Single Axis Solar Tracking System using Microcontroller and Servo Motor

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Abstract— As the energy demand and the environmental problems increase, the natural energy sources have become very important as an alternative to the conventional energy sources. The renewable energy sector is fast gaining ground as a new growth area for numerous countries with the vast potential it presents environmentally and economically. Solar energy plays an important role as a primary source of energy, especially for rural area. This project aims at the development of process to track the sun and attain maximum efficiency using Microcontroller for real time monitoring. The project is divided into two stages, which are hardware and software development. In hardware development, two light dependent resistor (LDR) has been used for capturing maximum light source. Servo motor has been used to move the solar panel at maximum light source location sensing by LDR. The performance of the system has been tested and compared with static solar panel. This project describes the design of a low cost, solar tracking system.

Key words: Solar Tracker, LDR, Single Axis, Microcontroller, Energy Storage System

I. Introduction

Solar energy is use as most renewable source of energy and most unlikely to vanish. Thesedays electrical generation is typically provided by fossil fuels such as coal, natural gas, and oil and also as nuclear power. Some of today's most serious environmental problems can be linked to world electricity production based primarily on the use of nonrenewable resources. One solution for these problems are renewable energy in the form of photovoltaic (PV) systems. Concepts related to the solar energy have constantly been under heavy research and development. The basic objective is to optimize the energy produced from photovoltaic cells, by making the overall systems more efficient and cost effective. Most solar panels are statically aligned; they have a fixed position at a certain angle towards the sky.

Therefore, the time and intensity of direct sunlight falling upon the solar panel is greatly reduced, resulting in low power output from the photovoltaic (PV) cells. Solar tracking system is the solution to this issue as it plays a major role in overall solar energy optimization. In order to ensure maximum power output from PV cells, the sunlight's angle of incidence needs to be constantly perpendicular to the solar panel. This requires constant tracking of the sun's apparent daytime motion, and hence develops an automated sun tracking system which carries the solar panel and positions it in such a way that direct is always focused on the PV cells. This paper is about moving a solar panel along with the direction of sunlight; it uses a gear motor to control the position of the solar panel, which obtains its data from a PIC16F877A microcontroller. The objective is to design and implement an automated, single–axis solar-tracking using embedded system design in order to optimize the efficiency of overall solar energy output. Light dependent resistor (LDR) is used to know the actual sun position as sensor. LDR is basically photocells that are sensitive to light. Software will be developed which would allow the PIC to detect and obtain its data from the LDR and then compare its resistance at each position. The MCU will detect the difference in resistance and thus actuate the motor to move the solar panel at a position where the light upon LDR is the most.

II. System Block Diagram of Solar Tracking System

The overall block diagram of the system is shown in Figure2.There are two main parts: maximum solar intensity tracking section and solar panel positioning section. The PIC microcontroller is a very common component in modern electronic systems. Not only is the cost of modern microcontroller based system decreasing but also the performance is raising daily. The four Permanent Magnet stepper motors will be used as actuators in this system. Two stepper motors are used to set the vertical and horizontal axis of the maximum solar intensity tracking section and other two motors are used in solar panel positioning section. Nowadays, a control system will be necessary for all electronics devices. Solar tracking control system is necessary for domestic and rural areas. In this research as a sensor is used because it is suitable for the proposed system and it has low cost.

