Extracting Maximum Energy from Solar using Microcontroller Tracking System and Solar Concentrator

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Abstract

Solar Concentrator & Solar Tracking Combine system is main option to decrease price of solar energy generation. This Paper contains Tracking system & solar concentrating in PV/Thermal applications. By combining Solar Panel with Tracking System & solar concentrator, we can get better efficiency compared to Conventional System. Using two light dependent resistor interface with microcontroller and compare both LDR value and rotate stepper motor either clockwise or anticlockwise according to sun position. Whenever sun is east direction that time solar panel are also in east direction and whenever at the end of the day sun are west direction that time panel are rotate and move on west direction. Using LDR sense the light intensity and according to that rotate automatically panel and get the extracting the maximum energy from solar using automatic mechanical single axis solar tracking system.

Keyword- LDR; Solar Concentrator; Solar Tracking; Solar Panel; Stepper Motor

I. INTRODUCTION

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 sever 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, infrared light, and ultraviolet radiation) streams out into space in all directions.

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.

Trackers direct solar panels or modules toward the sun. These devices change their orientation throughout the day to follow the sun's path to maximize energy capture. In photovoltaic systems, trackers help minimize the angle of incidence (the angle that a ray of light makes with a line perpendicular to the surface) between the incoming light and the panel, which increases the amount of energy the installation produces.

Single-axis trackers rotate on one axis moving back and forth in a in a single direction. Different types of single-axis trackers include horizontal, vertical, titled, and polar aligned, e-which rotate as the names imply. Dual-axis trackers continually face the sun because they can move in two different directions. Types include tip-tilt and azimuth-altitude. Dual-axis tracking is typically used to orient a mirror and redirect sunlight along a fixed axis towards a stationary receiver. Because these trackers follow the sun vertically and horizontally they help obtain maximum solar energy generation.

II. PHOTOVOLTAIC CELL

In Photovoltaic technology "Photo" means light and "Voltaic" means producing electricity. Whenever light is incident on Photovoltaic panel valance band electron are move on to the conduction band and current are generate. Energy generate by use of photovoltaic it's depend on the light projected on the cell. Time of day, season, incident angle between light intensity and solar cell also affect the energy production.

Whenever solar cell is connecting in parallel that time current are increase and whenever solar cell are connecting in series that time voltage is increase. The current-voltage characteristic and current-power characteristic are show in Fig. 1

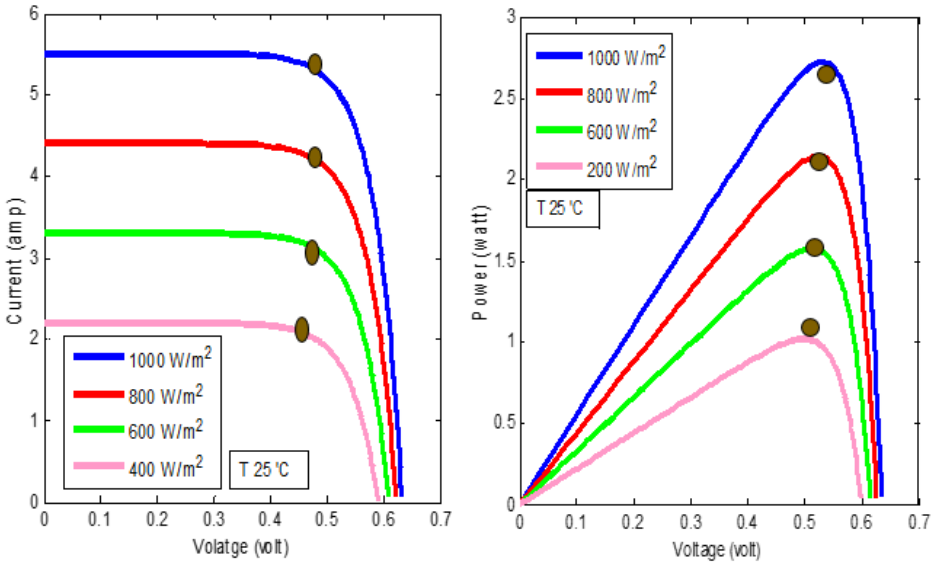

Fig. 1: Current-Voltage Characteristic and Power-Voltage Characteristic

When Positive and Negative terminal of the cell are shorted that time current are maximum is called the short circuit current (Isc) and when Positive and Negative terminal of the cell are open that time voltage are maximum is called the open circuit voltage (Voc). Whenever Power is maximum that volatage and current are called the Voltage at maximum power (Vmp) and Current at maximum Power (Imp) respectively. Fill Factor is define as ratio of Maximum power generate by cell and product of Voc and Isc. Eqations of fill factor and efficiency are shown in below :

