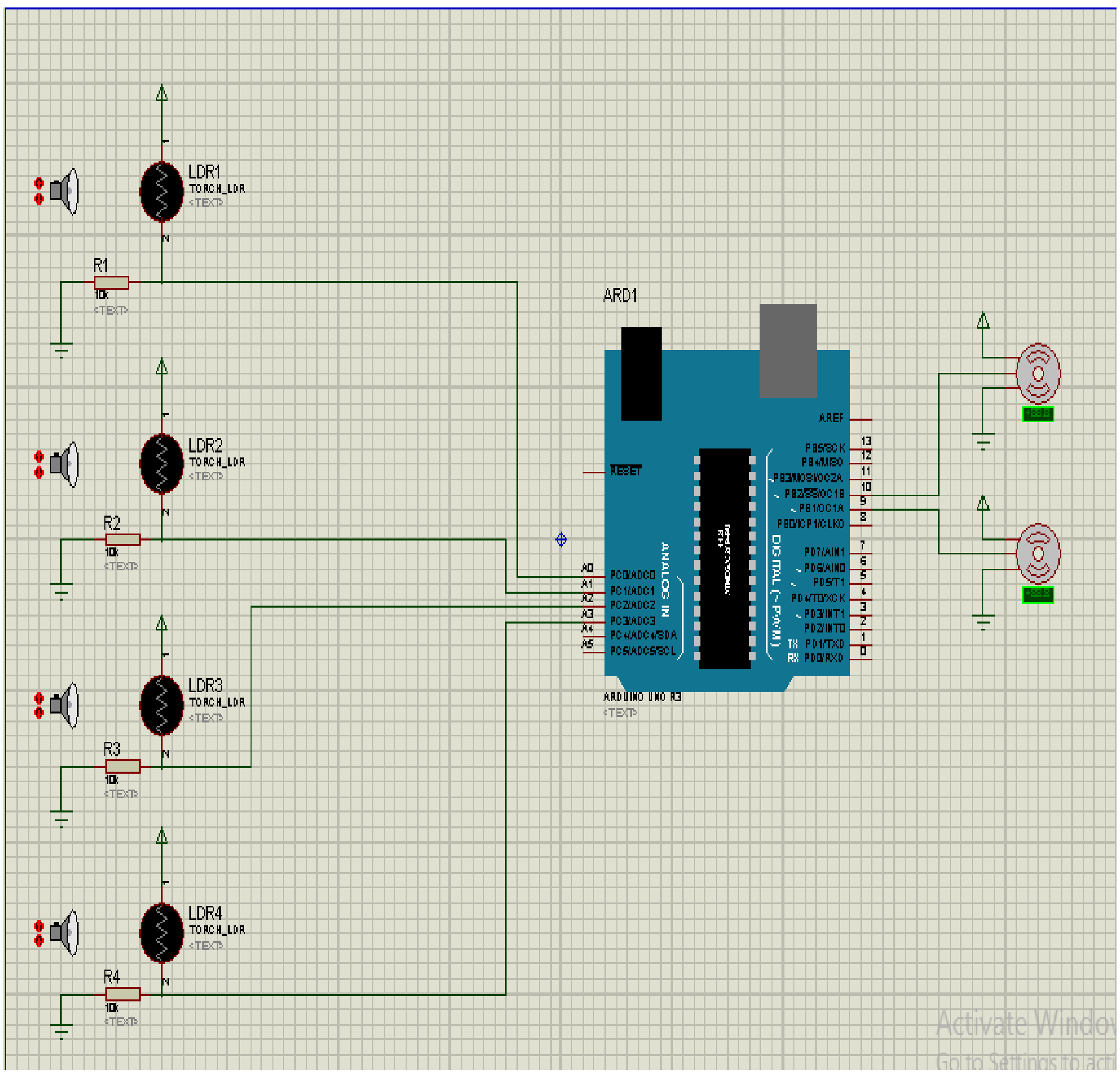

figure 4.4 : servo off-mode

4.5.2 Case 2 : servo1 clockwise rotation mode (from west to east)

In this case LDR 1 detected a sun light more than the other LDR'S , so the LDR 1 send a signal to the arduino then the arduino send another signal to servo 1 to rotate the solar panel to the east .