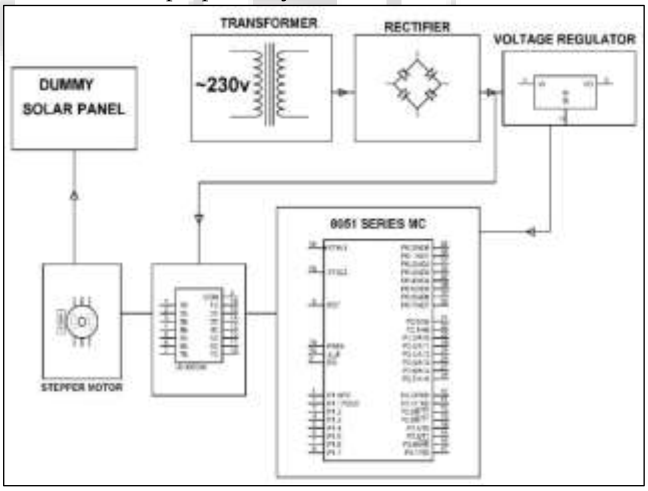

Fig. 1: The overall block diagram of solar tracking system

III. Main Components of Tracking System

In this design, the following main components are mainly used for tracking the sun intensity.

A. LDR-Light Dependent Resistor

A Light Dependent Resistor (LDR) is also called a photo resistor or a cadmium sulfide (CdS) cell. It is also called photoconductor. It is basically a photocell that works on the principle of photoconductivity. The passive component is basically a resistor whose resistance value decreases when the intensity of light decreases. It optoelectronic device is mostly used in light varying sensor circuit, and light and dark activated switching circuits. Some of its applications include camera light meters, street lights.

LDR Structure and Working: The basic structure of an LDR is shown below.

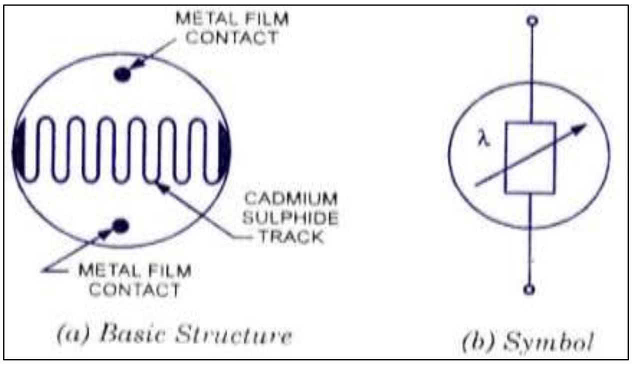

Fig. 2: LDR

The snake like track shown below is the Cadmium Sulphide (CdS) film which also passes through the sides. On the top and bottom are metal films which are connected to the terminal leads. It is designed in such a way as to provide maximum possible contact area with the two metal films. The structure is housed in a clear plastic or resin case, to provide free access to external light. As explained above, the main component for the construction of LDR is cadmium sulphide (CdS), which is used as the photoconductor and contains no or very few electrons when not illuminated. In the absence of light it is designed to have a high resistance inthe range of megaohms. As soon as light falls on the sensor, the electrons are liberated and the conductivity of the material increases. When the light intensity exceeds a certain frequency, the photons absorbed by the semiconductor give band electrons the energy required to jump into the conduction band. This causes the free electrons or holes to conduct electricity and thus dropping the resistance dramatically.

B. *Servo Motor*

Servo motors have been around for a long time and are used in many applications. They are small in size but pack a big punch and are very energy efficient. Because of these features, they can be used to operate remote-controlled or radio-controlled toy cars, robots and airplanes. Servo motors are also used in industrial applications, robotics, in-line manufacturing, pharmaceutics and food services. Servos are controlled by sending an electrical pulse of variable width, or pulse width modulation (PWM), through the control wire. There is a minimum pulse, a maximum pulse and a repetition rate. A servo motor can usually only turn 90° in either direction for a total of 180° movement. The motor's neutral position is defined as the position where the servo has the same amount of potential rotation in the both the clockwise or counterclockwise direction.

