

# AUTOMATIC SOLAR TRACKER

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**Abstract**— This paper present the hardware design and implementation of the system the generation of power from the reduction of fossil fuel is the biggest challenge for the half century. The idea of converting the solar energy to electrical energy using the photovoltaic panel holds its placed in the front row compare to the renewable source. But the continuous change in relative angle of the sun with the reference of the earth reduce the watt delivered by solar panel. The solar tracking system is the best alternative to increase the efficiency of the photovoltaic panel. Solar tracker move the payload toward the sun throughout the day. In this paper the different types of tracking system are reviewed and their pros and cons are discussed in detail. The result presented in this review confirm that the azimuth and altitude dual axis tracking system is more efficient compare to other tracking system is more feasible than dual axis tracking system.

**KEYWORDS:** Solar energy, Photovoltaic panel, solar tracker , Azimuth, Passive actuator , latitude

## I. INTRODUCTION

Energy is the prime factor for the development of a nation. An enormous amount of energy is extra, distribute, convert and consumed in the global society daily. 85% of energy production is depend on fossil fuel. [1]. The resource of the fossil fuel are limited and their use result in global warning due to emission of generator gases. To provide a sustainable power production and safe word to the future generation, there is growing demands for energy from renewable source like solar wind, geothermal and ocean tidal wave.

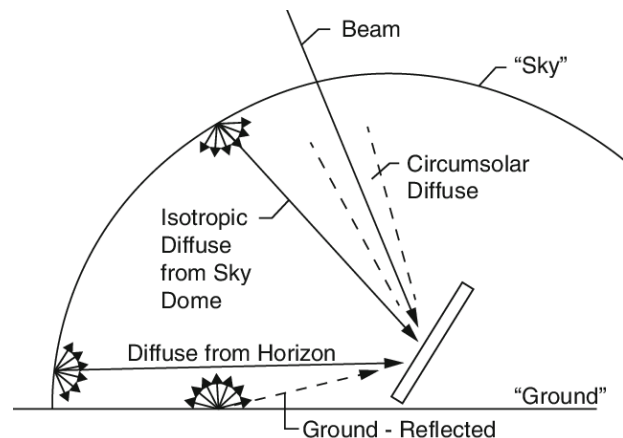
The sun is the prime source of energy, directly or indirectly, which is also the fuel for most renewable source, after some time these resource are run out of replenished in human life we need to focused on renewable energy which are given by nature and don't make harm to the some nature so many energy have been identify from that solar energy is one of the

best energy from renewable energy this energy is not replenished until the sun existed.

## SOLAR RADIATION

Solar Radiation is the radiant energy emitted by the sun from a nuclear fusion reaction that create electromagnetic energy. The spectrum of solar radiation is closed to that of a black body with temperature of about 5800k.

- Direct beam
- Diffuse beam
- Direct beam means which hits directly without any deviation in the travelling is called direst beam
- Diffuse beam which is been deviated by some other things in the way of travelling like clouds...etc is called diffuse beam
- Direct beam carries around 90% of solar energy from sum diffuse from sun..
- The diffuse beam less at blue sky an a clear day and increase at cloudy day
- The sum of beam, diffuse and reflected radiation is called as global radiation.



## SOALR ALTITUDE ANGLE ( $\Theta_Z$ )

The solar altitude angle is the angle between the sun's rays and a horizontal plane. It is related to the solar zenith angle  $\phi$  which is the angle between the sun's rays and the vertical the sun and horizontal at sunset / sunrise the altitude is zero (0 degrees) and ninety degrees (90 degrees) the altitude related to the latitude of the site, and the declination angle and the hour angle.