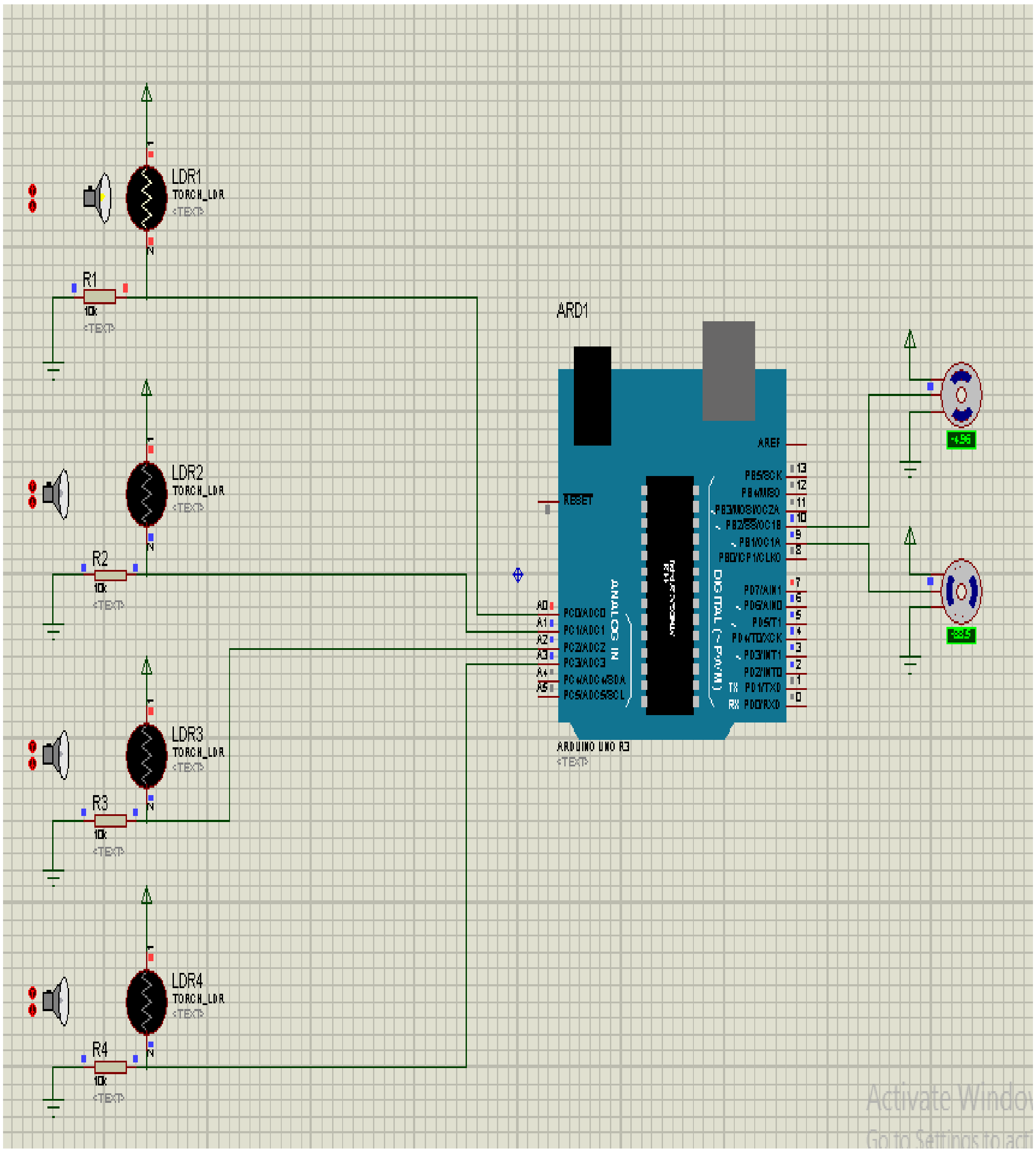

Figure 4.5 : servo1 clockwise rotation

4.5.3 Case 3 : Servo1 anticlockwise rotation mode

(from east to west)

In this case LDR 2 detected a sun light more than the other LDR'S , so the LDR 2 send a signal to the arduino then the arduino send another signal to servo 1 to rotate the solar panel to the west .