IV. Methodology

The main impulsion is to design a high quality solar tracker. This paper is divided into two parts; hardware and software. It consists of three main constituent which are the inputs, controller and the output as shown in Fig B photo resistor or Lightdependent resistor (LDR) or photocell is a light-controlled variable resistor. LDRs or Light Dependent Resistors are very useful especially in light/dark sensor circuits. Normally the resistance of an LDR is very high, sometimes as high as 1000 000 ohms, but when they are illuminated with light resistance drops dramatically. LDR’s have low cost and simple structure. The Servo motor can turn either clockwise or anticlockwise direction depending upon the sequence of the logic signals. The sequence of the logic signals depends on the difference of light intensity of the LDR sensors. The principle of the solar tracking system is done by Light Dependant Resistor (LDR). Two LDR’s are connected to Arduino analog pin AO to A1 that acts as the input for the system. The built-in Analog-to-Digital Converter will convert the analog value of LDR and convert it into digital. The inputs are from analog value of LDR, Arduino as the controller and the Servo motor will be the output. LDR1 and LDR2 are taken as pair .If one of the LDR gets more light intensity than the other, a difference will occur on node voltages sent to the respective Arduino channel to take necessary action. The Servo motor will move the solar panel to the position of the high intensity LDR that was in the programming.

V. Algorithm and C Code

- Step 1. Read all analog voltages from analog channels.
- Step 2. If all voltages are equal then Servo motor will be in stop position.
- Step 3. If LDR1>LDR2 Then the Servo motor will rotate clockwise.
- Step 4. If LDR2>LDR1 Then the down motor will rotate anti clockwise.

A. *Code*

```
#include <Servo.h>
Servo myservo
int pos=0; // Variable to store the servo position . int
inputPhotoLeft=1; //Easier to read, instead of just 1 or 0.
int inputPhotoRight=0;
int Left=0;// Store reading from the photo resistors.
int Right=0;// Store reading from the photoresistors.
void set up ()
{
myservo.attach(9); //Attach servo to pin 9.
}
void loop()
{
//Read the values from the photoresistors to the Left and
Right variables. Left=analogRead(inputPhotoLeft);
Right=analogRead(inputPhotoRight);
// Checks if Right is greater than Left, if so move to right.
if (Left > (Right+20))
// +20 is the deadzone, so it would not  jiggle back and forth.
{
if (pos < 55)
pos++;
myservo.write(pos);
}
// check if left is greater than right, if so move to left.
if (Right > (Left+20))
// +20 is the deadzone, so it wouldnot jiggle back and forth.
```

```
if (pos > 55)
pos--;
myservo.write(pos);
}
```

VI. BLOCK DIAGRAM

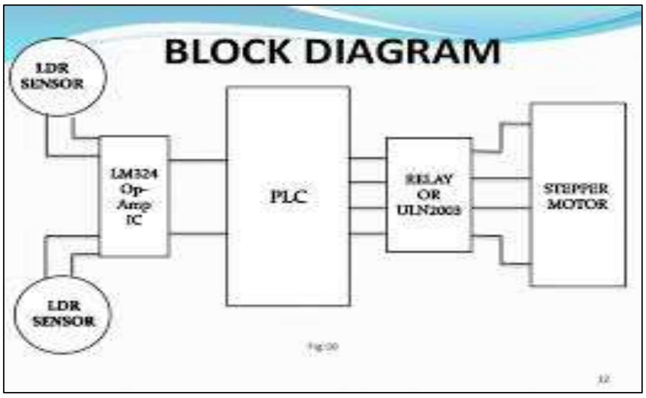

Fig. 3: Block Diagram

VII. CONCLUSION

Solar trackers generate more electricity than their stationary counterparts due to an increased direct exposure to solar rays. There are many different kinds of solar tracker, such as single-axis and dual-axis trackers, which can help us find the perfect fit for our unique jobsite. Installation size, local weather, degree of latitude, and electrical requirements are all important considerations that can influence the type of solar tracker that’s best for us. Solar trackers generate more electricity in roughly the same amount of space needed for fixed tilt systems, making them ideal optimizing land usage. Solar trackers are slightly more expensive than their stationary counterparts, due to the more complex technology and moving parts necessary for their operation. Some ongoing maintenance is generally required, though the quality of the solar tracker can play a role in how much and how often this maintenance is needed.

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