Sun Tracking Solar Panel

Project report submitted in fulfillment of the requirements for the Degree of

BACHELOR OF TECHNOLOGY

IN

ELECTRONICS AND COMMUNICATION ENGINEERING

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DECLARATION BY THE SCHOLAR

We hereby declare that the work reported in the B-Tech project report entitled **"Sun Tracking Solar Panel"** submitted at **Jaypee University of Information Technology ,Waknaghat India,** is an authentic record of our work carried out under the supervision of **Dr. Meenakshi Sood**. We have not submitted this work elsewhere for any other degree or diploma.

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CERTIFICATE

This is to certify that the work reported in the B.tech project report entitled **"Sun Tracking Solar Panel"** which is being submitted by **Surbhi Sharma, Aditya Parmar** in fulfillment for the award of Bachelor of Technology in Electronics and Communication Engineering by the **Jaypee University of Information Technology,** is the record of candidate's own work carried out by them under my supervision. This work is original and has not been submitted partially or fully anywhere else for any other degree or diploma.

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The outcome of this project required a lot of guidance and assistance and we are extremely fortunate to have got this all along the project work. Whatever we have done is only due to such guidance and assistance of Dr. Meenakshi Sood and we would like to express our gratitude to her. Also we would like to thank the HOD Prof. Sunil Bhooshan (ECE department) and the entire department for giving us such an opportunity and also for providing the necessary help.

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ABSTRACT

The depletion of non-renewable resources and increase in pollution, calls for an urgent need to find new ways of making use of renewable resources and energy. Global warming is also a problem being faced by all the countries in the world which also forces us to switch to renewable sources. This project is devoted to solar energy and use of solar tracker system, designed using different microcontrollers The proposed method of dual axis rotation will increase the amount of energy generated by solar panels by rotating them in sun's direction. The model makes use of DC motor being controlled by microcontroller that moves the panel according to the signals of LDR.

Chapter 1

INTRODUCTION

1.1 Overview

1.1.1 Solar Panel

Solar panel absorbs the sun rays and convert that energy to electricity. A photovoltaic (PV) module or a solar panel is a connected assembly of a large number of solar cells. Solar Photovoltaic panels consists of solar cell array that generates and supplies electricity for different commercial and household applications. The module is rated on the basis of DC output power generated under standard test conditions. There are a small number of available solar panels that has an efficiency more than 22% or 24%. A single solar module generates a small amount of power hence the final installations contain several modules. The photovoltaic system consists of a panel, a solar inverter, and sometimes a battery and interconnection wiring.

1.1.2 Working

Silicon is bulding ingredient of solar cells. Sunlight is constitutes of particles called photons, that are radiated from the sun. When they hit the

silicon atoms of the solar cell, they transfer their energy to the outer shell electrons, knocking them off the orbits. Freeing the electrons was half the work of a solar cell: it then needs to move these electrons in a particular direction resulting in electric current. This can be done by creating an electrical imbalance within the cell.

This is done by the internal organisation of silicon. Doping with small amounts of other elements into silicon structure results in two different types of silicon: n-type, which has extra electrons, and p-type, which has missing electrons. When p-n junctions are placed side by side inside a solar cell, the extra electrons in n-type silicon jumps to fill the holes in the p-type silicon. This makes n-type silicon positively charged, and the p-type negatively charged, resulting in an electric field across the cell which forces the electrons to move in a specific direction.

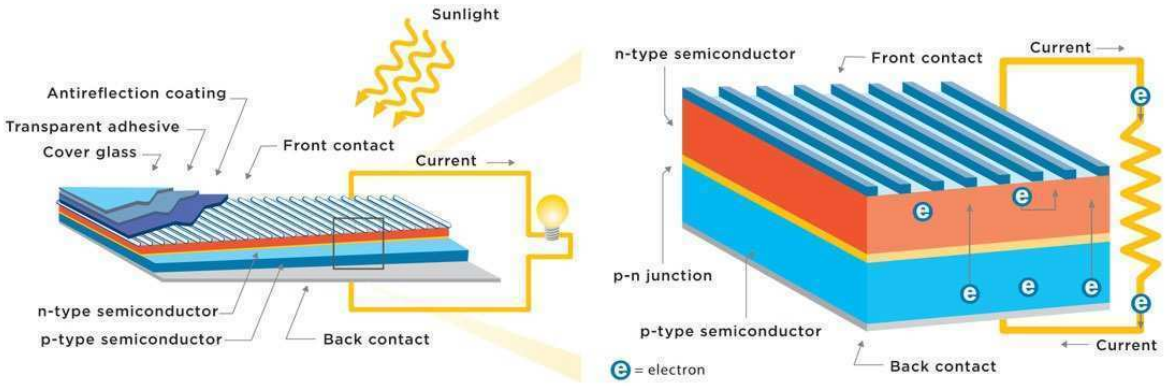

Figure 1.1: Solar Cell

1.2 Why Solar Energy?

The green energy is the urgent need of the time. This is because non renewable resources produce greenhouse gases which cause depletion of ozone layer. As the concern for environment grows so does the importance of re-

newable energy[2].The other reason except pollution is that non renewable resourses if energy are depleting at a very fast pace and we also know that the world population is increasing rapidly which will also increase the demand of energy. (The energy requirements of different countries is compared in Table 1). The other reason behind the importance to use renewable sources of energy is that they are cleaner, easy to use, require less

Table 1.1: Usage of energy in different countries

Solar Photovoltaics				
	GW installed	TWh consumed	24/7/365.25 TWh maximum output	Load factor %
USA	7.3	4.4	64.1	6.86
Czech republ	2.1	2.2	18.2	12.11
France	3.7	4.0	32.4	12.36
Germany	32.6	28.0	286.1	9.79
Italy	16.2	18.5	142.4	12.99
Portugal	0.2	0.4	1.9	21.52
Spain	4.5	11.9	39.8	29.92
UK	1.7	1.3	14.5	8.96
Australia	2.4	2.8	21.1	13.26
China	8.3	4.5	72.8	6.18
Japan	6.9	6.2	60.6	10.23

maintenance, and are always available. Lot of research has been carried out in improving solar cells efficiency. The SQ limit says that the maximum theoretical efficiency of a cell with a single pn junction is about 33.7% if the band gap is 1.34 eV.The reason behind this can be

1. Recombination: Electron hole combining to give out a photons.

2. Spectrum loss: The photons must have enough energy to knock off the electron. For silicon the photon must come from red,yellow or blue light.

3. Blackbody radiation: Any material having temperature greater than 0K emits EM rays which cause aproximately 7% of energy loss.

4. Impedance matching: If a resistance is too low the current in the circuit will be low and if it is too high voltage drop is too high, therefore only a particular load resistance can draw maximum power.

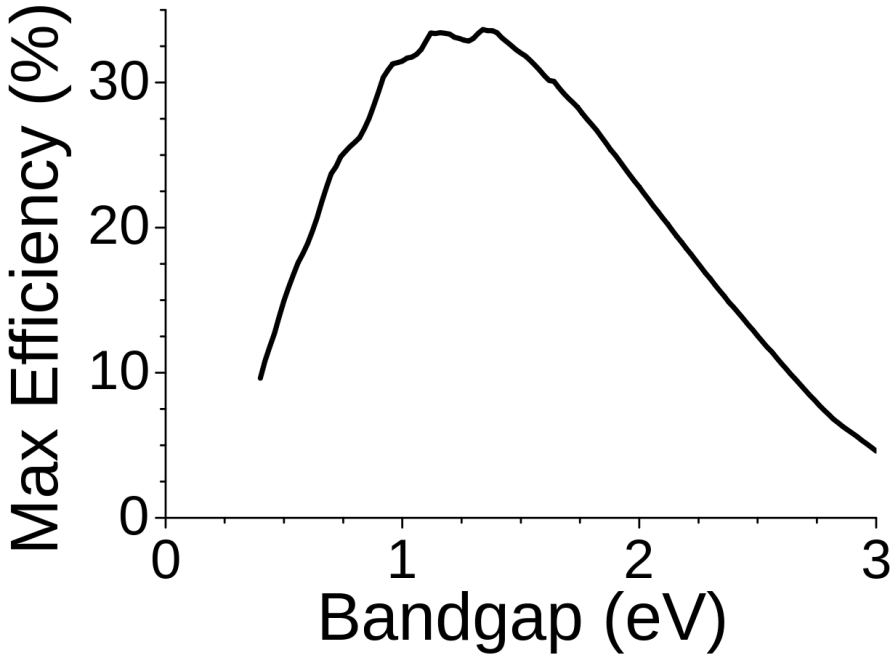

Figure 1.2: SQ limit

The cell efficiency has improved from 17% to 33% lately.[3] Solar energy is free,inexhaustible and causes no pollution or emission og greenhouse gases. The information of the quality and quantity of solar energy available at a particular location is of great importance for the development of a solar tracker.The amount of electrical energy generated is directly proportional to the intensity of the sun light that falls on the solar panel.

1.3 Solar Energy and Solar Trackers

Solar tracking is being applied as an adequate power generation solution, as tracking of the sun from the east to west can increase the efficiency of the solar panel by 4%. By 2050 solar energy will be the biggest source

of electricity. A solar tracker is a device that orients the panel towards the sun. These devices orient themselves throughout the day to follow the sun to maximize energy being captured. Solar Panel is a category of active solar power as solar panels gather sunlight and actively convert it to electricity. Solar Cells, are arranged in a grid pattern on the surface of the solar panel. PV modules are made up of crystalline silicon and the gallium arsenide. Solar panels consist of several solar cells arranged in a grid. When photons hit the silicon atoms of the solar cell, they transfer their energy to the outer shell electrons, knocking them off the orbits. Freeing the electrons was half the work of a solar cell: it then needs to move these electrons in a particular direction resulting in electric current. This can be done by creating an electrical imbalance within the cell. This is done by the internal organisation of silicon.[4] All concentrated solar systems have sun trackers as the systems do not produce energy until directed correctly toward the sun. Single-axis solar trackers rotate on one axis moving east to west in a single direction.This motion helps us to keep the track of the sun during the day.Dual-axis trackers continually face the sun because they can move in two different directions. As during different seasong the north to south location also gets changed it is necessary to make this adjustment which is done by the vertical motion of the trackers.

