Single Axis Sun Tracker Using Arduino
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Introduction:

If you've installed solar panels on a camper van to provide you with electricity on your camping trip or at home to supplement your electricity usage or take your home completely off grid then you probably know that the panels work the best when they are aligned directly towards the sun. This sounds simple enough, except that the sun moves throughout the day. This is why there are now a number of different mechanisms which work on a range of principles with the purpose of aligning your panel or array of panels directly towards the sun, they are called solar trackers.

There are two principle types of trackers, single and duel axis trackers. Single axis trackers are adjusted every month or so account for seasonal changes in the suns position, the single axis is then used to track the daily movement of the sun across the sky. Duel axis trackers eliminate the need for monthly adjustment by using one axis to track the suns daily movement and another axis to track the seasonal movement. A single axis solar tracker improves solar output by around 25% and a dual axis tracker by around 40% according to this article on Altestore.

Requirements:

Here is a list of the items which you need in order to complete this project. If you are looking to make a dual axis tracking stand then you will need to double up on the servos, LDRs and resistors.

- An Arduino (Uno is used here)

- Single Axis Tracking Stand (Brief DIY Design Shown In Step 6)

- 2 x 4.7K Resistors

- 2 x LDRs

- PWM Servo

The specific servo model or size has not been stated as it depends on the size and weight of your solar panel. The one used in this project is a 9 gram analogue servo. You can use any size PWM hobby servo with the Arduino although the larger servos will require their own power source.

Assembly:

First you need to start by assembling the components onto your solar panel, or breadboard. The LDRs (light dependent resistors) or PRs (photo-resistors) change resistance with changing light, therefore they need to be connected in such a way that the changing resistance is converted into a changing voltage signal which the Arduino understands. The servo is controlled through one of the Arduino's PWM outputs.

If you are going to be installing the solar tracker permanently then you may want to solder the resistors and LDRs together so that they cannot come loose. If you are simply trying this project for fun then a breadboard is perfect.
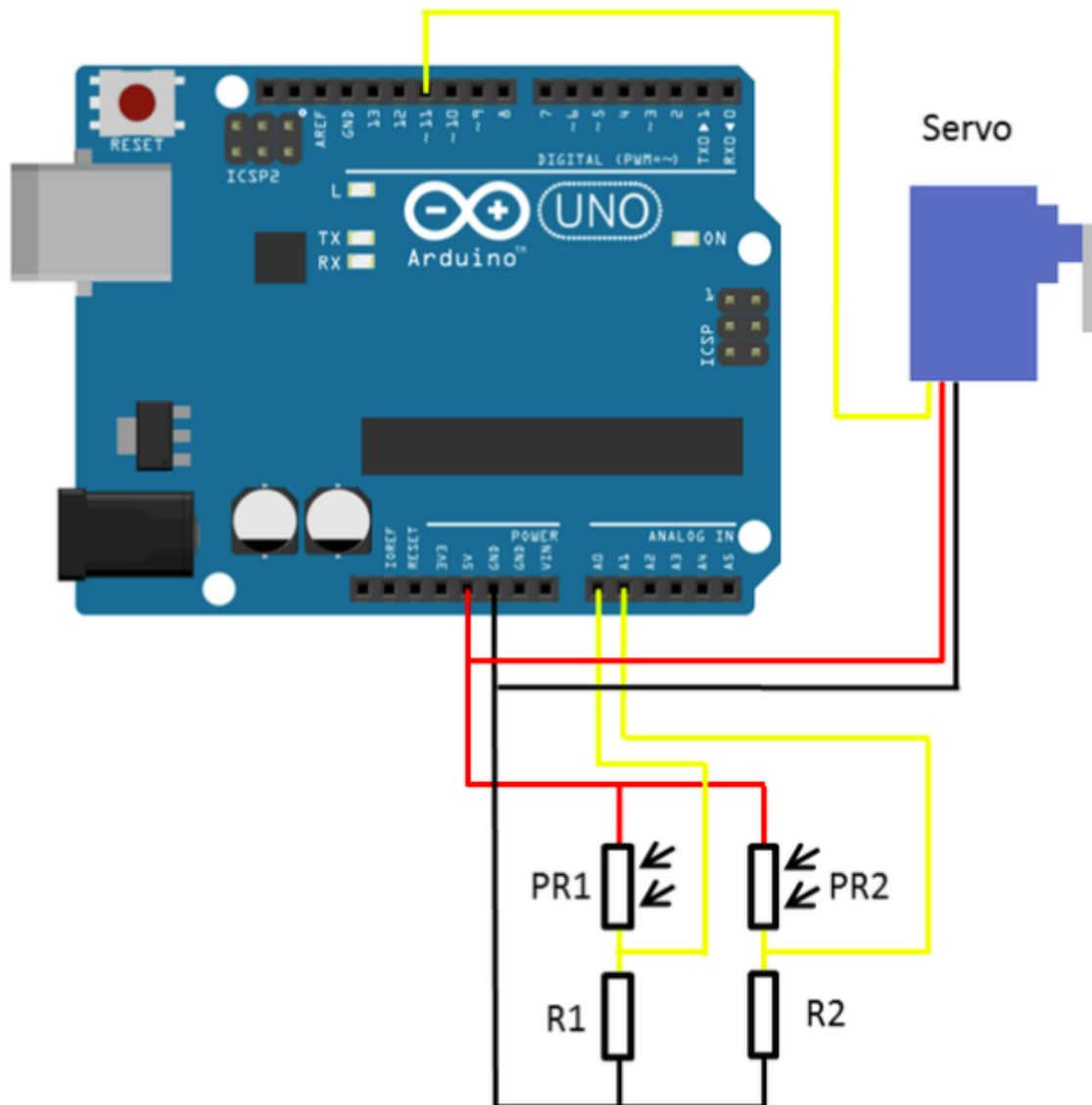
The basic circuit for the connection of the LDRs and servo to the Arduino is shown in the attached image.

