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Dual Axis Solar Tracker

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Abstract – **The solar photovoltaic system is in demand these days due to its efficient and clean energy. Setting up a solar panel which tracks the sun for the whole day can give a continuous power to any building for general utilities. The placing of solar panels at exact angle and direction according to the motion of sun can maximize the efficiency of the system. This research work implements the solar tracking system which tracks the sun in both the axis i.e. horizontal and vertical. Proposed in this report is a system that controls the movement of a solar array so that it is constantly aligned towards the direction of the sun. Solar modules are devices that cleanly convert sunlight into electricity and offer a practical solution to the problem of power generation in remote areas. The implementation of such a system is done by microcontroller controlled motor and sensor.**

Keywords: **microcontroller, tracker, sensor, motor, ldr.**

I. INTRODUCTION

Nowadays there is a depletion of renewable energy mainly solar energy, abundant amount of solar energy is produced but most of it going waste so there is a need of using the resources in a proper way by making some modifications in the installed system. Solar energy which produces non exhaustible energy can be put cleverly put to use as it is produced for free and doesn’t harm the environment.

The measure of sunlight based vitality achieving the surface of the earth is so huge that in one year it is about twice as much as will ever be gotten from the greater part of the Earth's non-sustainable assets. Presently in the event that we discuss separating sun powered vitality, daylight has two parts, the "immediate shaft" that conveys around 90% of the sun oriented vitality, and the "diffuse daylight" that conveys the leftover portion. As most of the light is in the immediate pillar, boosting accumulation requires the sun to be obvious to the boards to the extent that this would be possible. Improvement of sun oriented board following frameworks has been progressing for quite a long while presently. As the sun moves over the sky amid the day, it is worthwhile to have the sunlight based boards track the area of the sun, with the end goal that the boards are constantly opposite to the sunlight based vitality emanated by the sun. This will have a tendency to augment the measure of energy consumed by PV system. It has been evaluated that the utilization of a following framework, over a settled framework, can expand the power yield by 30% - 60%.

There are many types of solar trackers, of varying costs, sophistication, and performance. The required accuracy of the solar tracker depends on the application. Concentrators, especially in solar cell applications, require a high degree of accuracy to ensure that the concentrated sunlight is directed precisely to the powered device, which is at (or near) the focal point of the reflector or lens. It is conceivable to adjust the following reflector typical to sun utilizing electronic control by a microcontroller.

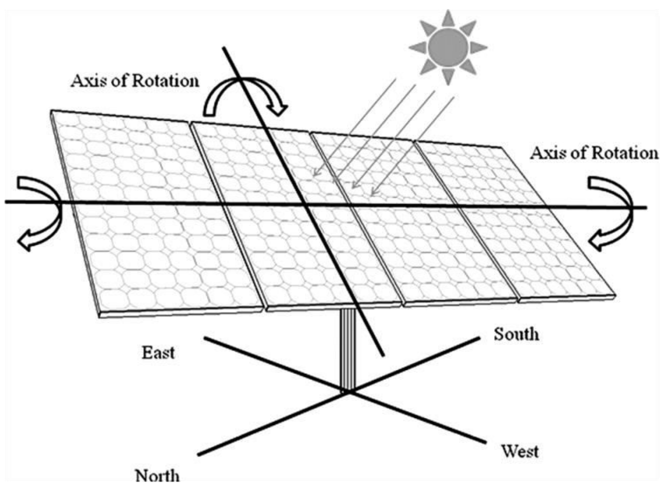

Fig. 1 sun tracking

Rotation and translation movements are the responsibility of the seasons, the succession of days and nights and the temperature differences around the world. Solar radiation depends on these movements and will change depending on the latitude and the time of the year. Sun's position directly affects the angle of incidence of the sun, and is determined by the elevation and azimuth angles.

The objective of this paper is constructing a moving solar panel to obtain more amount of solar power than a stationary solar panel does. A tracking device can track more amount of sunlight which results in more amount of production of electricity. So by installing a solar tracking device, the solar input can be tracked and more electricity can also be produced.

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II. MECHANISM DESIGN METHODOLOGY

This block diagram gives the structural methodology of the sun tracking system.