Chapter 2

OBJECTIVES

2.1 Problem Statement

Installion of solar panels require a roof space and initial investment depending on the size of panel.The initial cost is often quite This discourages people for installation of solar panels at home. Also, solar power is not available during night hours. In cases where solar electricity storage is not developed, use of alternative energy source is required during the night, therefore making it inefficient. A solar panel efficiency is usually 22% that means it can convert only 0.22 of the energy of the sun into electrical energy, means a bigger surface area is required to produce the desired amount of energy.

2.2 Motivation

Considering the true cost of energy, it is necessary to look at the big picture, not just the installation costs. Non renewable resources are depleting rapidly. If not today then may be in a few decades they will vanish from the surface of the Earth. Not only this excessive use of these resources has resulted in environmental pollution. It has caused issues like ozone deple-

tion, global warming which are capable of damaging life from the planet. Solar panels may cost initially too much but the maintenance cost is neglegible. Not only this they are easy to use and with the coming up pf stand alone panels they can be during any hour of the day also at night. the solar energy is almost free of cost not like grid electricity for which bills have to be paid throughout the lifetime. Also the cost of non renewable resources is increasing day by day.

2.3 Objective

Global warming is the major issue being faced by the world today which has raised the demand of green energy production such as solar power. Solar trackers can be used as solution to increase the efficiency of panels. sOlar energy is usable in homes as a supplement source of power or can be used as independent power source. The system responds to its environment in the shortest possible time. Any error be it software or hardware is eliminated or controlled. The system is tested for responsiveness, stablility, reliability, and safety. The design of the system is such that it is stable when being operated and is weather resistant.

2.4 Cost

Solar panels use semiconductor material to generate electricity from sunlight. Semiconductor factories need clean environments and are costly to maintain. The characteristic of the material is such that its electrons get excited in sunlight. Solar cells can be made of single-junction or use multijunctions to make the fullest of various absorption mechanisms(as mentined

in fig:4). Solar cells can be classified into three generation cells:1st,2nd and 3th. The first generation or conventional, traditional or wafer-based cells are made up of crystalline silicon, that includes polysilicon and monocrystalline silicon. Second generation cells or thin film solar cells include amorphous silicon, CdTe and CIGS cells and are used in photovoltaic power stations or in stand-alone power system. The third generation of solar cells includes a large number of thin-film cells and is the emerging technology.

2.5 Efficiency

Solar cell efficiency is the amount of energy converted to electricity from total incident energy. The efficiency is the i combination of latitude and climate, that determines the annual energy output . For example, a solar panel with 30% efficiency and an area of $2m^2$ will produce 600 W at std.test conditions, but will produce more when the sun is high in the sky and less in cloudy weather.

Other factors affecting efficiency-

1. conversion efficiency value
2. reflectance efficiency
3. thermodynamic efficiency
4. charge seperation efficiency

Sunlight has two components: the direct and the diffused. The direct component carries about 90% of the total solar energy while the diffused carries the remaining. As the major part of the energy is in the direct sunlight,it is necessary that the sun remains visible to the panel. The

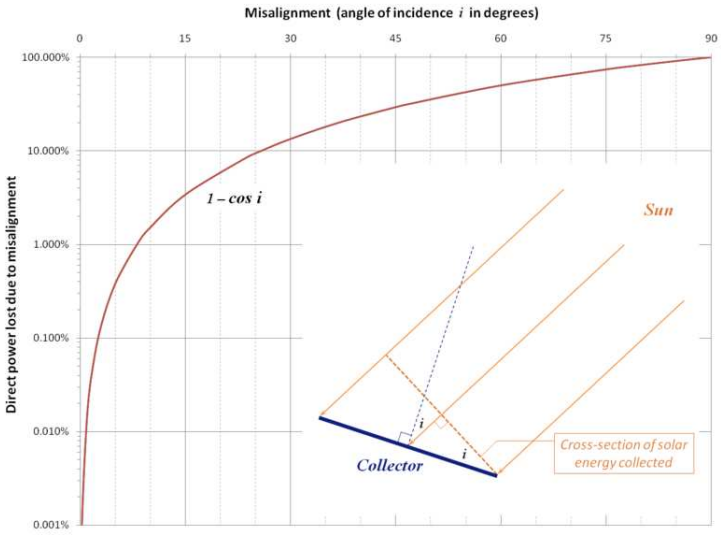

Figure 2.1: Efficiency due to misalignment

energy contribution of the direct rays falls with the cosine of the angle between the incident ray and the panel.

Chapter 3

PROPOSED METHODOLOGY

3.1 Related Work

The entire solar tracking mechanism varies with the location of the place.

1. Single Axis Trackers: Single axis trackers rotate to and fro on single axis. The axis of rotation is aligned along a North meridian. These include:

   (a) horizontal single axis tracker

   (b) vertical single axis tracker

Figure 3.1: Horizontal Single Axis tracker with Tilted Modules in Xitieshan, China. Commissioned in July 2014

   (c) tilted single axis tracker

(d) polar aligned single axis tracker

Figure 3.2: Tilted single axis tracker in Siziwangqi, China

The module orientation with respect to the tracker axis is important while modeling the performance.

2. Sun tracker using lab view to detect the position of the sun: The project has assumed solar energy as a numerical value and is a complete software based project. The problem is that concepts of programming language like C etc. cannot be used in Lab View & the applications produced often run slower. On the other hand, in our research we are using 8051/arduino which can be programmed using simple C logic.

3.2 Proposed Methodolgy

Solar tracker circuit consists of:

1. *Light Sensor Circuit:* Consists of LDRs and resistance combination connected to the microcontroller and placed near the solar panel. Its signals is responsible for movement of the solar panel.

2. *Motor control circuit:* Consists of motor driver IC and a motor. The input pins of the motor driver are connected to the microcontroller and the output pins to the motor. Servo motor will not require any driver IC.

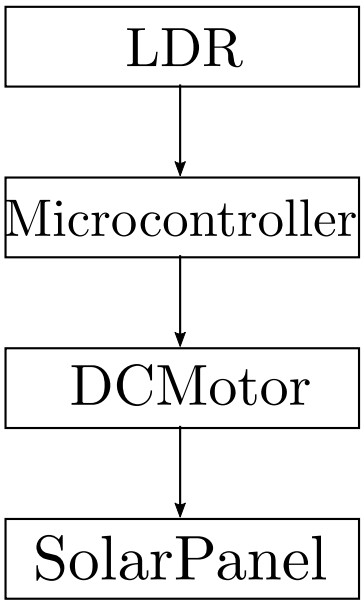

Figure 3.3: Block Diagram

The basic concept behind the working of LDR is the light intensity increases as its resistance decreases. If constant current flows through the LDR and is exposed to light the voltage across it decreases as per the basic principle of V=IR. Using this concept we have measured the voltage across different LDRs and placed it in either logic 0 or logic 1. On the basis of these logics signals are sent to the input pins of the motor driver which makes the motor rotate either clockwise or anticlockwise. The rotation continues till the logic across the LDRs is not equal.

3.3 Algorithm Flowchart

Fig:3.4 is a flow chart on the basis of which horizontal tracker is made. Angle a1 and a2 are limiters and they define the maximum and minimum angle of rotation of servo motor.

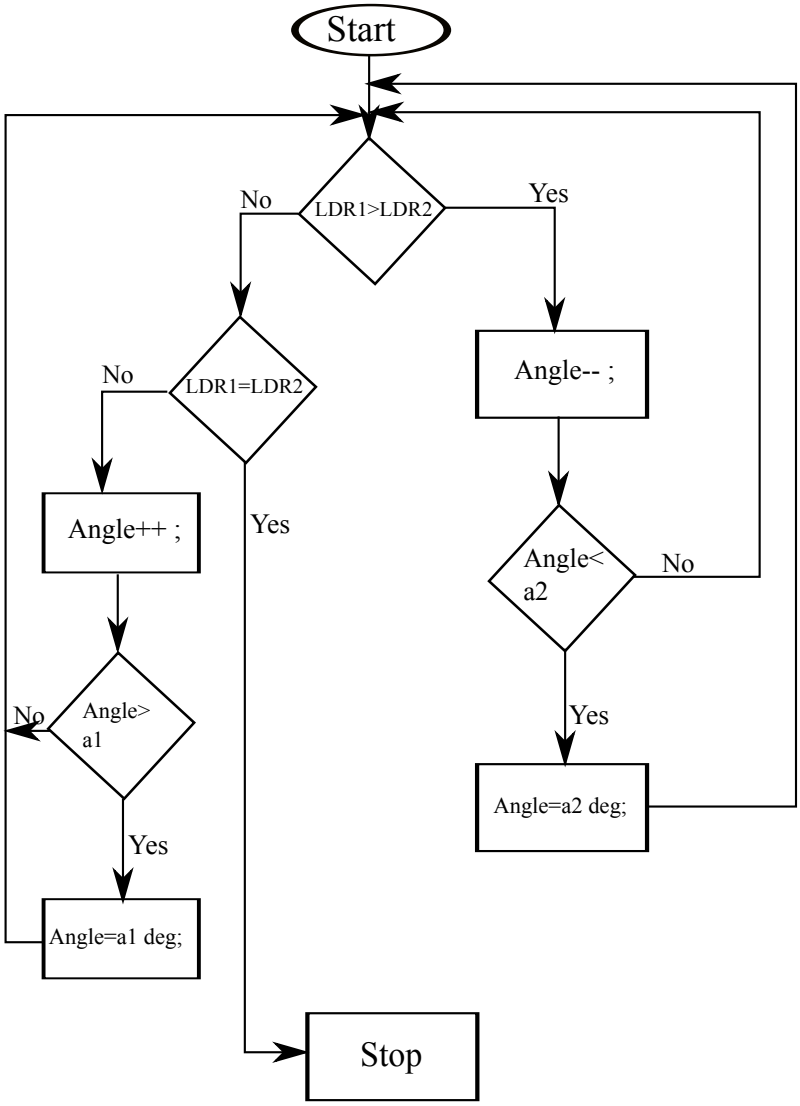

Figure 3.4: Algorithm for Horizontal Tracking

Fig:3.5 is a flow chart on the basis of which vertical motion occurs. Angle a3 and a4 are to limit the angle of servo motor.