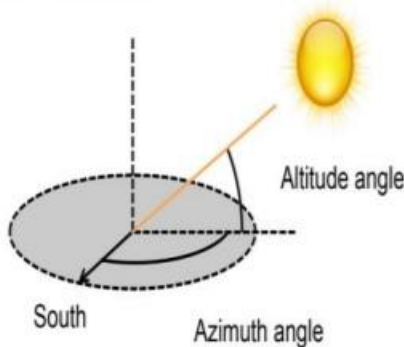


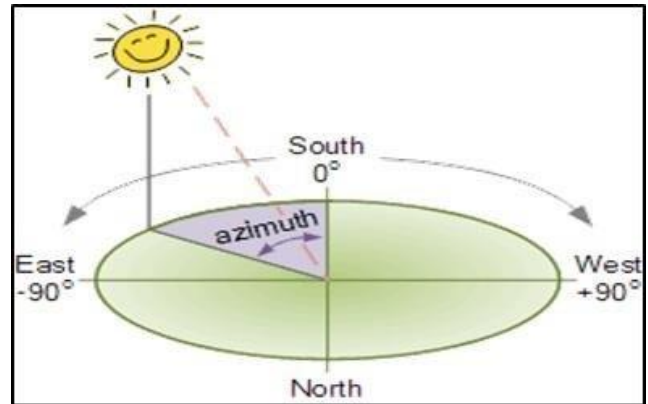
Fig .2 altitude and azimuth angle

## SOLAR AZUMITH ANGLE

Solar azimuth angle define the horizontal coordinate of the sun relative to the observer. It is defined as the angular distance between the projection of the sun on the imaginary horizontal plane on which the observer is standing and the reference direction. In solar technology, the reference direction is north.

There are other convention but here will be stick with National Renewable Energy Laboratory stand. Thus the azimuth angle is the angle between the north and the sun on the local horizon with the observe. The angle is positive clockwise and negative counter clockwise.

The Northern hemisphere the zero-azimuth angle is toward the south; the azimuth angle is negative before solar noon after solar noon it will be positive at noon it will be equal zero



## LDR ( LIGHT DEPENDENT RESISTOR )

Light dependent resistor is also called photo resistor or it also called a cadmium sulfide (cds) cell is also called a photo conductor it basically a photo cell which works depends on the basically a resistor which is been inversely proportional to light when the light intensity increase or the lux (unit of light)

Increase the resistance decrease if the light intensity decrease or the lux decrease the resistance value been increased.

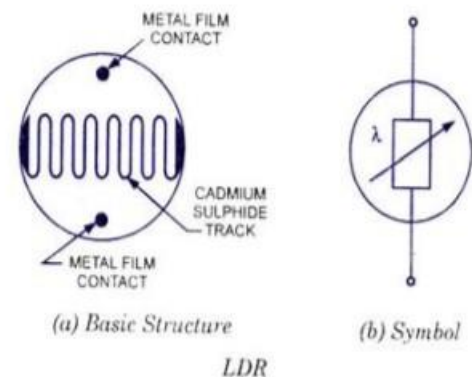
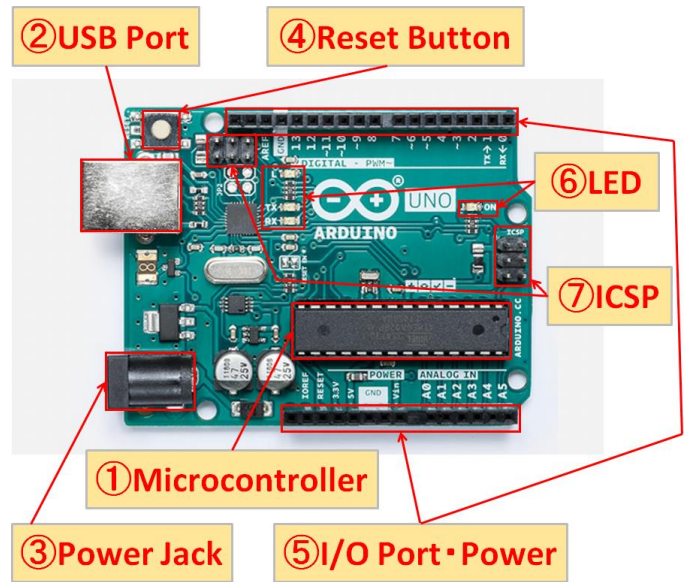


Fig .3 light dependent resistor -LDR  
Light is inversely proportional to resistance

## STEPPER MOTOR

Stepper motor is the electric motor whose main feature is that its shaft rotate by performing steps, that is by moving by a fixed amount of degree. The feature is obtained thanks to the internal structure of the motor, and allow to know the exact angular position of the shaft by sampling counting how many steps have been performed, with no need for sensor. The feature also make it fit for a wide range of application.

The stepper motor in many different size, style and electrical characteristic.