$$FF = \frac{Vmp \times Imp}{Voc \times Isc}$$

$$\eta = \frac{Voc \times Isc \times FF}{Pin}$$

III. SOLAR CONCENTRATOR

By use of solar Concentrator, we can increase the capacity of the solar panel output current by 1.5 to 2.0 times more than conventional rating of solar panel. For an example if 3 W solar panel is conventionally gives rated output voltage 12 V and rated output current 0.35 mA than by using of solar concentrator & solar tracker combined system, we can have increased rated current value nearer to 0.65 to 0.70 mA. By focusing or reflecting solar rays on the solar panel through solar concentrator, we can increase the rated value of output current of solar panel. So, by this we can increase the overall efficiency of the solar panel & so by this we can charge battery faster than conventional method. Following Fig. 2 shows the Solar concentrator assembly, which is made by Glass pieces. By this parabolic reflector disk/concentrator, we can reflect/focus sun rays at a Solar panel, which is placed at a predefined distance. Solar concentrator shows in Fig. 2.

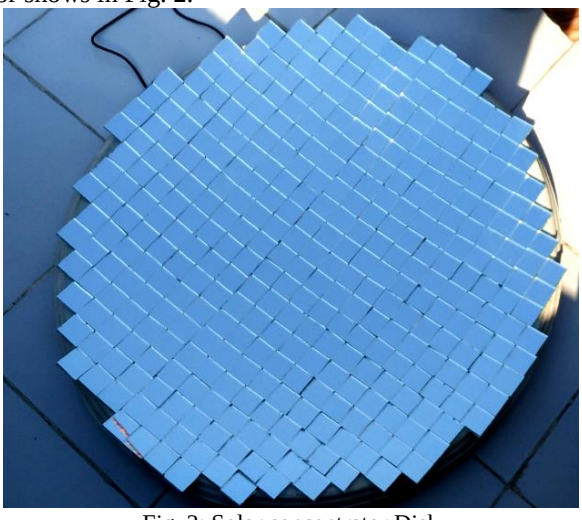

Fig. 2: Solar concentrator Disk

IV. SOLAR TRACKING SYSTEM

By use of solar tracking system increase efficiency of the solar cell compare to stationary system. Whenever solar tracking system are use that time minimize incident angle between the solar cell and incoming incident sun rays. Improve the solar cell efficiency by use of solar tracking system. Automatic solar tracking system is rotating the panel aligned with the sun. Solar tracking system is mechanically track the sun and increases the efficiency of solar system and increase the output of power generation 30% to 60% of stationary solar system.

V. CONSTRUCTION SOLAR TRACKING SYSTEM

In automatic solar tracking system microcontroller and light sensor are use. Using this sensor measures the light intensity and according to that rotates the solar panel according to sun position. As a light sensor we use LDR (Light Depended Resistor) and Photo-diode.

Nowadays, many types of tracker are available like a single axis, double axis, open loop and close loop. Solar tracking system is mainly depending upon the four factors:

1) Cost
2) Reliability
3) Efficiency
4) Accuracy of sensor

To build an efficient solar tracker system necessary require to build a proper algorithm for operate a whole solar tracking system accurately. Solar tracking algorithm is shown in Fig. 3.