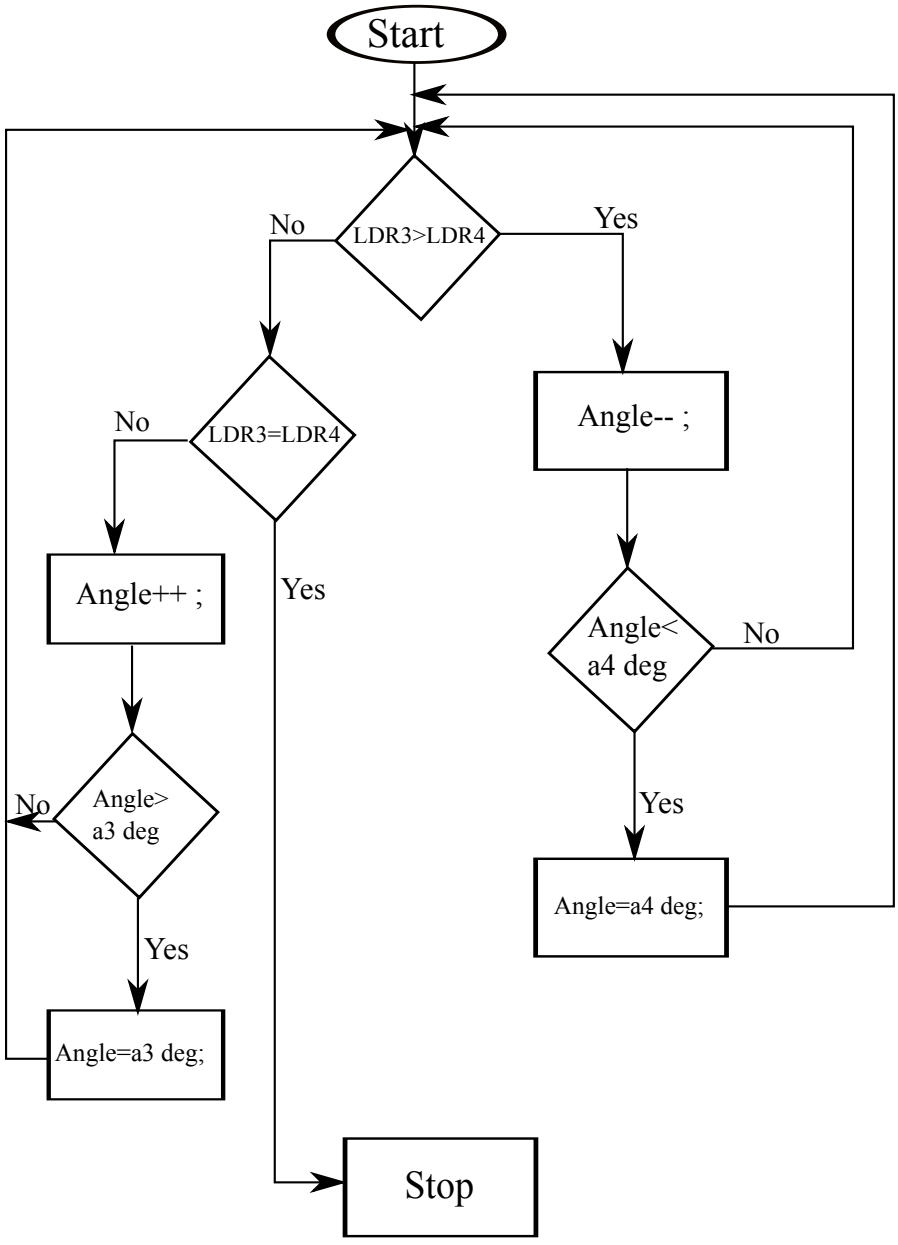

Figure 3.5: Algorithm for Vertical Tracking

3.4 Hardware Specifications

1. *Microcontroller 8051:* The Intel 8051 microcontroller is the most used general purpose microcontrollers . It has 40 pin and an an 8-bit architecture which means data bus is limited to 8 bits. It consists of four ports having eight pins each. Some of the features that have made the 8051 popular are:

   - 4 register banks further divided into sets
   - 8-bit data bus
   - Address bus of 16 bits
   - Timers of 16 bits (usually 2, but may have more, or less)
   - 3 internal and 2 external interrupts
   - Four ports :8-bit
   - 16-bit program counter and data pointer
   - 11.0592 MHz Crystal
   - 4 KB ROM
   - 128 bytes of RAM

   Pin Description:

   PIN 9: reset pin which is used to reset the microcontroller's internal registers and ports to make the code start again.

   PINS 18 & 19: external oscillator connection pins

   PIN 40 and 20: supply pins with 40 connected to 5V and 20 to ground.

   PINS31: 8051 has a ROM of 4k which means external memory is required whenever the code exceeds this value. If connected to Vcc

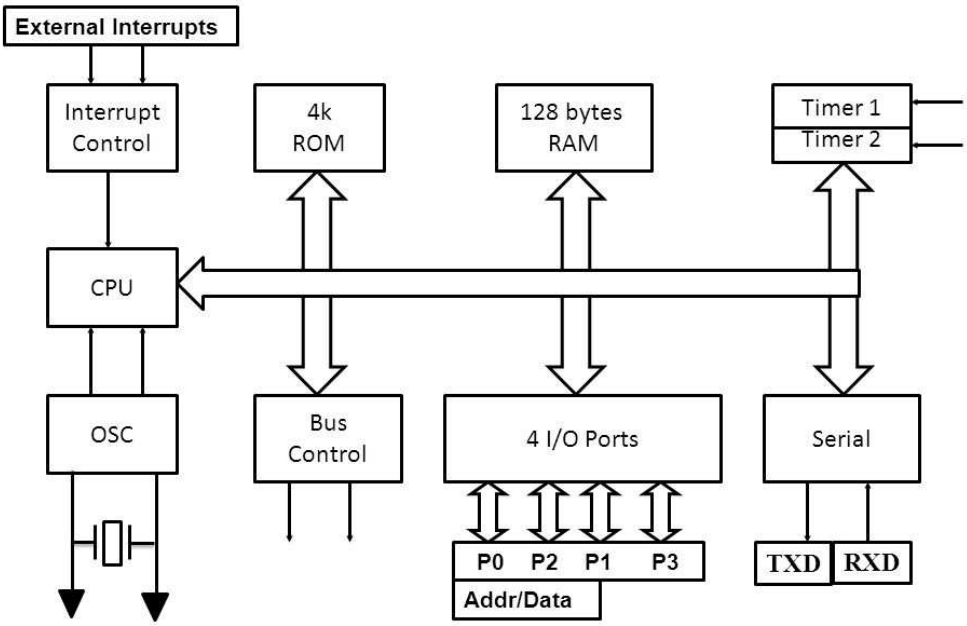

Figure 3.6: The Internal architecture of 8051

means no ext memory if to ground ext memory present.

PINS30: ALE used whem there are many memory chips connected and one of them has to be selected.

PINS29: PSEN has to be connected to ground to use ext memory. In case of ext ROM connected to ground which means data is being read from memory.

2. *Light Dependent Resistor:* A photoresistor is a light-controlled varistor.The resistance of LDR decreases with increase in light intensity: photoconductivity. It is made up of a high resistance semiconductor. In the dark, it has a resistance as high as several megaohms (M),in light,it has a resistance as low as a few hundred ohms. It works on the simple principle of photoconductivity as light strikes its surface electrons get ejected and become free electrons thus decreasing the

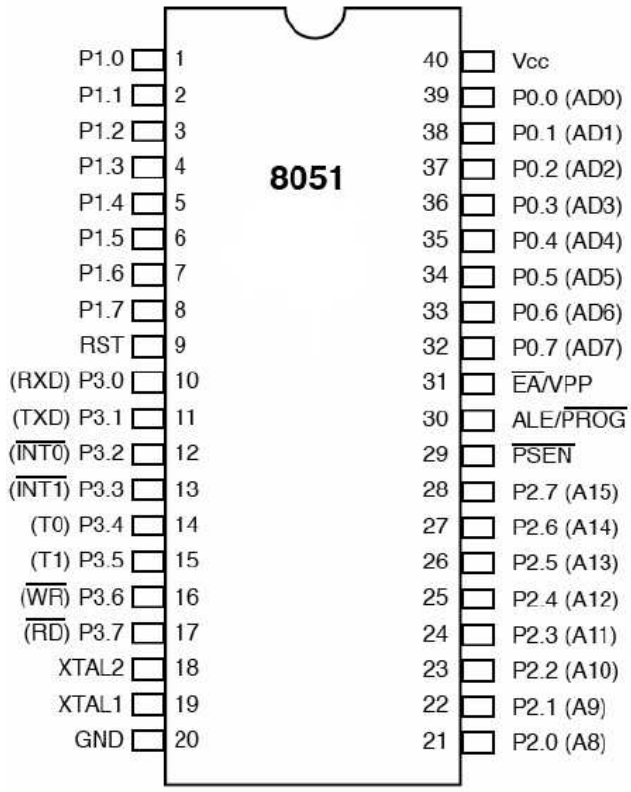

Figure 3.7: Pin Diagram of IC 8051

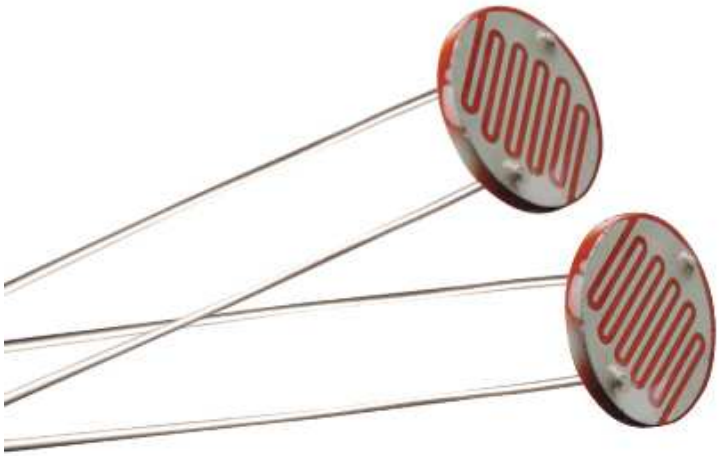

Figure 3.8: LDR

resistance.