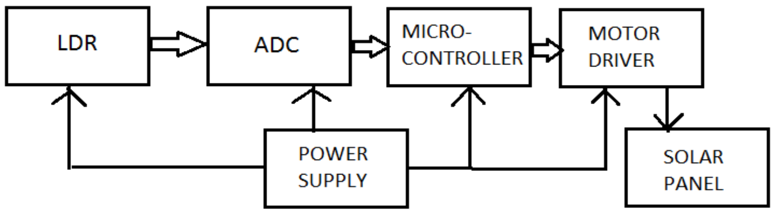

Fig. 2 design methodology

2.1. Hardware description

Solar panel

Solar panel is collection of solar cells which absorbs and converts light energy to electricity. In this prototype a 4volts, 100mA panel is used.

Fig. 3 solar panel

Microcontroller

It is the core element of this prototype. In this prototype we are using ATMEGA328P. It features analog comparator, analog to digital converter, universal synchronous asynchronous receiver transmitter, and parallel slave port.

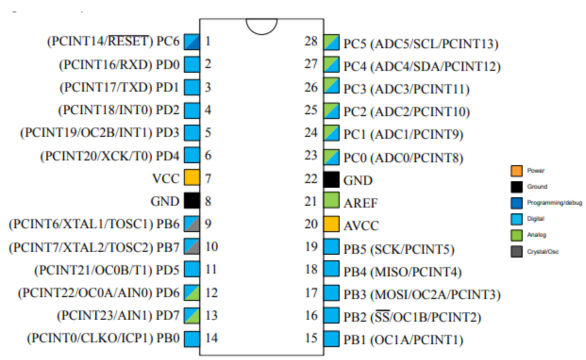

Fig. 4 pin diagram ATMEGA328P

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Servo motor

It is a rotary actuator for a high output. The movement of solar panel is done by motor. The motor used for positioning the solar module may be a servo motor. This allows for precise control of angular position. It consists of a suitable motor coupled to a sensor for position feedback. It has good holding torque and amazing response characteristics. Specifications of motor given below.

- Dimension: 22.2 x 11.8 x 31 mm approx.
- Stall torque: 1.8 kgf·cm
- Operating speed: 0.1 s/60 degree
- Operating voltage: 4.8 V (~5V)
- Dead band width: 10 µs
- Temperature range: 0 oC – 55 oC

Fig. 5 servo motor

Light Dependent Resistor

Light Dependent Resistors (LDR) is most common light sensor. Ldr is a variable resistor which varies with intensity of light falling on it. Due to illumination the electrons jumps to conduction band and hence conducts.

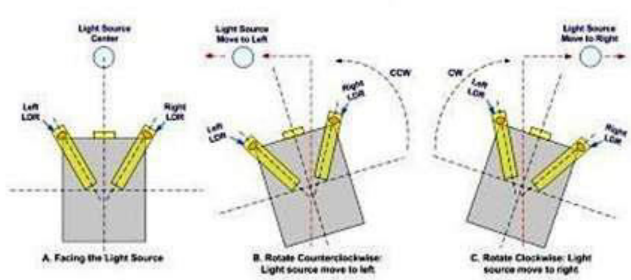

Fig. 6 position of ldr for tracking

In this prototype we fix the sensors on the panel to sense the sunlight which is further connected to arduino board giving microcontroller a signal. When there is maximum illumination the signal is again sent to microcontroller and the panel stays in that position for maximum sunlight.

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2.2. *Existing methodology*

The existing methodology of a solar tracking device consists of a single axis tracker. These tracking devices work on the method of minimising the angle of incidence of the sunlight incoming on the solar panel with the help of a sensor.

Such tracking systems can either move from east to west or north to south.the following figure shows the single axis tracking system. compared to the solar panel in a fixed tilt, this system has a better efficiency. Its about 25-30%. This system consists of two parts such as hardware part and programming part.