The resistors R1 and R2 are each 4.7K, the PR1 and PR2 are the two LDRs and the servo can be any PWM hobby servo If you are using a servo larger than 9 grams then the Arduino will probably not be able to supply it enough power to achieve its full torque capability, you will need to supply the servo directly with its own 5v power source.

If you are making this a permanent installation, then it is best to solder the resistors right up near the LDRs on the panel. This way you can run a single 4 core wire from the control box up to the sensors on the panel, the four cores will be 5V, Gnd and then signal 1 and 2 from the LDRs. Once your LDRs and resistors have been soldered together, you can mount them on your solar panel. Mount the LDRs on the east and west (left and right) sides of the panel facing towards the sun. Make sure that they are not shaded in any way by the frame and have an unobstructed view of the sun.

A breadboard has been used in this project purely to distribute the Ardunio's 5V power supply to both the resistors and the servo.

The servo needs to be sized according to the size of your solar panel. The panel used in this example is small and relatively light; a small servo was therefore used and is powered by the Arduino. For a larger servo (anything above 9 grams), you will need to power the servo externally as the Arduino doesn't have sufficient capacity for it. Make sure that you connect the external power sources ground to the Arduinos GND as well otherwise the PWM control signal to the servo will not work.

The code essential measures the light intensity from both photo resistors, it then compares the two to see which is receiving more light. If the difference is greater than a small threshold then the Arduino tells the servo to move in that direction to direct the panel towards the light source. If the light falls below a certain level on both sensors then it is detected as night time and the panel is moved to face east again for sunrise.

Calibration:

Because of differences between the LDRs, resistors and the resistance of the wire used, there will be a difference between the signal received from both sensors even when they are receiving the same amount of light. This is taken into account by introducing a calibration offset into the calculation, this number will need to be adjusted in your code according to your setup. Adjust this calibration factor where it is declared in the code,

The most accurate way to determine this factor is to shine a light equally between both sensors and then use the Serial monitor on your computer to read the values output by the east and west sensor. The difference between these two values will be the calibration offset. The LDRs are very sensitive so the tracker only moves when the difference between them is greater than 15 in the code otherwise it would be continuously tracking forwards and backwards and wasting power.