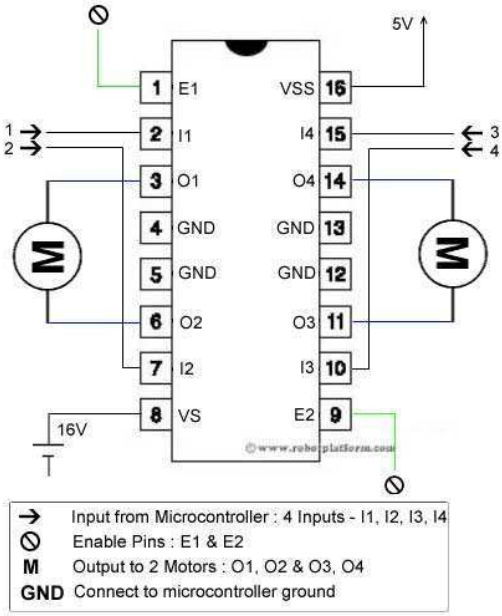

Figure 3.9: L293D Pin Diagram

3. *Motor Driver (L293D):* L293D has a dual h-bridge internal structure. Motor drivers are current amplifiers as they take a low-current control signal and give a higher-current signal. This high current signal can be used to drive different motors. L293D contains two H-bridge driver circuits.It can be used to drive two DC motors at the same time.

   (a) Pin 2,7,10 & 15: Input pins connected to microcontroller.

   (b) Pin 3,6,11 & 14: Output pins connected to motor.

   (c) Pin 1 & 9: Enable pins connected to Vcc.

4. *Solar Panel:* Solar panel absorbs the sun rays and convert that energy to electricity. A photovoltaic (PV) module or a solar panel is a connected assembly of a large number of solar cells. Solar Photovoltaic panels consists of solar cell array that generates and supplies

Table 3.1: Working

InputPin1	InputPin2	Action
0	0	NoRotation
0	1	Clockwise
1	0	Anticlockwise
1	1	NoRotation

electricity for different commercial and household applications. The module is rated on the basis of DC output power generated under standard test conditions. There are only a small number of available solar panels that have efficiency greater than 22% or 24%. A single solar module generates small amounts of power and hence the installations contain several modules. The photovoltaic system consists of a panel, a solar inverter ,a battery and interconnection wiring. Silicon is the main ingredient for making solar cells. Sunlight constitutes of particles called photons, that radiate from the sun. When photons hits the silicon atoms of the solar cell, they transfer their energy to the outer shell electrons, knocking them off the orbits. Freeing the electrons was half the work of a solar cell: it then needs to move these electrons in a particular direction resulting in electric current. This can be done by creating an electrical imbalance within the cell.

This is done by the internal organisation of silicon. Doping with small amounts of other elements into silicon structure results in two different types of silicon: n-type, which has extra electrons, and p-type, which has missing electrons. When p-n junctions are placed side by side inside a solar cell, the extra electrons in n-type silicon jumps to fill the holes in the p-type silicon. This makes n-type silicon positively

charged, and the p-type negatively charged, resulting in an electric field across the cell which forces the electrons to move in a specific direction.

Figure 3.10: DC Motor

5. *DC motor:* A DC motor is an electromagnetic motor based on the principle that current carrying conductor in magnetic field faces a force which makes it rotate.

Figure 3.11: Servo Motor

6. *Servo motor:* It consists of a small DC motor,potentiometer & control circuit.The rotation of motor causes change in potentiometer resis-

tance which regulates the motion. When a desired position is reached the supplky to motor is stopped.It makes use of PWM signals. The duration of width cause the motor to rotate by a certain angle. In Fig:3.8, Orange=PWM , Red=+Vcc , Brown=Gnd

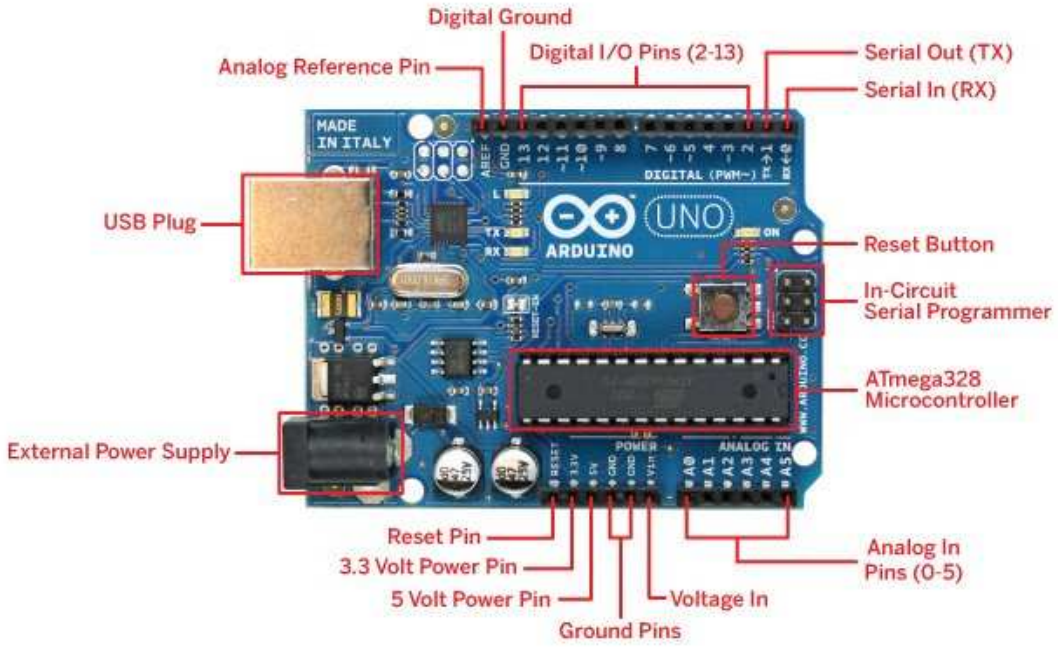

Figure 3.12: Arduino Uno Pin Diagram

7. *Arduino:* Arduino Uno is a microcontroller board based on the ATmega328P. Arduino has 14 digital i/o pins (6 of which can be used as Pulse Width Modulation outputs), 6 analog inputs, a 16 MHz quartz crystal, a USB connection, a power jack, an ICSP header and a reset button. It has a flash memory of 32KB, SRAM of 2KB, EEPROM of 1KB.The Arduino Uno board can be programmed with the Arduino Software (IDE). All the 14 digital pins on the Uno board can be used as an input or output. Every pin can provide or receive a current of 20 mA and has internal pull-up resistor of 20-50k ohm. A maximum of 40mA current is the value that must not be exceeded on any I/O

pin.

3.5 Software Specifications

1. *Keil Microvision:* The μVision IDE is used for embedded system development.It is used for debugging and editing of codes.The code can be written in different languages and it also creates the HEX file used for burning on the controller.

2. *Proteus:* The Proteus Design Suite an Electronic Design Automation (EDA) tool is used to design PCB layouts,schematic captures.It is widely used to run simulations that is used for testing of code and structure. It gives a demo of how the circuit will work in real life.

3. *Arduino IDE:* It is an offline software provided by Arduino to program the boards. It can be used for both compiling and uploading the code to the board. Under "Tools" by selecting the port the board can be easily connected to the PC and after a successful compilation the code can be verified and uploaded.

Chapter 4

RESULTS

4.1 Simulations

4.1.1 Using DC Motor

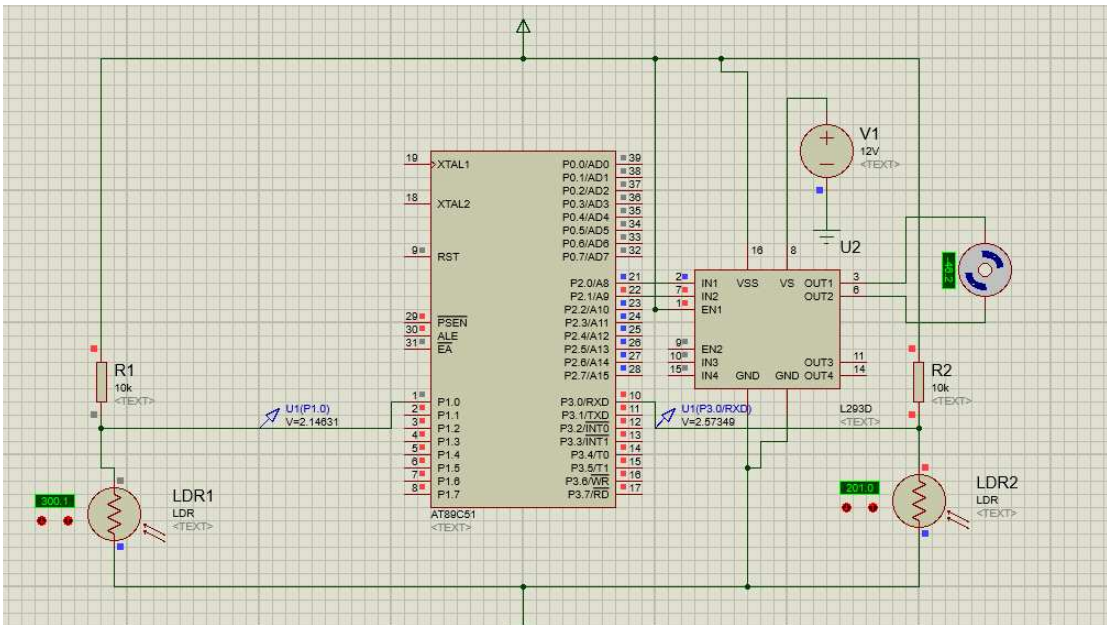

Figure 4.1: Simulation 1 Anticlockwise rotation

The simulations are made using Proteus Design Suite. Port1 & Port3 are programmed as input ports to fetch signals from the LDRs. Port2 is programmed as output port for the use of motor. For the different intensities of light falling on LDRs, the motor will rotate either clockwise or