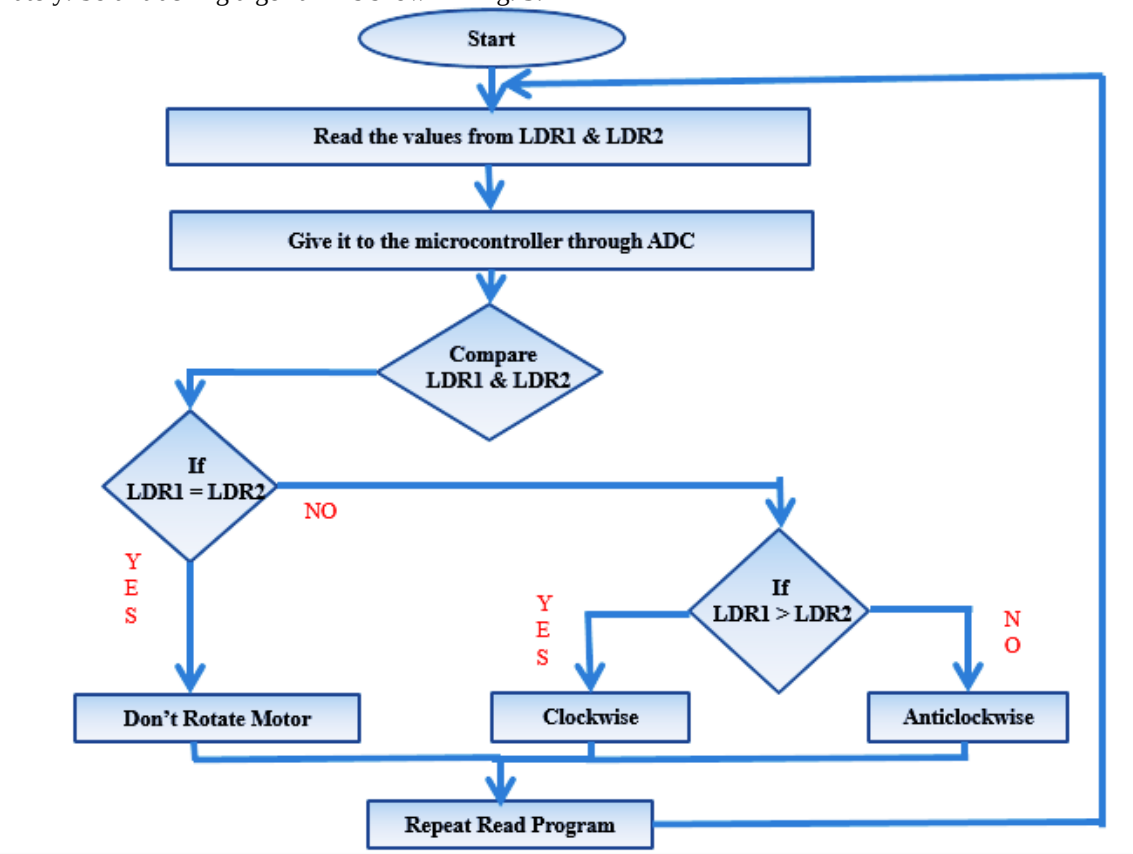

Fig. 3: Algorithm for solar tracking system

Two LDR or Photo-diode are sense the light intensity of the sun according to that rotate the solar panel. Whenever the LDR1 are sense more intensity compare to LDR2 that time panel rotate are direction of LDR2 to LDR1. And whenever the LDR2 are sense more intensity compare to LDR1 that time panel are rotate are direction of LDR1 to LDR2.

In our solar tracking system LDR1 are place at East side of panel and LDR2 are place at West side of panel. In a day, at morning time solar panel direction in east side because of east side more light intense on LDR1 and at evening time panel direction is west side because of west side more light intense on LDR2. Solar tracking system for Morning, afternoon and evening is show in Fig. 4

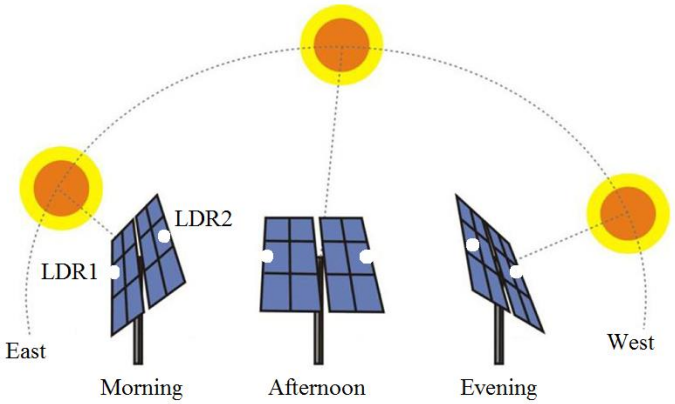

Fig. 4: Solar Tracker Position

Where LDR or Photo diode is sense the light intensity of the sun and according to rotate the motor.