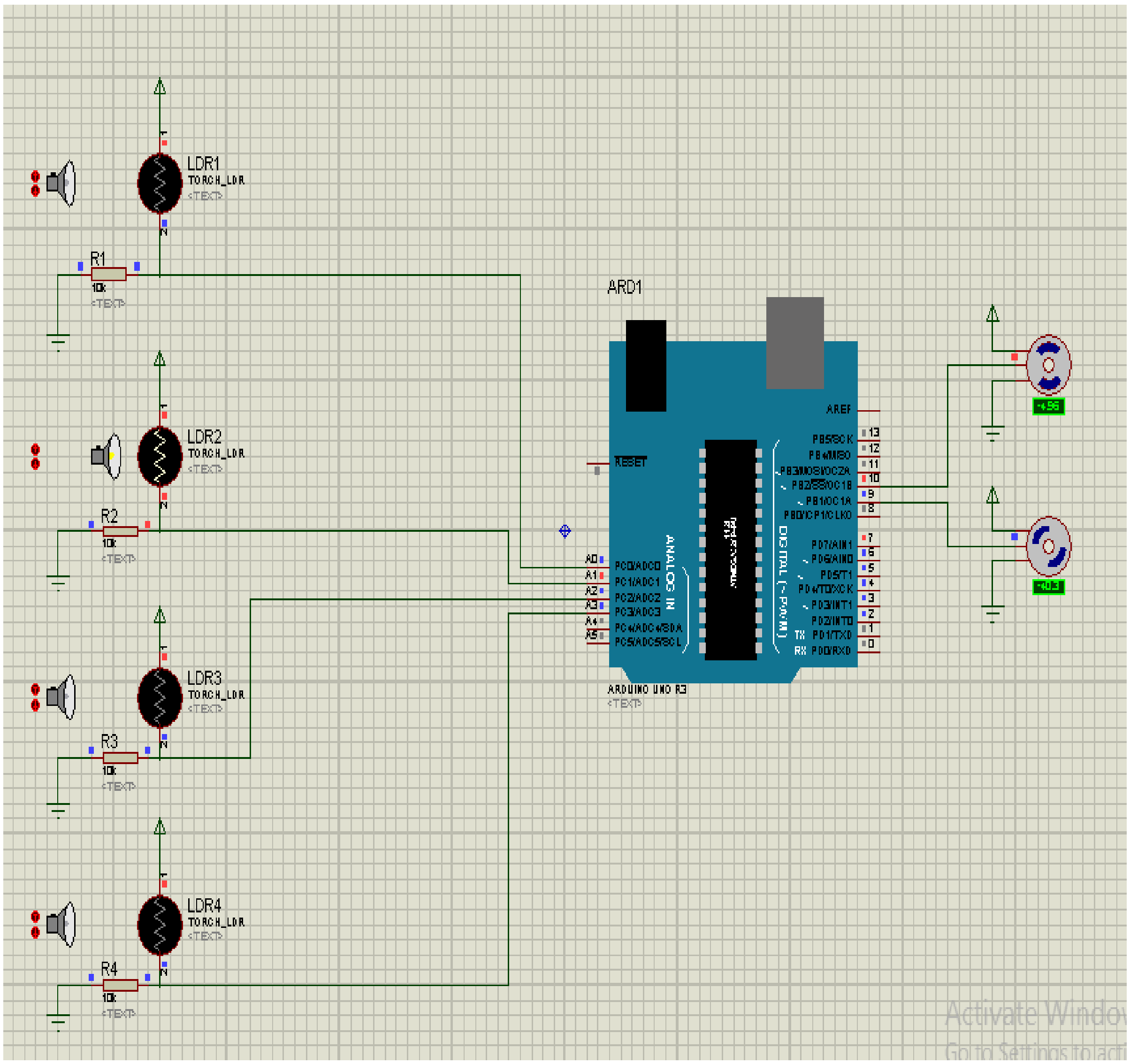

figure 4.6 : servo1 anticlockwise rotation

4.5.4 Case 4 : Servo2 clockwise rotation mode (from south to north)

In this case LDR 3 detected a sun light more than the other LDR'S , so the LDR 3 send a signal to the arduino then the arduino send another signal to servo 2 to rotate the solar panel to the north .