## ARDUINO UNO

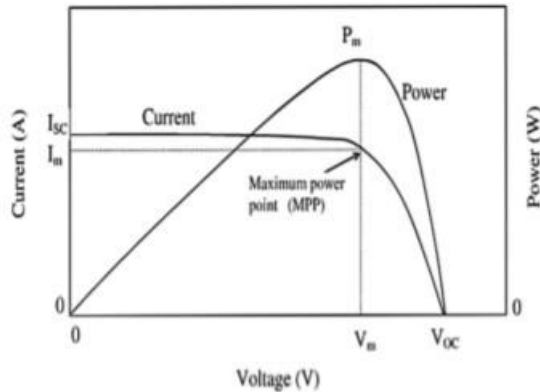
**Arduino Uno** is a microcontroller board based on the ATmega328P (datasheet). It has 14 digital input/output pins (of which 6 can be used as PWM outputs), 6 analog inputs, a 16 MHz ceramic resonator (CSTCE16M0V53-R0), a USB connection, a power jack, an ICSP header and a reset button. It contains everything needed to support the microcontroller; simply connect it to a computer with a USB cable or power it with a AC-to-DC adapter or battery to get started. You can tinker with your Uno without worrying too much about doing something wrong, worst-case scenario you can replace the chip for a few dollars and start over again.

"Uno" means one in Italian and was chosen to mark the release of Arduino Software (IDE) 1.0. The Uno board and version 1.0 of Arduino Software (IDE) were the reference versions of Arduino, now evolved to newer releases. The Uno board is the first in a series of USB Arduino boards, and the reference model for the Arduino platform; for an extensive list of current, past or outdated boards see the Arduino index of boards.

## MPPT( MAXIMUM POWER POINT TRACKER)

An MPPT is basically an efficient DC to DC converter used to maximize the power output of a solar panel. The first MPPT was invented by a small Australian company called AERL way back in 1985, and this technology is now used in virtually all grid-connect solar inverters and many solar charge controllers. The functioning principle of an MPPT solar charge controller is rather simple - due to the varying degree of sunlight (irradiance) landing on a solar panel throughout the day, the panel voltage and current continuously changes. In order to generate the most power, the maximum power point tracker sweeps

through the panel voltage to find the 'sweet spot' or the best combination of voltage and current to produce the maximum power. The MPPT is designed to continually track and adjust the voltage to generate the most power no matter what time of day or weather conditions. Note, generally only high-end MPPT controllers can detect partial shading, or are able to track multiple power points. Using this clever technology, the solar panel efficiency increases and the amount of energy generated can be up to 30% more than a PWM solar charge controller.


**Fig.4 MPPT POINT**

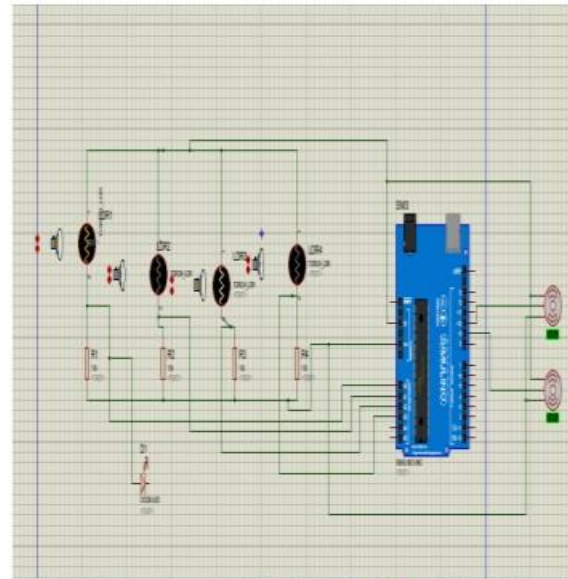
## VI. MPPT TRACKING SYSTEM (OR) DUAL AXIS SOLAR TRACKING SYSTEM& RESULTS

### MPPT TRACKING SYSTEM (OR) DUAL AXIS SOLAR TRACKING SYSTEM

This is one of the finest methods which are been introduced until right now compare to other technique this is a unique one [11].