A. East Side Light Intensity Greater Than West Side Light Intensity

Whenever east light intensity is greater than west light intensity motor rotates east side anticlockwise. Whenever both light intensity is equal that time motor is stop.

B. West Side Light Intensity Greater Than East Side Light Intensity

Whenever west light intensity is greater than east light intensity motor rotates west side clockwise. Whenever both light intensity is equal that time motor is stop.

C. West Side Light Intensity Equal to Than East Side Light Intensity

Whenever west light intensity and east light intensity both are same that motor are not rotate either clockwise or anticlockwise.

VI. HARDWARE IMPLEMENTATION OF SOLAR TRACKING SYSTEM

Develop the solar tracking system and track the sun throughout the day. Using of solar tracking system solar panel always perpendicular to sun that cause minimizes the incident angle between the solar panel and incoming sun rays. The major components are used in solar tracking system are:

- LDR or Photo-diode
- Analog to Digital Converter
- Microcontroller
- Motor driver IC
- Motor

A. LDR (Light Depended Resistor)

LDR is Light Depended Resistor and made of Cadnium sulphide (Cds). LDR is passive element and inversely proposal with light intensity. LDR connect with another resistor and using voltage divide rule resistor of LDR is convert into the voltage and this analog signal are given to the adc0808 IC. Characteristic of LDR is shown in Fig. 5.

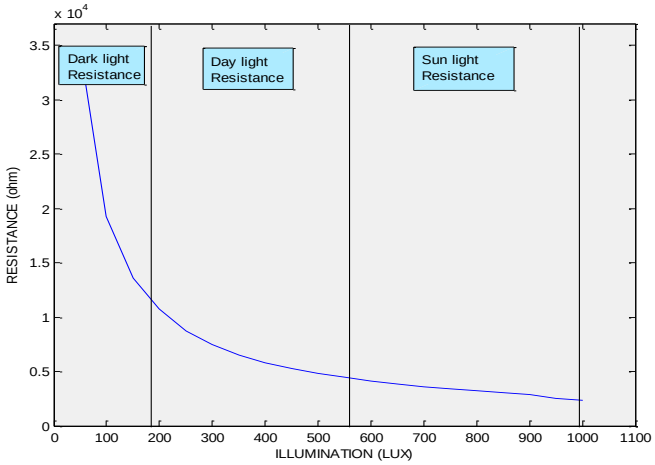

Fig. 5: Characteristic of LDR

B. Analog to Digital Converter

Whenever light fall on LDR that time resistance are decrease and this resistance value of LDR are convert into the voltage and give it to ADC0808 IC. This ADC0808 IC analog value of LDR is converting into the digital form and gives it to the microcontroller. Pin diagram of ADC0808 IC is show in Fig. 6.

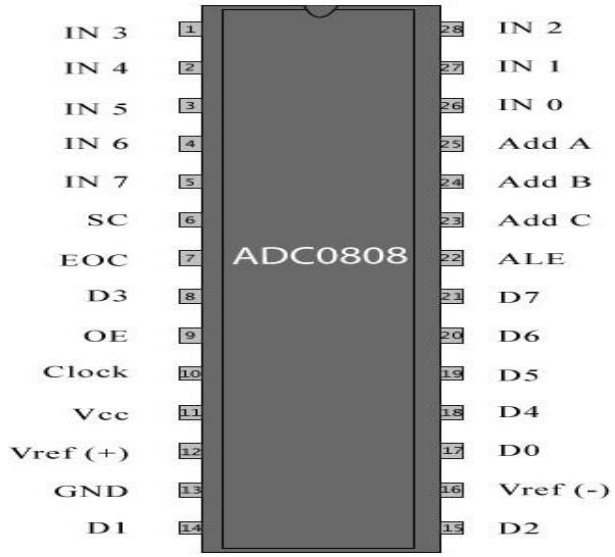

Fig. 6: Pin Diagram of ADC0808

C. Motor Driver IC

In microcontroller compare the both LDR value and according to this comparison microcontroller give signal it to motor driver IC. This motor driver IC are motor rotate either clockwise or anticlockwise. Motor Driver L293D IC pin diagram is show in Fig. 7