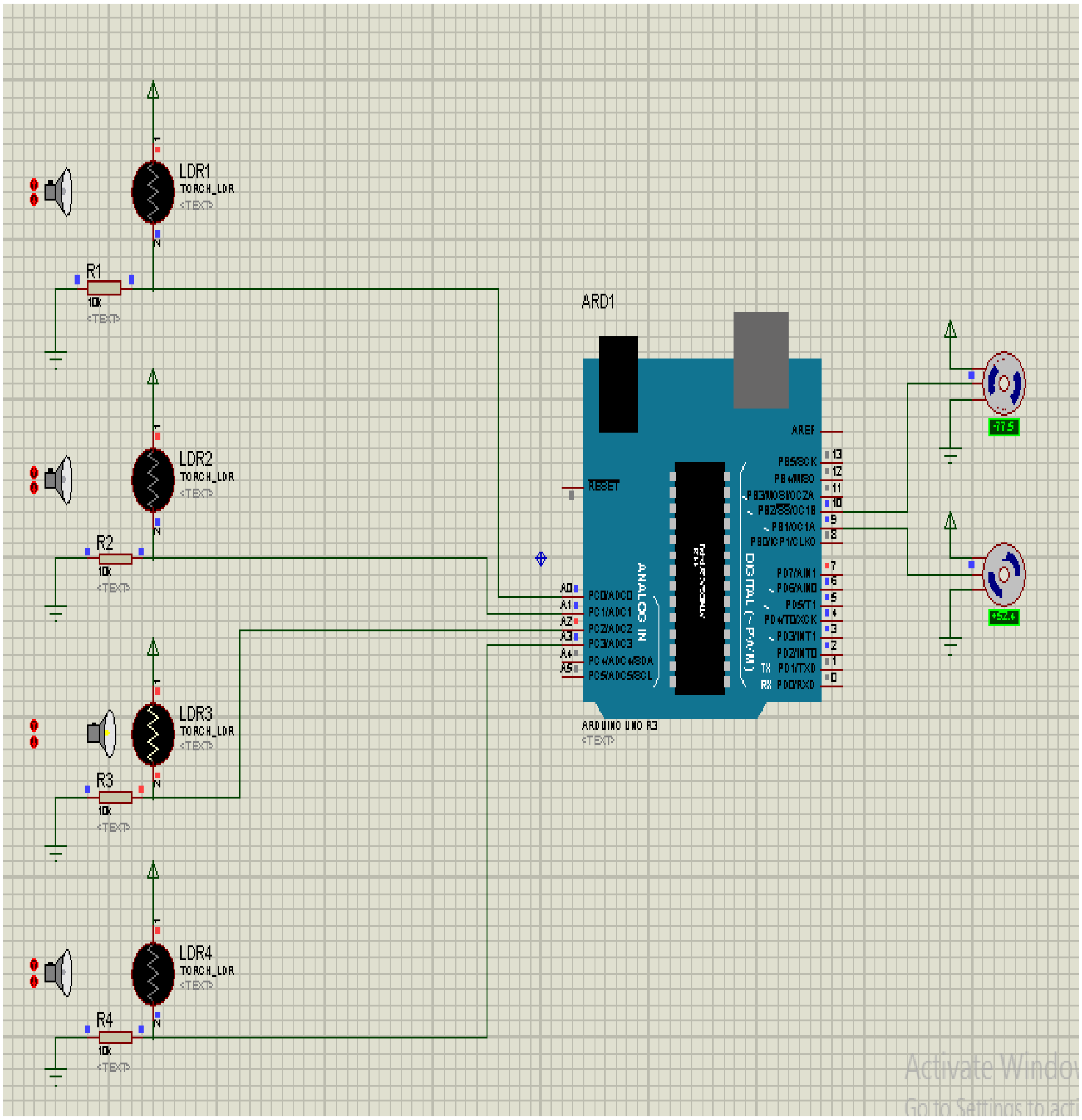

figure 4.7 : servo2 clockwise rotation

45.5 Case 5 : Servo2 anticlockwise rotation mode (from north to south)

In this case LDR 4 detected a sun light more than the other LDR'S , so the LDR 4 send a signal to the arduino then the arduino send another signal to servo 2 to rotate the solar panel to the south .