- The name itself justify about it self it is a two-axis tracking system.
- It was better than one way tracking system.
- It can used for closed loop or open loop control system.
- The motion of sun is calculated from time to time by its position and its angle with the help of LDR sensor the position of sun is been tracked.
  - With the help of sensors, the we make sure that the panel should be placed in MPPT-point to get more efficiency.
- MPPT-(maximum power point tracking) in this point will maximum amount of energy or to observe maximum amount of light from sun, the amount of energy generation was more at this point.[12][2][13][4]
- At initial the cost of installing was more but the comeback period of returns in less time can be seen in this method.
- There are 2 angle like tilt angle and azimuth angle which are most important things in this method.
- 20-30% of efficiency increases in this method.
- In this method the degrees of freedom were two.

## RESULT


**Fig .5 proteus module for circuit verification**

Components when light or lux (units of light )was increases it is inversely proportional to resistance if the light intensity increases the resistance valve decreases if lux was decreases the resistance valve increases this is a basic principle behind LDR (light dependent resistor )which gives feedback to the Arduino no board.

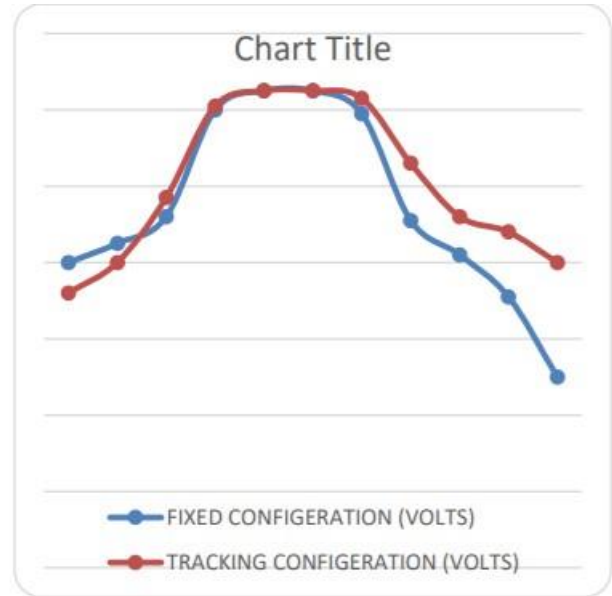
LDR1	LDR2	LDR3	LDR4
798	825	807	816
820	820	829	811
786	816	795	807
816	813	825	804
779	812	788	803
811	811	820	802
785	811	796	801
798	812	808	802
798	812	811	799

**Fig .6sensor response results from hardware**

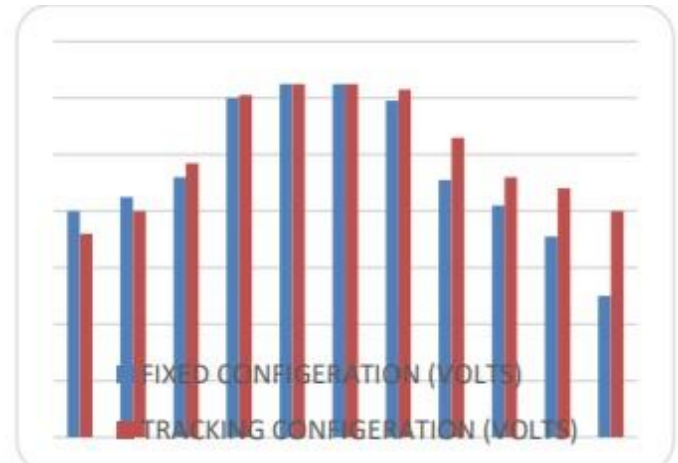


The above screenshots about the hardware valves of LDR and how they are been responding to light when the light intensity or lux increases the LDR-light dependent resistance where been decreases.

Time (Hour)	FIXED CONFIGURATION (VOLTS)	TRACKING CONFIGURATION (VOLTS)
8AM	8.0	7.2
9AM	8.5	8
10AM	9.2	9.7
11AM	12	12.1
12AM	12.5	12.5
1PM	12.5	12.5
2PM	11.9	12.3
3PM	9.1	10.6
4PM	8.2	9.2
5PM	7.1	8.8
6PM	5	8