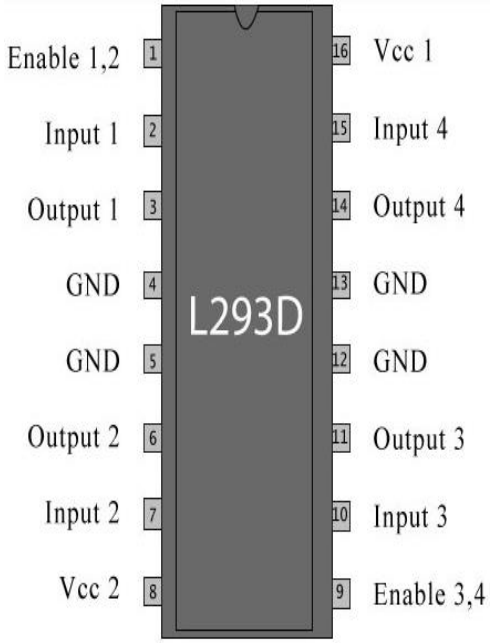

Fig. 7: Pin Diagram of L293D

D. Microcontroller

ADC0808 IC are analog signal convert into digital signal and give it to the microcontroller IC (at89c51). A microcontroller (at89c51) is heart of overall system. Write the algorithm in the form of program into the microcontroller using the keil compiler and download the hex file into the microcontroller. Pin diagram of microcontroller AT89C51 IC is show in Fig. 8.

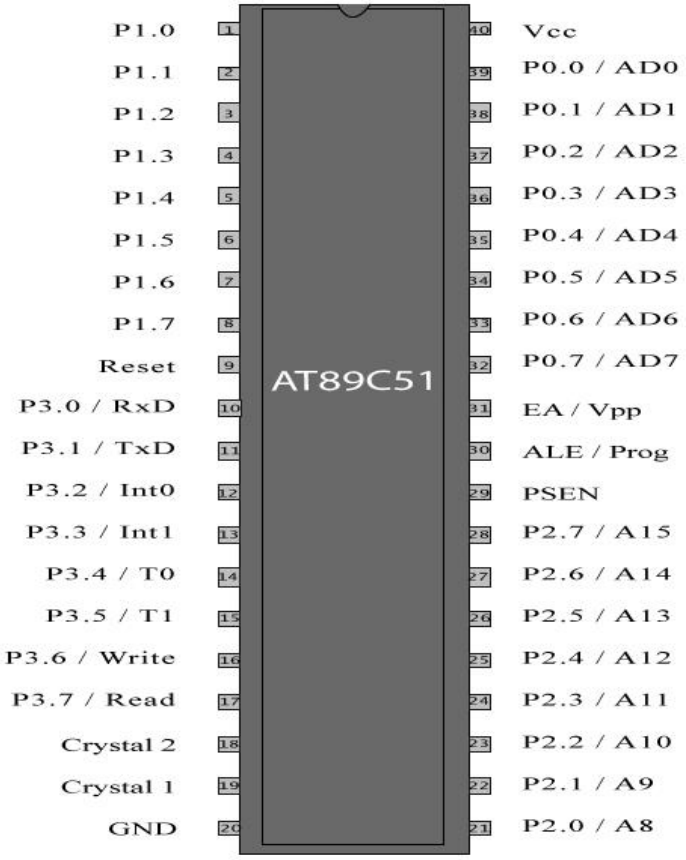

Fig. 8: Pin Diagram of AT89C51

E. Stepper Motor

Using L293D IC stepper motor are control and rotate according to sun position either clockwise or anticlockwise. In stepper motor step angle in very small so very accurately track the sun and increase the efficiency and accuracy. Bipolar stepper motor wiring diagram is show in Fig. 9.

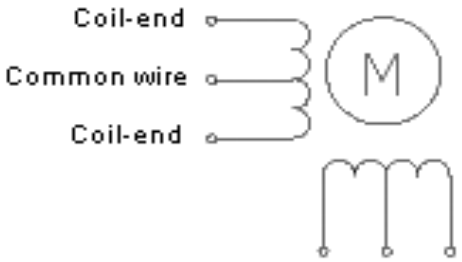

Fig. 9: Stepper Motor

VII. PROTEUS SIMULATION

This solar tracking system circuit diagram and proteus simulation is show in Fig. 10