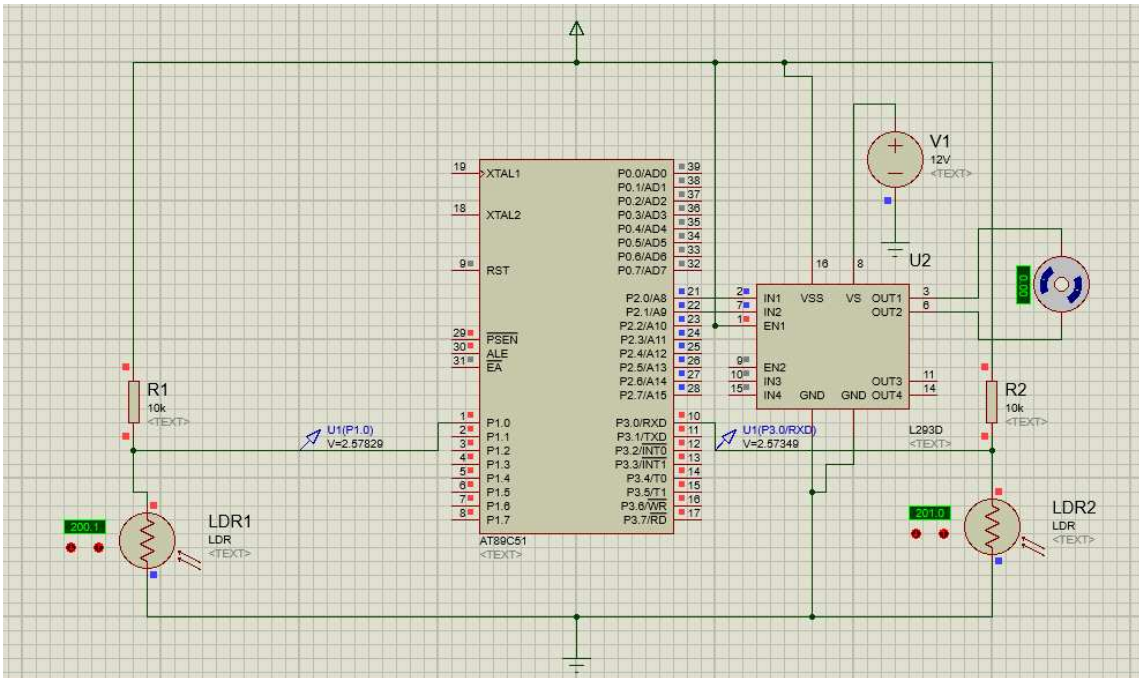

Figure 4.2: Simulation 2 No rotation

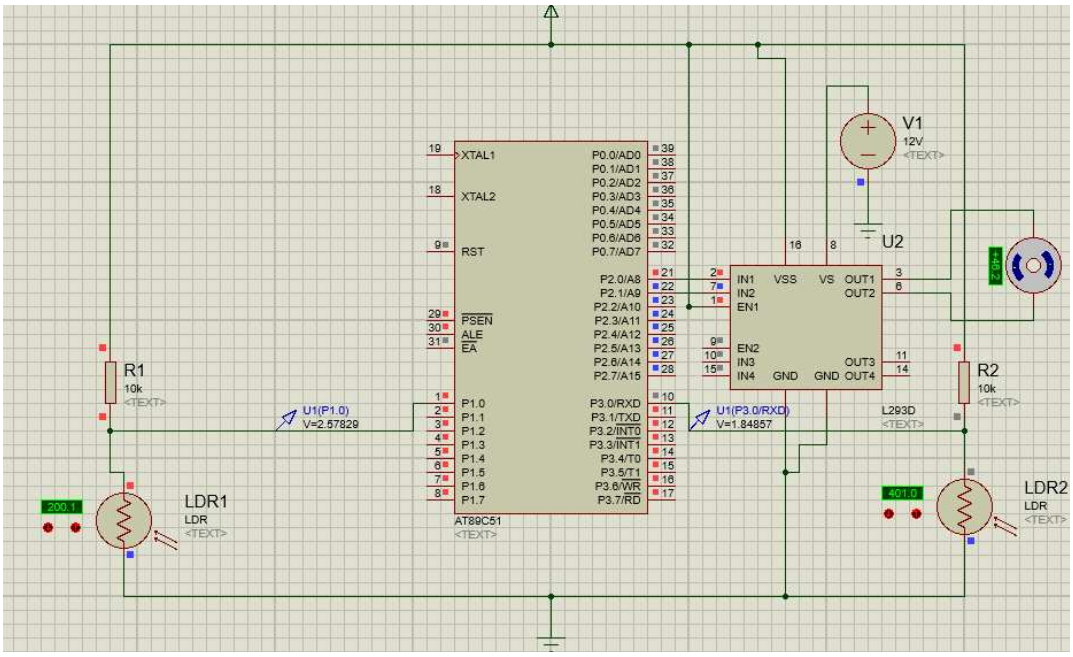

Figure 4.3: Simulation 3 Clockwise rotation

Table 4.1: Results using DC Motor

IntensityOf LDR1(lux)	IntensityOf LDR2(lux)	AngleOf Rotation
300	201	$-46.2°$
201	201	$0°$
201	400	$+46.2°$

anticlockwise. Fig 4.1 shows that the LDR1 is having greater light intensity than LDR2 so the motor start to rotate in anticlockwise direction. The direction and angle of the motor is depicted by the bar across the motor. Fig 4.2 shows that the light intensities are nearly equal at both LDRs. The motor will show no rotation. Fig 4.3 shows the clockwise rotation of the motor as LDR2 has greater light intensity than LDR1.

4.1.2 Using Servo Motor

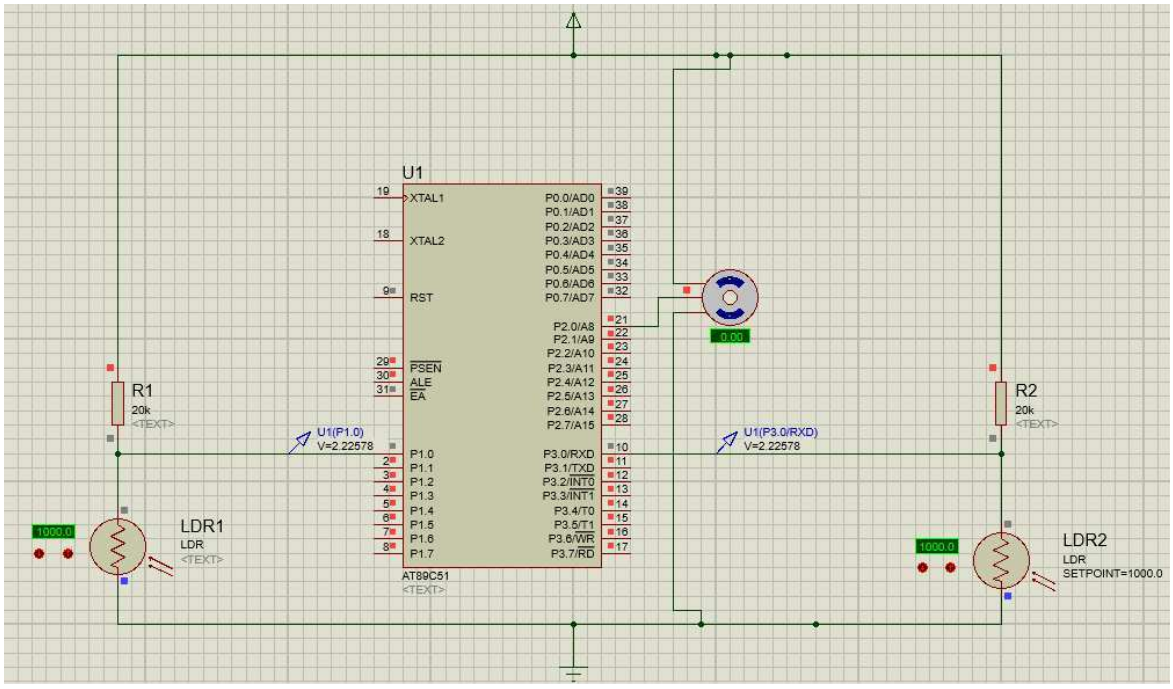

Figure 4.4: Simulation 4 No Rotation

Table 4.2: Results using servo motor

IntensityOf LDR1(lux)	IntensityOf LDR2(lux)	AngleOf Rotation
1000	1000	0°
750	1000	+11.9°
1000	750	−29.3°