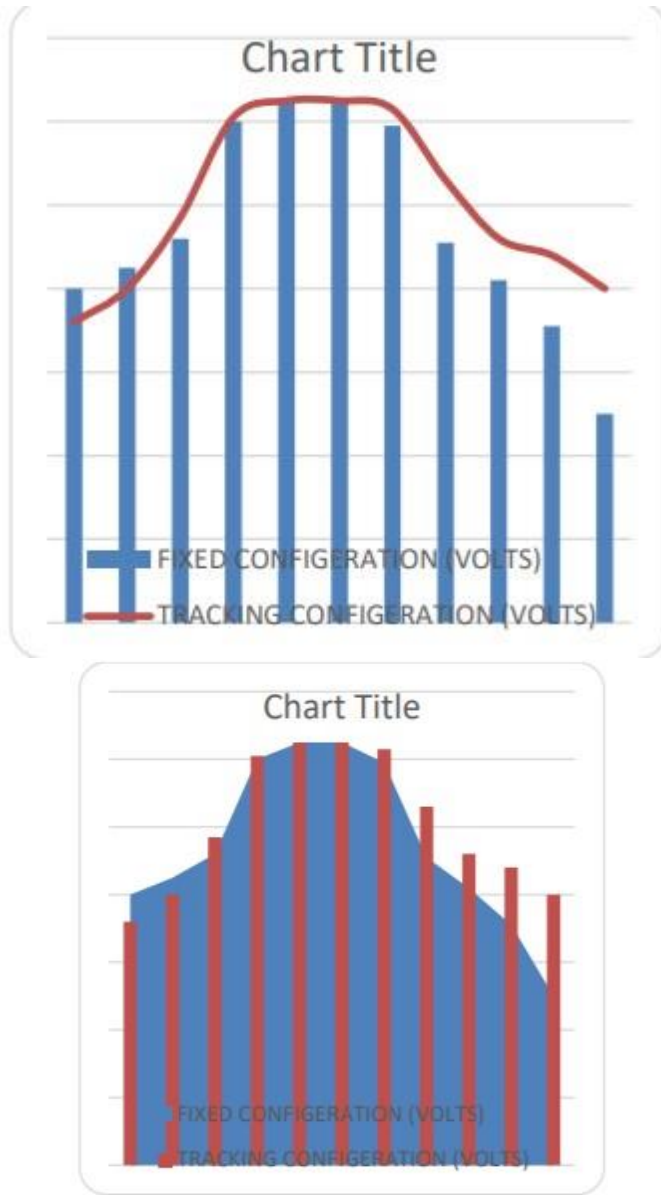
Graphical representation from the results of fixed and dual tracking configuration.



Bar graph analysis for fixed and tracking configuration was shown in the above figure .

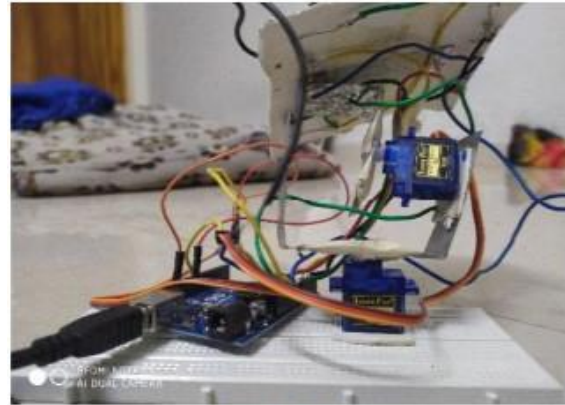
## RESULT ANALYSIS

From the results we can say that the dual axis solar tracker is more effective compared than the fixed solar panel, it is 12% more effective than the fixed solar panel .



Above graph about competition between fixed and tracking configuration in various types. With the help of graphical representation, we can see the clear analyses while comparing the values of the both fixed and tracking configuration.

## PROJECT PROTO TYPE



**SIDE VIEW**



**TOP VIEW**

## CONCLUSION

A cost effective intelligent automatic solar tracking system prototype to extract maximum solar energy possible was designed, built and tested. The system is based on two mechanisms. The first one is the search mechanism (PILOT) which locates the position of the sun. The second mechanism (intelligent PANELS) aligns itself with the PILOT only if maximum energy possible could be extracted. Thus, solar tracking system is an efficient and feasible means of obtaining optimal solar energy from the sun by constantly aligning the photovoltaic panel along the direction of sun. The solar module with automatic tracking system as demonstrated in the analysis achieves about 25% output power improvement at 10:00am over the fixed solar

module.

## REFERENCE

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