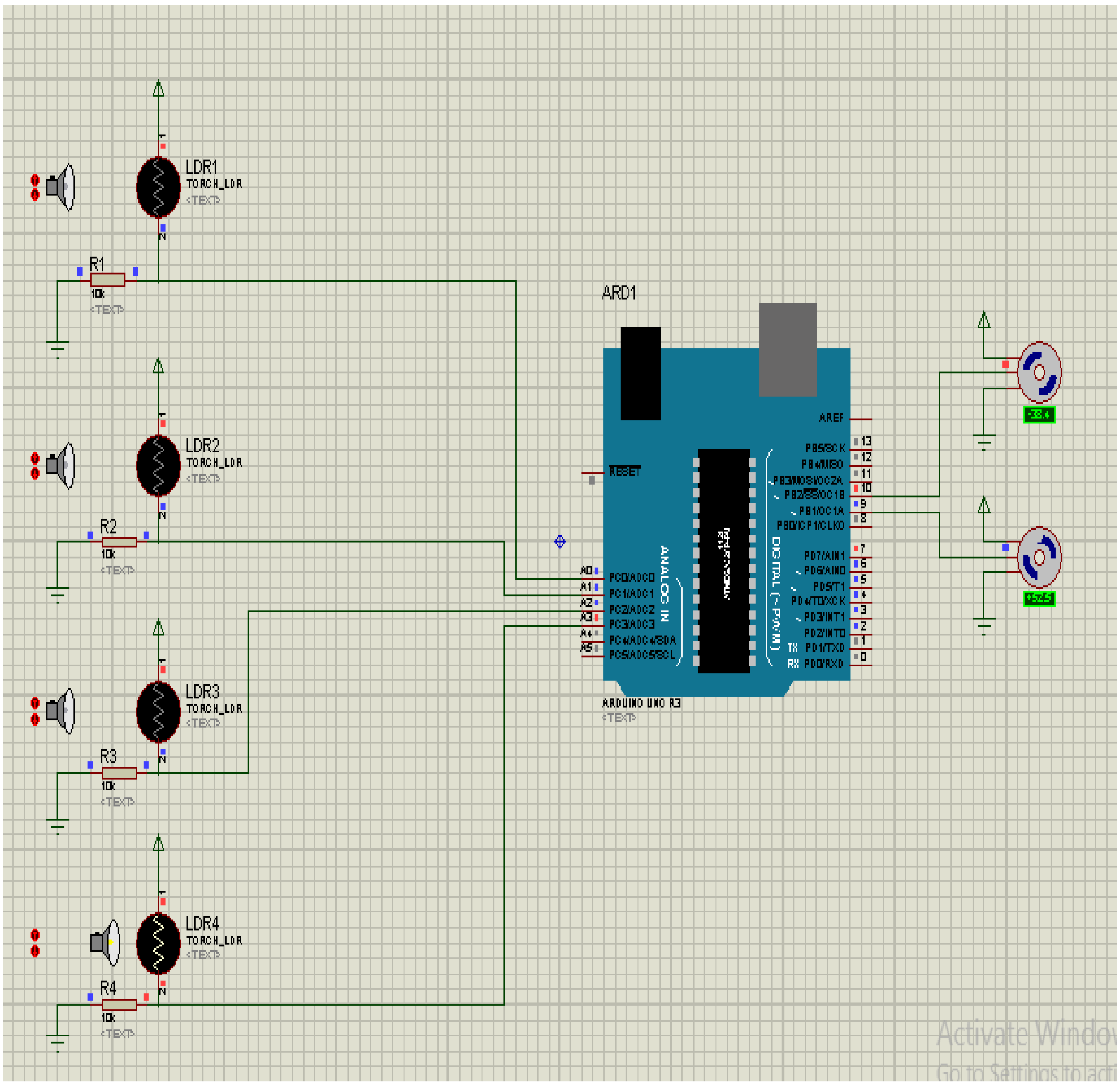

figure 4.8 : servo2 anticlockwise rotation

4.6 Design

The design has three main parts that combined together in on full-design.

The design has been chosen due to two factors :

- Simplicity
- Financial factor

4.6.1 Lower part:

The lower part is important for the equilibrium of the design and also It's responsible of the horizontal movement of the model .

4.6.2 Middle part:

The middle part is responsible of the vertical movement of the model.

4.6.3 Upper part:

It's the part that hold the solar panel and the LDR's .

