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# Single Axis Solar Tracking System using Microcontroller (ATmega328) and Servo Motor

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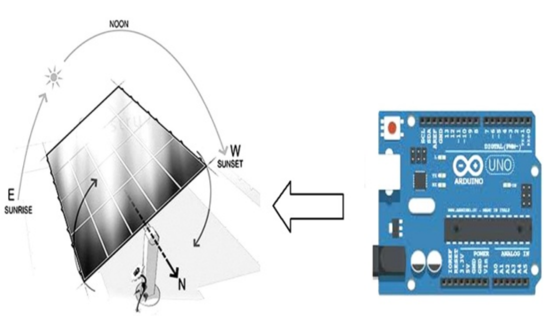
***Abstract-*** As the energy demand and the environmental problems increase, the natural energy sources have become very important as an alternative to the conventional energy sources. The renewable energy sector is fast gaining ground as a new growth area for numerous countries with the vast potential 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 Arduino Uno 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.

***Index Terms-*** Solar tracker, Arduino ATmega 328, LDR, Single Axis ,Energy storage system

## I. Introduction

Tracker systems follow the sun throughout the day to maximize energy output. The Solar Tracker is a proven single-axis tracking technology that has been custom designed to integrate with solar modules and reduce system costs. The Solar Tracker generates up to 25% more energy than fixed mounting systems and provides a bankable energy production profile preferred by utilities.

### 2.1 BlOCK DIAGRAM:

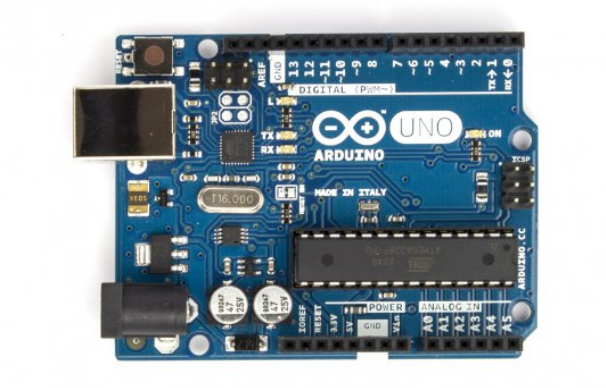



Arduino UNO Basic Information:

The Arduino Uno is a microcontroller board based on the ATmega328.It has 14 digital input/output pins (of which 6 can be used as PWM outputs), 6 analog inputs, a 16 MHz ceramic resonator, 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.

### 2.2 SPECIFICATIONS:

Microcontroller : ATmega328
Operating Voltage : 5V,Input Voltage (recommended) : 7-12V
Input Voltage (limits): 6-20V
Digital I/O Pins: 14 (of which 6 provide PWM output), Analog Input Pins :6,DC Current per I/O Pin:40 mA, DC Current for 3.3V Pin :50 mA
Flash Memory :32 KB of which 0.5 KB used by bootloader, SRAM:2 KB
EEPROM :1 KBClock Speed:16 MHz




### 2.3 SERVO MOTOR:

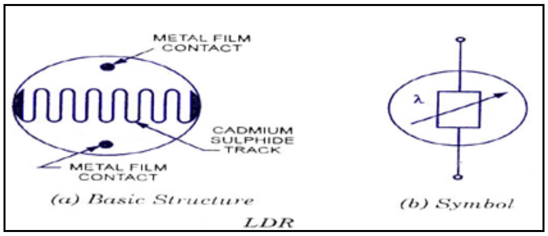
Servo motors have been around for a long time and are used in many applications. They are small in size but pack a big punch and are very energy efficient. Because of these features, they can be used to operate remote-controlled or radio-controlled toy cars, robots and airplanes. Servo motors are also 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 counter-clockwise direction. The PWM sent to the motor determines position of the shaft, and based on the duration of the pulse sent via the control wire the rotor will turn to the desired position. The servo motor expects to see a pulse every 20 milliseconds (ms) and the length of the pulse will determine how far the motor turns. For example, a 1.5ms pulse will make the motor turn to the 90° position. Shorter than 1.5ms moves it to 0° and any longer than 1.5ms will turn the servo to 180°. When these servos are commanded to move, they will move to the position and hold that position. If an external force pushes against the servo while the servo is holding a position, the servo will resist from moving out of that position. The maximum amount of force the servo can exert is called the torque rating of the servo. Servos will not hold their position forever though; the position pulse must be repeated to instruct the servo to stay in position.