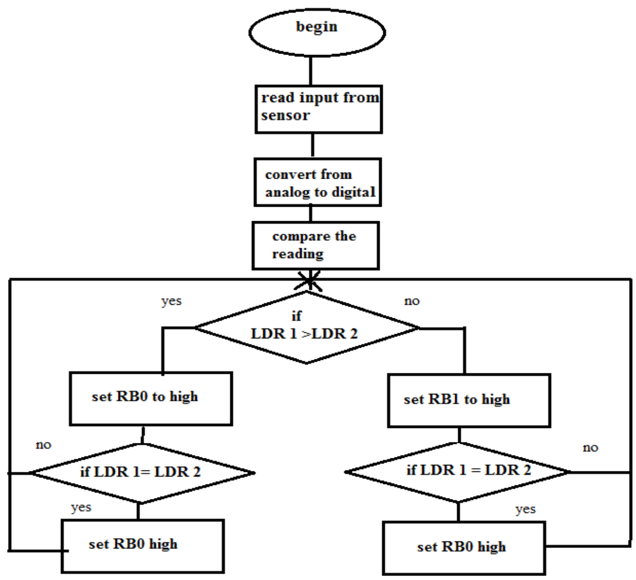

Fig. 7 system methodology flowchart

III. MAIN MODEL

Operation

This system consists of four LDRs, 2 motors, 4 resistors and an Arduino. LDRs are used as the main light sensors. Two servo motors are fixed to the structure that holds the solar panel. The program for Arduino is uploaded to the microcontroller. From the circuit diagram of this tracking system, it is seen that there are two motors connected to the arduino which are used to rotate the panel in both X and Y axis i.e., in all the four north, south, west and east directions. The four LDRs are placed such as two at the top and two at the bottom on the either side of the panel. This makes the panel move in the direction accordingly.

The program of the arduino is coded in such a way that the amount of the sunlight falling on the top two LDRs and the bottom two LDRs of the panel are compared and the area where larger amount of sunlight falls on the panel is taken by the arduino and commands one of the motors to move the panel in that direction i.e., if the top two LDRs gets more amount of sunlight, the motor will move the panel in the north direction and if bottom two LDRs gets more amount of sunlight, it moves the panel in the south direction. In this way one motor works.

Then, the second motor is used to move the panel either in the west direction or in the east direction. Here too, like the previous case, the code given to the arduino states that the LDRs that are placed in left side of the panel are taken as the pair and the LDRs in the right side are taken as the other pair. When the left sided region receives more sunlight than the right sided, the arduino makes the motor to move in the left direction .Similarly, when the right side receives more, it moves in the right side. In this way the second motor works.

So finally by installing two motors, the panel can be moved in both the axes.

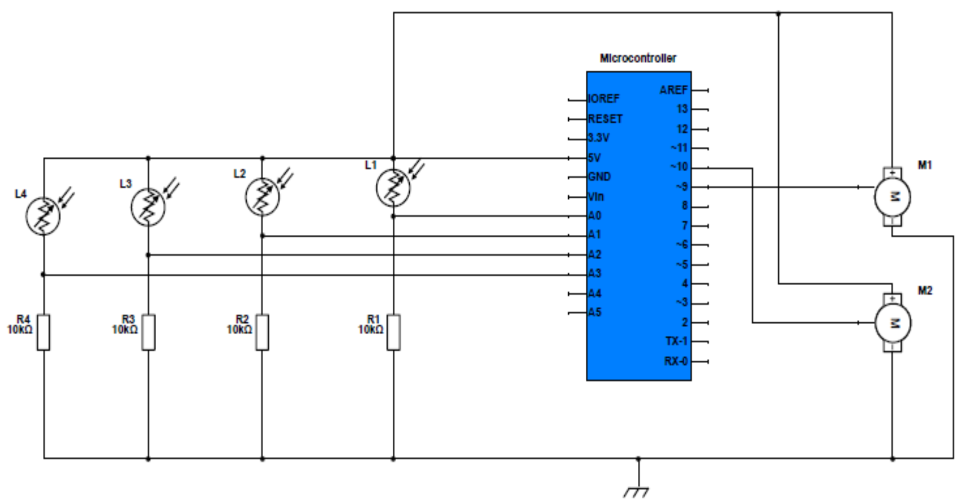

Fig. 8 circuit diagram

IV. PROJECT CODE

```
#include <Servo.h>

//defining Servos

Servo horiorizontal;

int hori = 0;

int horiLimitHigh = 170;

int horiLimitLow = 30;

Servo vertiertical;
```

```
int verti = 0;
int vertiLimitHigh = 170;
int vertiLimitLow = 30;
//Assigning LDRs
int ldrtopl = 2; //top left LDR green
int ldrtopr = 1; //top right LDR yellow
int ldrbotl = 3; // bottom left LDR blue
int ldrbotr = 0; // bottom right LDR orange
 void setup ()
 {
  horiorizontal.attach(10);
  horiorizontal.write(0);
  vertiertical.attach(9);
  vertiertical.write(0);
  delay(500);
 }
void loop()
{
  hori = horiorizontal.read();
  verti = vertiertical.read();
  //capturing analog values of each LDR
  int topl = analogRead(ldrtopl);
  int topr = analogRead(ldrtopr);
  int botl = analogRead(ldrbotl);
  int botr = analogRead(ldrbotr);
  // calculating average
  int avgtop = (topl + topr) / 2; //average of top LDRs
```