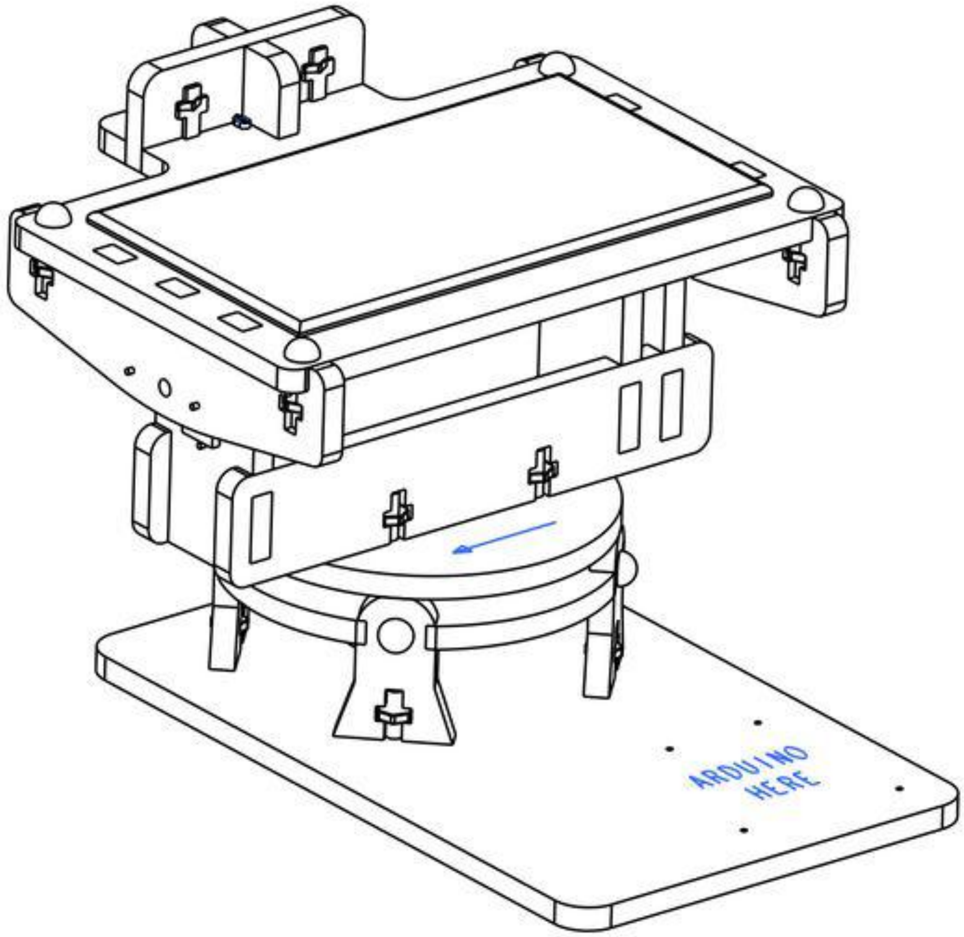

Figure 4.9 : Full-design

CHAPTER FIVE

CONCLUSION AND RECOMMENDATION

5.1 Conclusion

One of the most important problems facing the world today is Energy problem. Most of energy production is depended on fossil fuel like oil and coal. These mains sources of fossil fuel are expected to end up from the world during the recent century. Therefore, renewable energy replaces the conventional fuels for producing electricity. Renewable energy is energy which comes from natural resources such as sunlight, wind tides and waves Solar energy is one of the most popular renewable sources now a day . In these a solar tracking system has been developed to increase the amount of power generated by the solar panel. An arduino Uno r3 is used to control the movement of the solar panel. The complete simulation diagram of the solar tracker system is built using proteus software. A series of simulation studies have been conducted in order to evaluate the performance of the solar tracker system. The simulation result is shown good performance of the solar tracker system controlled by arduino .

5.2 Recommendations

- To use PID controller for tracking the sun location for maximum power.

- To use fuzzy logic for tracking the sun location.

- To use fixed control algorithms and compare the result of dynamic system.

-To use :

Optional Electronics

5.5V Solar Cell
LED Volt Meter

Arduino Sensor Shield

- To use a Reflection mirrors to concentrate more sun light to the center of the solar panel to increase the production of energy .

5.3 programming code

```
 #include <Servo.h>
Servo myservo;
Servo myservo1;
int pos = 90;   // initial position