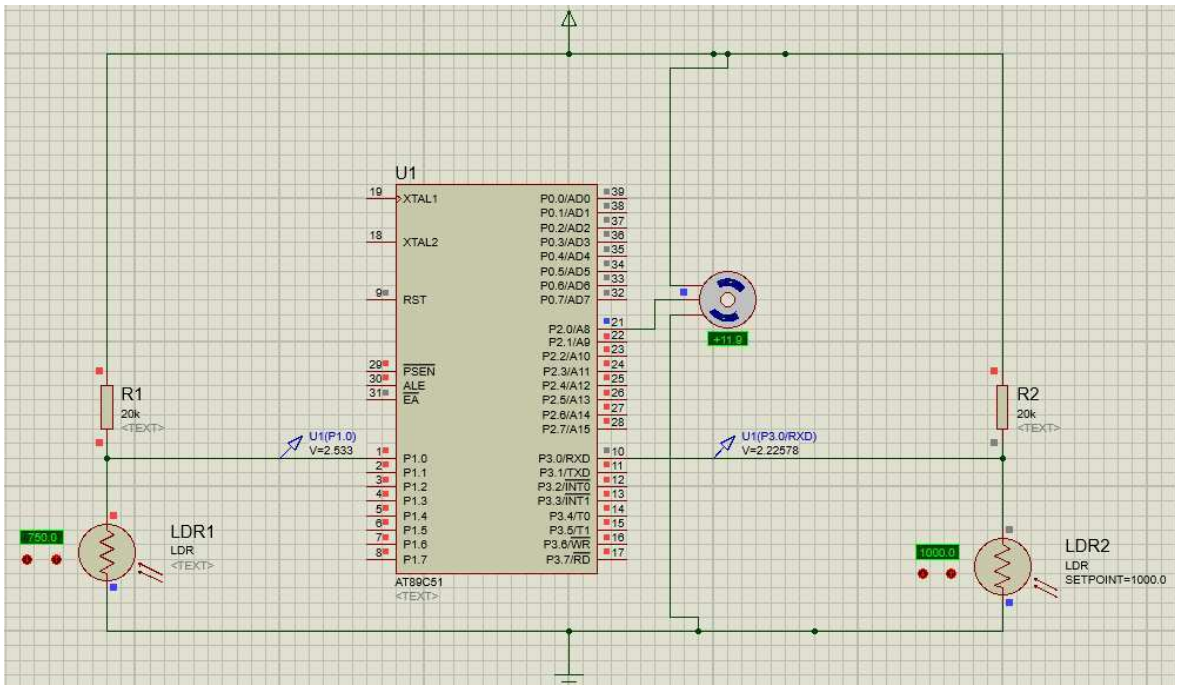

Figure 4.5: Simulation 5 Clockwise rotation

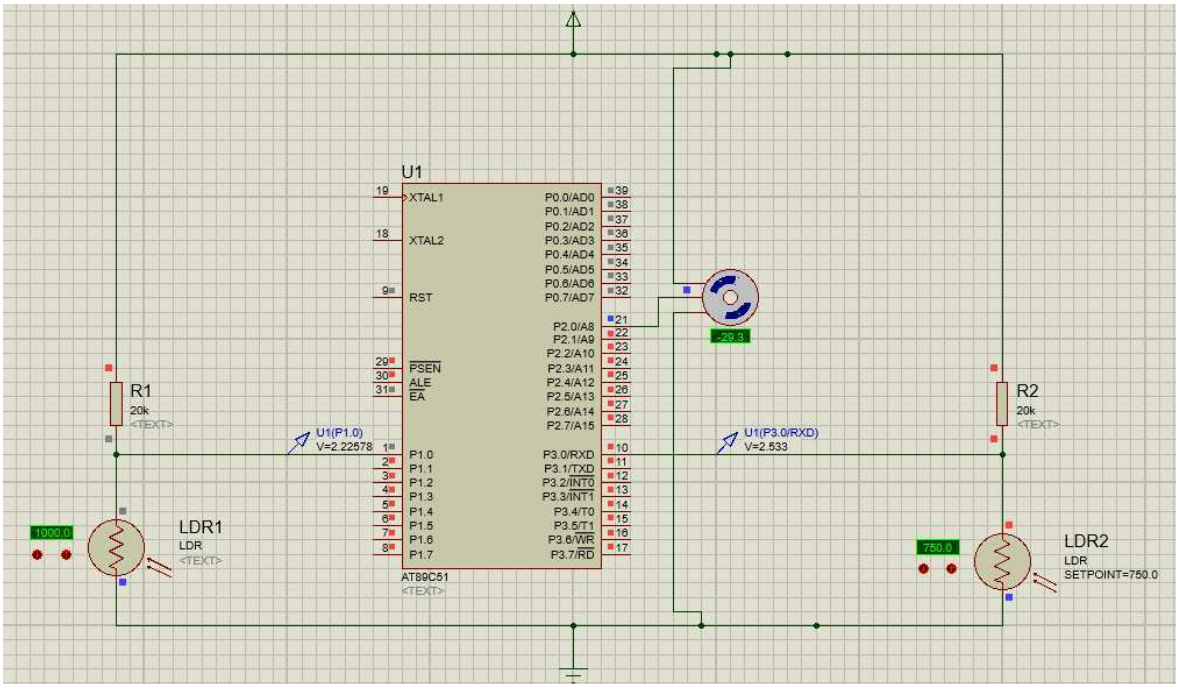

Figure 4.6: Simulation 6 Anticlockwise rotation

In this case, Port 2 is used for generating control signal for the servo. Port 1 & Port 3 are used as input from the two LDRs.

4.2 Hardware

The hardware is designed for both single axis and dual axis tracking.

Fig 4.7, shows a DC motor connected to motor driver L293D connected to 8051 microcontroller and controlled by signals from LDRs.

Fig 4.8, shows that the servo motor is controlled using LDR signal using Arduino and there is a capping angle for the servo after which it goes no further. Using the servo motor and arduino model becomes more precise as arduino allows control of servo angle.