If you are not familiar with the Serial interface then you can play around with this value until the tracker remains still when a light is shined equally on to both sensors.

Making:
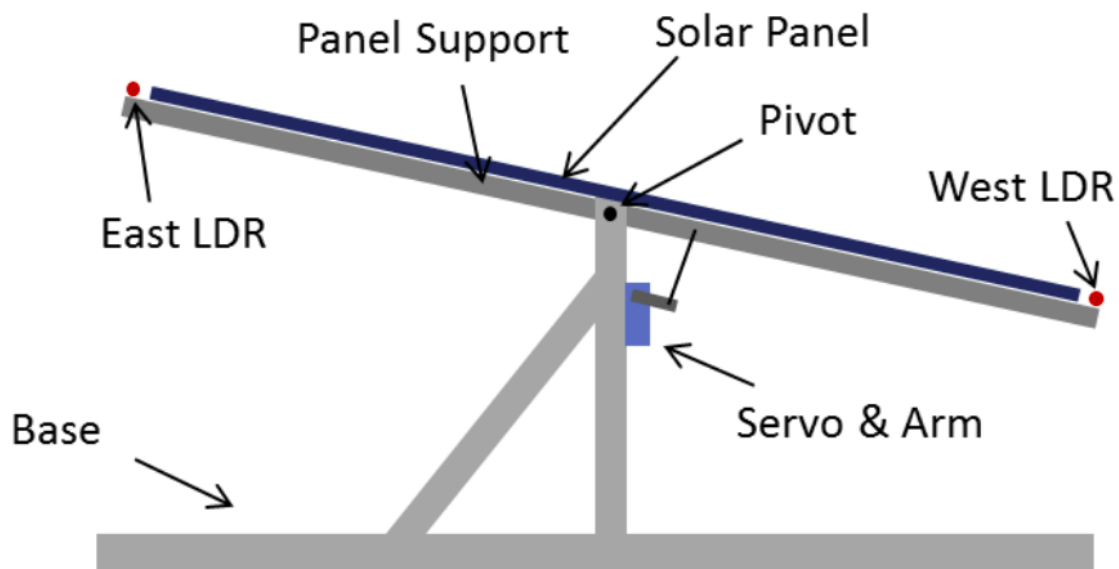
While this instructable is centered more around the Arduino control and is not intended to detail making a tracking stand because of the extremely diverse range and size of panels available, here is a brief outline on the design along with some key pointers.

Your stand should look something like the attached image when it is complete.

Ideally the stand should be made from aluminium angle as it is strong, durable and suitable for outdoor use but it can also be made from wood, plywood or PVC piping.

The stand is essentially made in two parts, the base and the panel support. They are joined around a pivot point on which the panel support rotates. The servo is mounted onto the base and the arm actuates the panel support.

The panel should protrude from the panel support as little as possible to keep the out of balance load on the servos to a minimum. Ideally, the pivot point should be placed at the centre of gravity of the panel and panel support together so that the servo has an equal load placed on it no matter which direction the panel is facing although this is not always practically possible.

Two servos may be used for heavier panels, one on each side of the panel. The geometry needs to be the same and the servos need to be the same type/model. You can then duplicate the servo code in the software so that both servos are given the same reference position and move together to actuate the panel.

For very heavy panels or for solar arrays, the servos will need to be replaced with stronger stepper motors. The stepper motors will need to be driven by a driver board.

Results:

Solar panel while tracking generates 30-40% more energy as compared to the traditional fixed mount Solar panel. The energy required to track the sun is minimal in comparison to the generated energy. Which is 5% of the generated output. Hence can be neglected in front of net energy.