int pos1 = 90;   // initial position
int sens1 = A0; // LRD 1 pin
int sens2 = A1; //LDR 2 pin
int sens3 = A2; // LRD 3 pin
int sens4 = A3; //LDR 4 pin
int tolerance = 2;
int tolerance1 = 2;

void setup()
{

  myservo.attach(9);  // attaches the servo on pin 9 to the servo object
  myservo1.attach(10);
  pinMode(sens1, INPUT);
  pinMode(sens2, INPUT);
  pinMode(sens3, INPUT);
  pinMode(sens4, INPUT);
  myservo.write(pos);
  myservo1.write(pos1);

}

void loop()
```

```
{
  int val1 = analogRead(sens1); // read the value of sensor 1
  int val2 = analogRead(sens2); // read the value of sensor 2
  int val3 = analogRead(sens3); // read the value of sensor 1
  int val4 = analogRead(sens4); // read the value of sensor 2

  if((abs(val1 - val2) <= tolerance) || (abs(val2 - val1) <= tolerance)) {

    //do nothing if the difference between values is within the tolerance
  } else {
    if(val1 > val2)
    {

      pos = --pos;
    }
    if(val1 < val2)
    {

      pos = ++pos;
    }
  }

  if(pos > 180) { pos = 180; } // reset to 180 if it goes higher
  if(pos < 0) { pos = 0; } // reset to 0 if it goes lower

  myservo.write(pos); // write the position to servo
  delay(50);
```

```
if((abs(val3 - val4) <= tolerance1) || (abs(val4 - val3) <= tolerance1)) {

   //do nothing if the difference between values is within the tolerance 1
  } else {
    if(val3 > val4)
    {

      pos1 = --pos1;
    }
    if(val3 < val4)
    {

      pos1 = ++pos1;
    }
  }

  if(pos1 > 180) { pos1 = 180; } // reset to 180 if it goes higher
  if(pos1 < 0) { pos1 = 0; } // reset to 0 if it goes lower

  myservo1.write(pos1); // write the position to servo
  delay(50);
}
```

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