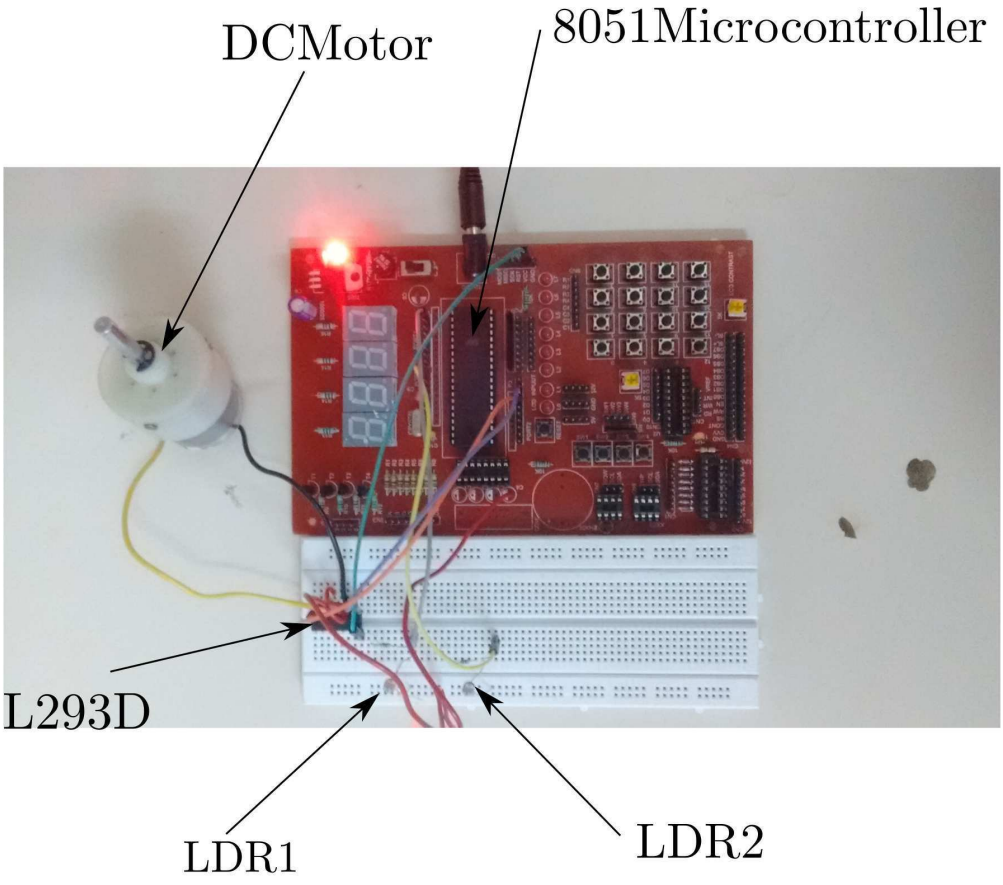

Figure 4.7: DC Motor hardware

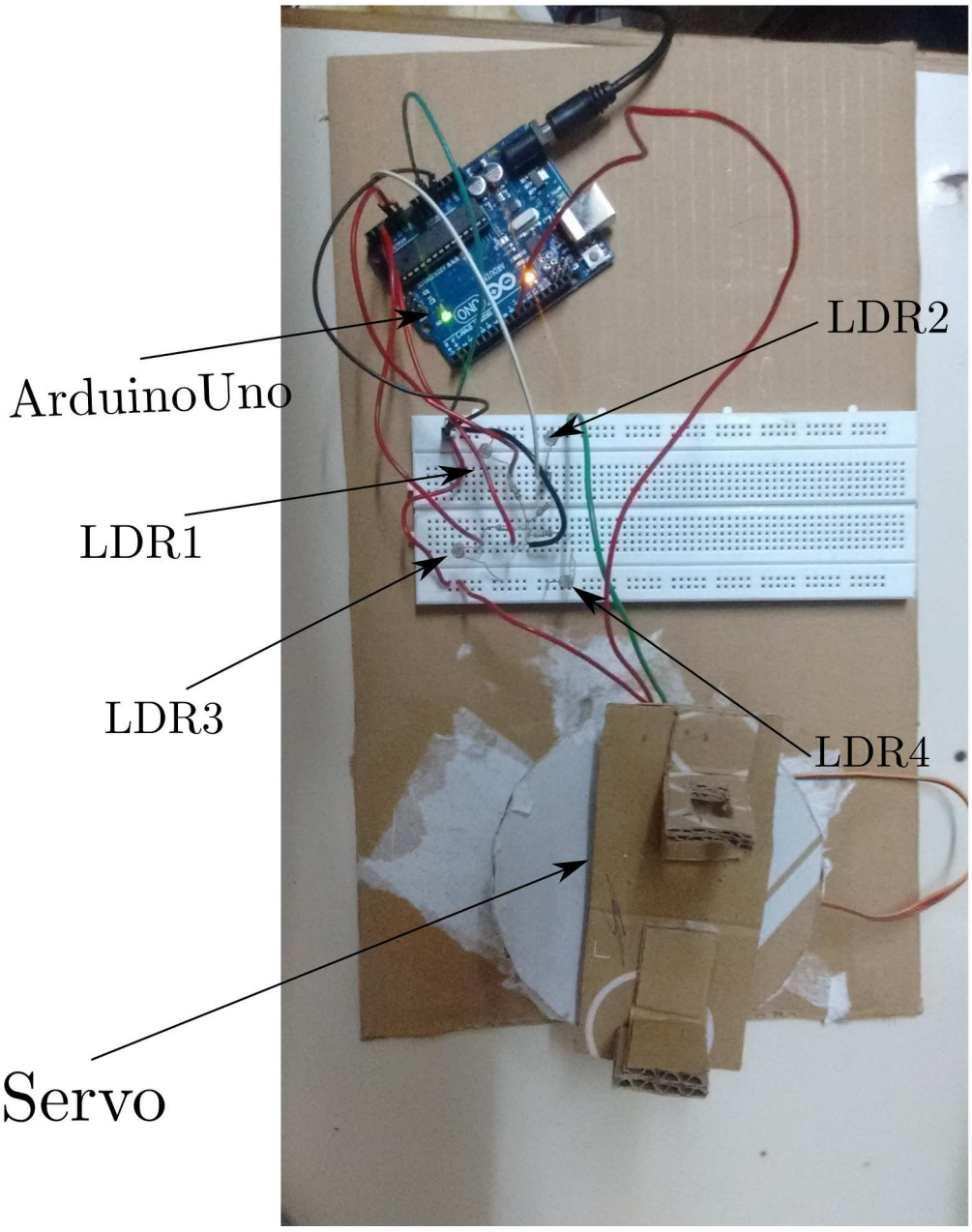

Figure 4.8: Servo Motor hardware using Arduino

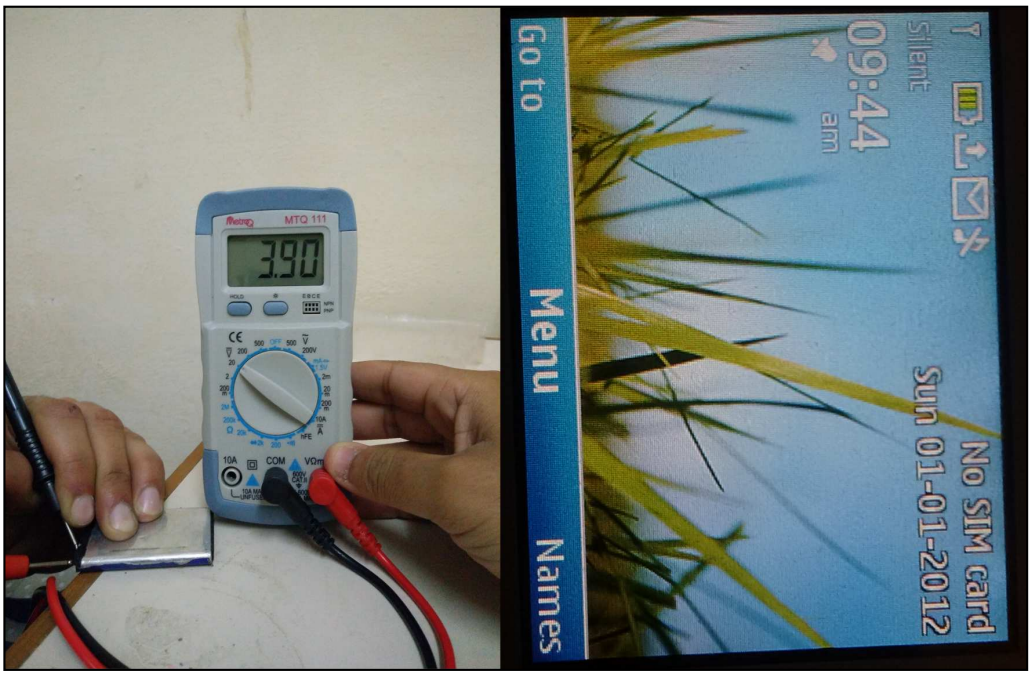

Figure 4.9: Battery Charge and Voltage without rotation

4.2.1 Efficiency Calculation

Time	Altitude Angle	Azimuth Angle	%charge
10am −12 : 30pm	18.4°	73.28°	80

Table 4.3: Without Rotation

Fig 4.9 shows the battery charge to 80%. The battery used for the experiment is Nokia BL-5C and the terminal voltage is measured to be 3.9V. The duaration of the experiment was 2.5hrs in which the battery is charged with the solar panel. The same experiment was with the rotation of solar panel for the same duration of a time. Fig 4.10 shows the battery charge to 100% and the battery is overcharged from its capacity. The terminal voltage is 5V at the ends of battery which shows that there is an

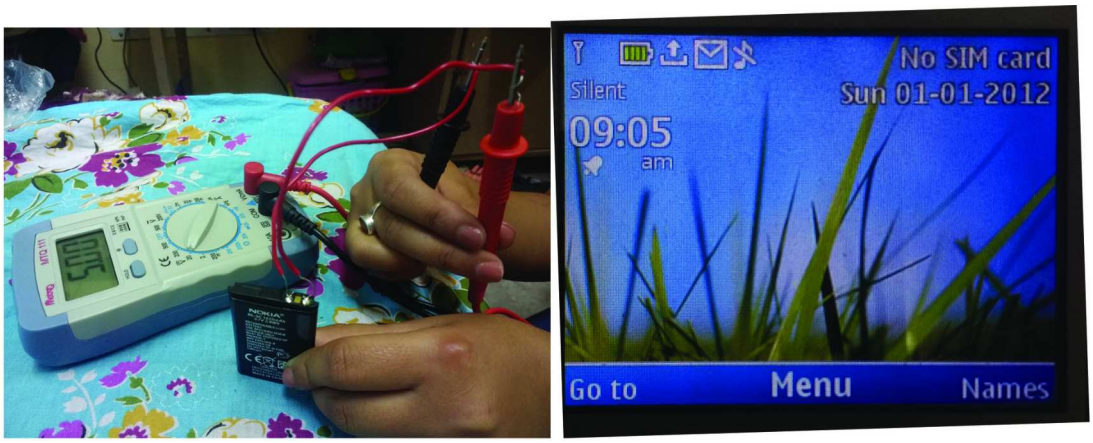

Figure 4.10: Battery Charge and Voltage with rotation

increase in the efficiency when solar tracking is done.

Time	Altitude Angle	Azimuth Angle	%charge
1pm– 3 : 30pm	26.55°	51.11°	100 (overcharged)

Table 4.4: With Rotation

CONCLUSION AND FUTUREWORK

It has been concluded from the above simulations that, at varying light intensities the motor will start rotating. The rotation is decided by the side having more light intensity, the side having greater light intensity the motor will rotate towards that and stops when the light intensities at both the LDRs gets equal. For powering the traffic lights and streetlights these panels can be used ,they can be used in homes to power the appliances using solar power. Also the industries can use these panels to generate energy. The advantage of such a system is that it is smart enough to make the panels rotate with the sun, thus contributing to extra energy extraction. The system will align itself to a perfect angle either on sunrise or sunset so no drift could occur.[3]

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PUBLICATIONS

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SUN TRACKING SOLAR PANEL

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Abstract **- Due to the depleting non-renewable resources and increasing pollution, there is an urgent need to find new ways of harnessing renewable resources and energy. Global warming also plays a major role in the increasing demand and request for green energy. This paper is dedicated to the extraction of solar energy using solar tracking system, designed using 8051 microcontroller. The proposed dual axis rotation will increase the efficiency of solar panel. The experimental model makes use of stepper motor controlled by microcontroller, which makes the panel move according to the signals received from the LDR. The all-weather reliability and affordable tracking and positioning systems make solar panels appropriate to work on, among all other methods of conserving renewable sources.**

Keywords - Stepper motor, solar panels, solar energy, renewable sources, 8051 Microcontroller, green energy.

I. INTRODUCTION

The green energy produced by the renewable resources like solar power is the dire need of the hour. The reason being, the greenhouse gases are not produced by these energies and hence, they are not a threat to the environment and the ozone layer. [2]

Due to the depletion of non-renewable resources and the problem of greenhouse emissions it is necessary to switch to solar energy.

The other reason is that renewable sources of energy require less maintenance and are cleaner. Also, they are easy to use and will always be available in abundance. Research is being done to improve solar cell efficiency. The improvement of the cells efficiency from a mere percentage of 17% in the early 90's to the recent 33%, has encouraged the above stated fact. [3]

Table 1. Usage of energy in different countries.

Solar Photovoltaics				
	GW installed	TWh consumed	24/7/365.25 TWh maximum output	Load factor %
USA	7.3	4.4	64.1	6.86
Czech republ	2.1	2.2	18.2	12.11
France	3.7	4.0	32.4	12.36
Germany	32.6	28.0	286.1	9.79
Italy	16.2	18.5	142.4	12.99
Portugal	0.2	0.4	1.9	21.52
Spain	4.5	11.9	39.8	29.92
UK	1.7	1.3	14.5	8.96
Australia	2.4	2.8	21.1	13.26
China	8.3	4.5	72.8	6.18
Japan	6.9	6.2	60.6	10.23

Solar energy is free, available in abundance and causes no pollution. It is necessary to know about both quality and quantity of solar energy of a given location. However, the sunlight's intensity on the photovoltaic panel is directly proportional to the amount of electrical energy obtained.
The unavailability and too much cost of efficient power makes it less accessible for people who live in secluded areas. Also, people living in standard-sized homes are more interested in reducing domestic electricity cost by finding alternative energy sources. Solar energy turns out to be a good solution for people living under these circumstances.