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```
int avgbot = (botl + botr) / 2; //average of bottom LDRs
int avgleft = (topl + botl) / 2; //average of left LDRs
int avgright = (topr + botr) / 2; //average of right LDRs
if (avgtop < avgbot)
{
  vertiertical.write(verti +1);
  if (verti > vertiLimitHigh)
   {
    verti = vertiLimitHigh;
   }
  delay(10);
}
else if (avgbot < avgtop)
{
  vertiertical.write(verti -1);
  if (verti < vertiLimitLow)
{
  verti = vertiLimitLow;
}
  delay(10);
}
{
  vertiertical.write(verti);
}

if (avgleft > avgright)
{
```

```
  horiorizontal.write(hori +1);
  if (hori > horiLimitHigh)
  {
  hori = horiLimitHigh;
  }
  delay(10);
}
else if (avgright > avgleft)
{
  horiorizontal.write(hori -1);
  if (hori < horiLimitLow)
   {
   hori = horiLimitLow;
   }
  delay(10);
}
else
{
  horiorizontal.write(hori);
}
  delay(50);}
```

V. RESULT

Prototype of a sun tracker has been designed and implemented. The prototype is successfully working with the logic from the operation of individual system components the solar panel tracks sunlight from morning to evening by moving in accordance with the movement of motor. A solar tracker is designed employing the new principle of using small sensors to function as self-adjusting light sensors, providing a variable indication of their relative angle to the sun by detecting their voltage output. By using this method, the solar tracker was successful in maintaining a solar array at a sufficiently perpendicular angle to the sun.

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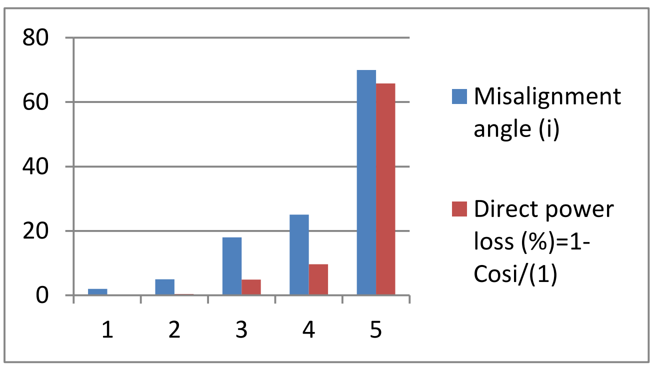
TABLE I. direct power loss for misalignment angle

Misalignment angle (i)	Direct power loss (%)=1-Cosi/(1)
2	0.0609
5	0.3805
18	4.8943
25	9.6392
70	65.7979



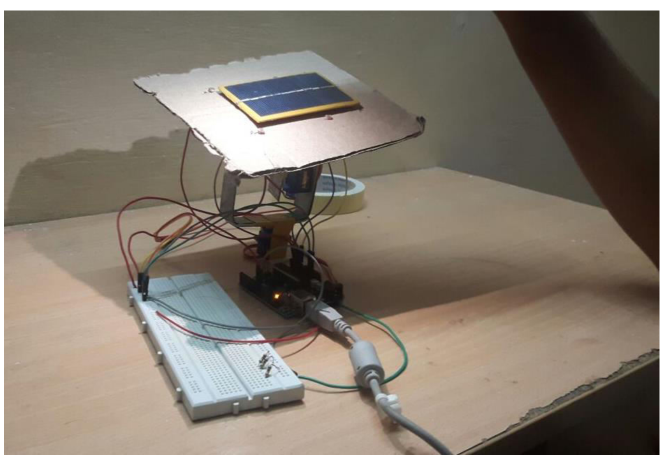


Fig. 9 hardware result

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