**2.4 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 a 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. This 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.




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 (< 1 Kiloohm).

**2.5 GEAR:**

A toothed wheel that works with others to alter the relation between the speed of a driving mechanism (such as the engine of a vehicle) and the speed of the driven parts (the wheels).

**What do gears do... and how do they do it?**Gears are used for transmitting power from one part of a machine to another. In a bicycle, for example, it's gears (with the help of a chain) that take power from the pedals to the back wheel. Similarly, in a car, gears transmit power from the crankshaft (the rotating axle that takes power from the engine) to the driveshaft running under the car that ultimately powers the wheels.

**Increase speed:** If we connect two gears together and the first one has more teeth than the second one (generally that means it's a bigger-sized wheel), the second one has to turn round much faster to keep up. So this arrangement means the second wheel turns faster than the first one but with less force.

**Increase force:** If the second wheel in a pair of gears has more teeth than the first one (that is, if it's a larger wheel), it turns slower than the first one but with more force.

**Change direction:** When two gears mesh together, the second one always turns in the opposite direction. So if the first one turns clockwise, the second one must turn counterclockwise. We can also use specially shaped gears to make the power of a machine turn through an angle. In a car, for example, the differential (a gearbox in the middle of the rear axle of a rear-wheel drive car) uses a cone-shaped bevel gear to turn the driveshaft's power through 90 degrees and turn the back wheels.

**Four different ways to use gears:**

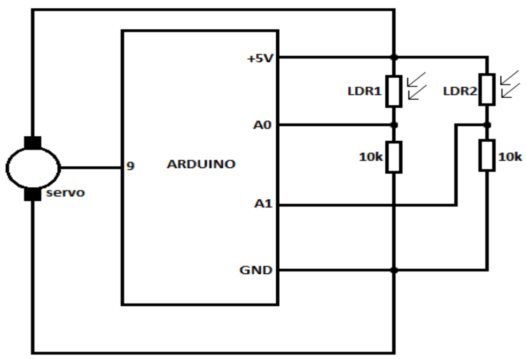
**Gears for speed:**In this simple gearbox, we got (from right to left) a large gear wheel with 40 teeth, a medium wheel with 20 teeth, and a small wheel with 10 teeth. When we turn the large wheel round once, the medium wheel has to turn twice to keep up. Similarly, when the medium wheel turns once, the small wheel has to turn twice to keep up. So, when we turn the large gear wheel on the right, the small wheel on the left turns four times faster but with one quarter as much turning force. This gearbox is designed for increasing speed.

**Gears for force:** If we power the same gearbox in the opposite direction, by turning the small wheel, I'll make the large wheel spin a quarter as fast but with four times as much force. That's useful if I need to make a heavy truck go up a hill, for example.

**Worm gears:** Here we use an electric motor (the gray box on the right) and a long screw-like gear to drive a large gear wheel. This arrangement is called a worm gear. It reduces the speed of the motor to make the large wheel turn with more force, but it's also useful for changing the direction of rotation in gear-driven machinery.

**Rack and pinion gears:** We've probably seen one of these in cliff- and hill-climbing rack railroads, but they're also used in car steering systems, weighing, and many other kinds of machines as well. In a rack and pinion gear, a slowly spinning gear wheel (the pinion) meshes with a flat ridged bar (the rack). If the rack is fixed in place, the gear wheel is forced to move along it (as in a railroad). If the gear is fixed, the pinion shifts instead. That's what happens in car steering: we turn the steering wheel (connected to a pinion) and it makes a rack shift from side to side to swivel the car's front wheels to the left or the right. In simple weighing scales, when you load a weight on the pan at the top, it pushes a rack straight downward, causing a pinion to rotate. The pinion is attached to a pointer that rotates as well, showing the weight on the dial.

## II. Schematic of the Arduino Solar Tracker Circuit




**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 Light-dependent 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.

## III. 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.

**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);
}
```

## IV. 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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