II. SOLAR ENERGY AND SOLAR TRACKERS

Solar tracking is now being used as a sustainable solution for power generation as tracking sun from east to west will increase the efficiency of solar panel.
A solar tracker will orient the panel towards the sun. The maximum energy is captured by these devices by changing their orientation to follow sun's path throughout the day. Solar Panels are a form of active solar power as they harvest sunlight and actively convert it to electricity. Solar Cells, or photovoltaic cells, are arranged in a grid-like pattern on the surface of the solar panel. Solar panels are made up of crystalline silicon and the more expensive gallium arsenide,

which is produced exclusively for use in photovoltaic (solar) cells. Solar panels actively convert the sun rays into electricity. A solar panel is made up of several solar cells. Solar cells are p-n junction diode that convert light energy to electricity. Photon striking the surface of solar panel transfers its energy to the electron and it gets released from the orbit. The electric field pulls the electrons which results in the flow of directional current. This process is called photovoltaic effect [4].

Single axis trackers track the sun from east to west during the day. Dual axis trackers track the sun by making use of two axes, one going east to west another following the change of sun in north-south direction due to change in seasons. Therefore, they help to obtain maximum sun's energy. The basic principle states that the sunlight is made up of two components - the direct beam and the diffused beam. 90% of the solar energy is carried by the direct beam while the remaining by the diffused sunlight – the diffuse portion increases as a proportion on cloudy days and is the blue sky on a clear day. The direct beam contains the majority of the energy. Sun's visibility to the solar panels for most of the time is required for maximising the collection of direct beam. The energy contribution made by the direct beam decreases with the cosine of angle between incident light and panel [7].

III. PROPOSED METHODOLOGY

Solar tracker circuitry consists of light sensing circuit and motor control circuit as shown in fig 1.

1. *Light Sensing Circuit*: It Consists of LDRs connected to the microcontroller and placed on the edges of the solar panel. Its signals will cause the motion of the solar panel.
2. *Motor control circuit*: It consists of the driver IC and a DC motor. The input pins of the driver IC are connected to the microcontroller and the output pins to the stepper motor.

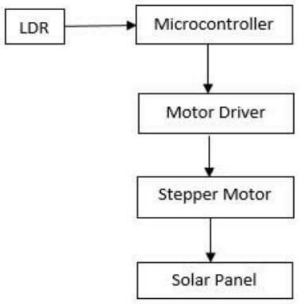

Fig 1. Block diagram of solar tracker

The basic principle behind the working of LDR being that the falling light intensity increases as its resistance decreases. If constant current is passed through the LDR and it is exposed to light the voltage across it will also decrease as V=IR. Making use of this concept we will be measuring the voltage across different LDRs and comparing it using comparators. On the basis of this signals will be sent to the input pins of the motor driver thus making the panel rotate either clockwise or anticlockwise. The rotation will continue till the voltage across the LDRs is not equal.

HARDWARE SPECIFICATIONS –

1. *Microcontroller 8051*: The 8051 Microcontroller has two buses and two memory spaces of 64K X 8 size for program and data units. It has an 8bit processing unit and 8bit accumulator units.
2. *LDR*: LDR is popularly known as a photoresistor. Photocell, light controlled variable resistor and light dependent resistors are also the terms used to refer to LDR. They are very useful, especially in dark/light sensor circuits. It exhibits photoconductivity, as with the increasing incident light intensity, the resistance of a photoresistor decreases. The structure of an LDR is made up of a light sensitive material deposited on an insulating substrate. This is done in a zig-zag manner to get desired resistance. Commonly used materials are Cadmium Sulphide.
3. *Motor Driver (L293D):* L293D is used to drive DC motor in either direction. It consists of 16 pins and can be used to control two DC motors at the same time.

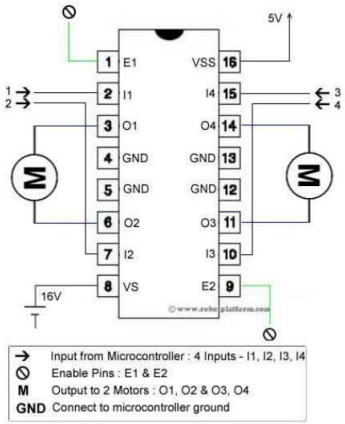

Fig 2. Interfacing of motor with L293D IC

Two DC motors can be controlled with a single L293D IC as a conclusion, as shown in Fig 2.

4. *DC Motor*: It is an electro-magnetic motor used to convert DC electric power to mechanical power. It is based on the principle that when a current carrying conductor is placed in magnetic field it experiences a force.

5. *Solar Panel*: Solar panel refers to a panel designed to absorb the sun's rays as a source of energy for generating electricity or heating. A photovoltaic (PV) module is an assembly of many solar cells. Solar panel absorbs sun's rays to generate electricity. They consist of an assembly of solar cells. The photon transfers its energy to the electron and ejects it from its orbit. Due to the electric field a force acts on the electron

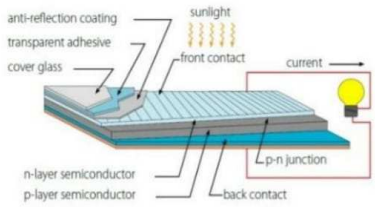

Fig 3. Solar cell

resulting current flow of directional current. The structure of solar cell is shown in Fig 3. The modules are rated on the basis of their DC output power.

SOFTWARE SECIFICATIONS-

KeilMicrovision: It is a tool used for embedded software development which can be used for code editing and program debugging. We have used this software for developing the source code using embedded C.

EXISTING SOLUTIONS

1) *Sun tracker using lab view software to detect the position of the sun.*

The project assumed solar energy as a numerical value and was a complete software based project. The problem faced was that concepts learned in programming language like C etc. can't be used in LabView & the applications produced tend to run slower. On the other hand, in our research we are using 8051 which can be programmed using simple c language.

2) *Sun tracking using arduinouno and energy stored in a battery.*

This system design is only suitable for a standalone system as it makes use of a battery to store the energy and an inverter to convert stored energy into AC. The requirement of an external battery and inverter adds to the cost of the overall circuit.

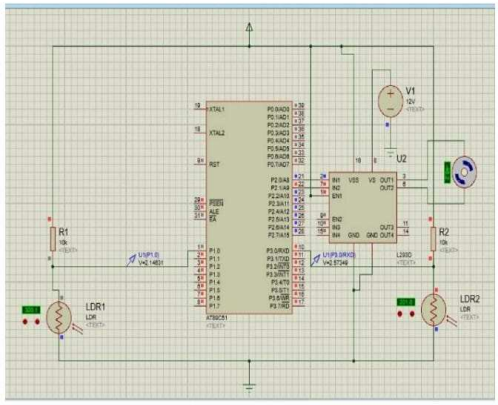

Fig 4. When Intensity at LDR1 > intensity at LDR2

IV. RESULTS

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

In this dual axis tracking solar tracker design, two axes of solar tracker were moving in the sun's direction- one is the horizontal and other one the vertical axis**.** The maximum power is obtained when the intensity of the sunrays is highest. Proteus8 has been used for the simulation purposes and the results are as follows. The result shows a single axis tracker with DC motor. For dual axes rotation LDRs and a motor will be added in a similar fashion for rotation in north-south direction.

Fig 4 shows that the LDR1 is having greater intensity so the motor start moving in anticlockwise direction. The direction of the motor is depicted by the digital bar across the motor showing negative angle. The circuit is programmed in such a way that when the intensities are

made equal the motor will stop its rotation. Fig 5 shows that the light intensities are made nearly equal at both LDRs. The motor will stop revolving.

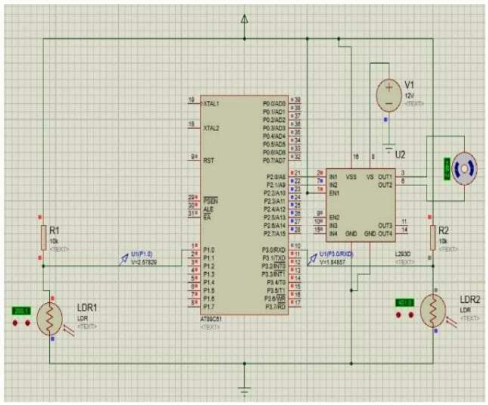

Fig 5. When Intensity at LDR2> intensity at LDR1

Fig 6 shows the clockwise rotation of the motor as LDR2 has higher light intensity as compared to LDR1.

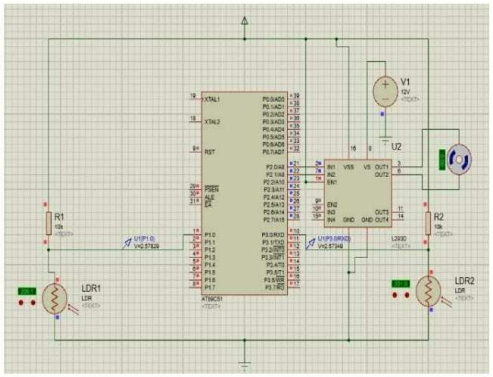

Fig 6. When Intensity at LDR2 = intensity at LDR1

V. CONCLUSION

The objective of the proposed paper is to implement dual-axis sun tracking system with the help of 8051 microcontroller effectively. Hardware has been chosen in order to keep the output and efficiency maximum and reduce the overall cost. Also, the affordability, accessibility and reliability of the proposed solution has been kept in mind while designing the overall solution. It has been concluded from the above simulations that, at varying light intensities the motor will start rotating. The rotation is decided by the side having more light intensity, the side having greater light intensity the motor will rotate towards that and stops when the light intensities at both the LDRs gets equal.

AUTHORSHIP

All authors have contributed equally to this work.

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