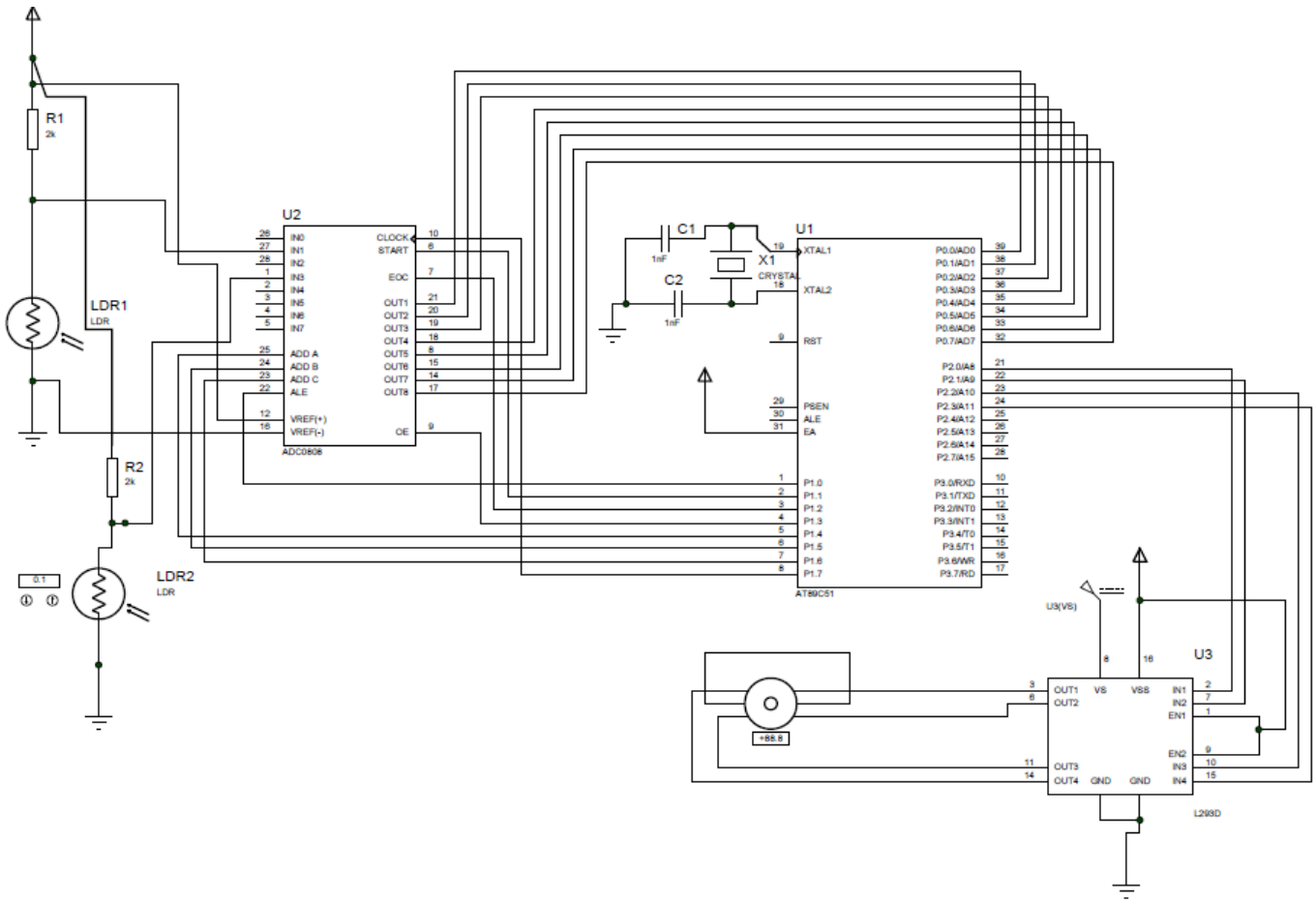

Fig. 10: Proteus simulation and Circuit diagram of Solar tracking system

VIII. CONCLUSION

Using automatic solar tracking & solar concentrating system maximizing the energy compare to conventional method of without tracking the sun. In this system automatic track sun using microcontroller, LDR are sense the light and according to that microcontroller rotate the motor either east to west or west to east. And concentrator concentrate the light on PV panel at particular area and by this we can increase light intensity at solar panel and we can increase the efficiency of solar panel/system compare to conventional system/panel.

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