ELEC 327 Final Project: Light-Tracking Solar Panel

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Motivation

Solar energy is a clean, renewable, and inexhaustible energy source increasingly used in transportation, lighting, and many more applications. Solar energy has great potential because it is derived from the sun's radiation and is accessible as long as the sun exists. However, a major problem is that we are currently able to harness only 0.001 percent of the total amount of solar energy available. Solar energy is harnessed through solar panels. For our project, we built a light-tracking solar panel whose surface points in the direction with greatest light, allowing more solar energy to be collected and produced.

Architecture

Our light-tracking solar panel uses two photoresistors to detect the direction of greatest light intensity and a servo motor to tilt the panel in that direction.

Our project consists of two main parts: light-sensing and servo motor control. The input is the amount of light, which is obtained from the light-sensing part of our project. In this part, two photoresistors are placed on the opposite ends of the board and are used to detect the amount of light near its respective areas. In the servo motor control part, the direction and angle of rotation of the servo motor are determined by the the direction of greatest light intensity and the difference between the amounts of light at each photoresistor. The solar panel is attached to the servo motor and is thus tilted accordingly. We were able to set up a system to have the solar panel power our system. We had a smaller solar panel that worked well and would have been implemented with our system had it not generated too little power. We ordered a large solar panel, 9V, and created a 9v to 5v regulator circuit for our board, but the solar panel seemed to not work. The voltage measurement out of the solar panel was 0 even though we tested it several times, which lead us to conclude it might have been defective.

Components

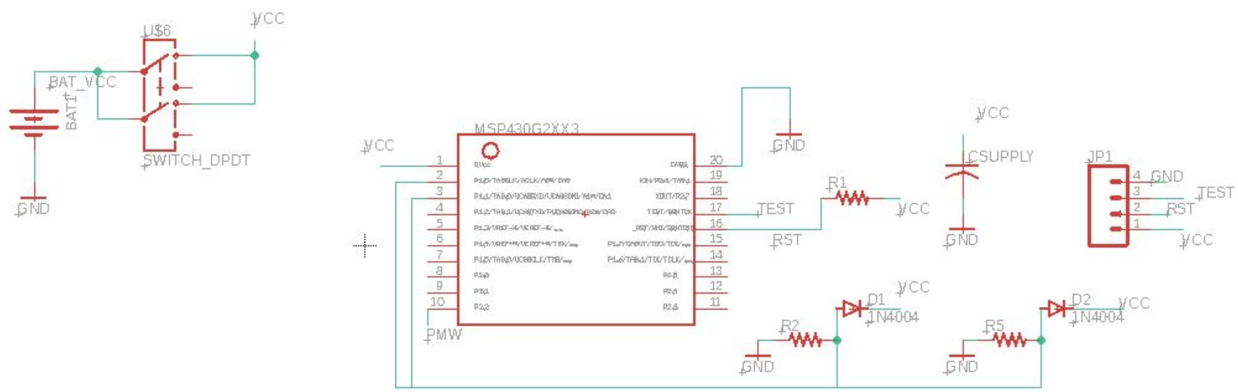
- MSP430G2553 microcontroller
- Mini solar panel
- 180 degree servo motor (TowerPro SG-5010)
- 2 photoresistors
- 3 resistors (one 47k, two 10k)
- 10 microfarad capacitor
- Three 1.5V Batteries
- Switch

Technical Details

- Photoresistors: Photoresistors are resistors whose resistances depend on the intensity of the lights they are exposed to. Their resistances decrease with increasing light intensity. In our project, the analog light detected by the photoresistors are converted into digital light values using the analog to digital conversion module of the MSP430.

- Servo motor: A servo motor is a motor that allows for precise control of angular position, velocity, and acceleration. It has 3 pins: one is connected to GND, one to VCC, and one to a PWM signal generated by the MSP430. The PWM signal determines the motor's rotation. Our servo motor has a 180 degree rotation range, with 0 and 179 corresponding to complete rotation in the direction of one of the photoresistors and 90 corresponding to a neutral position. We attached our solar panel to the motor so that it will tilt according to the motor's rotation.

Circuit Schematic

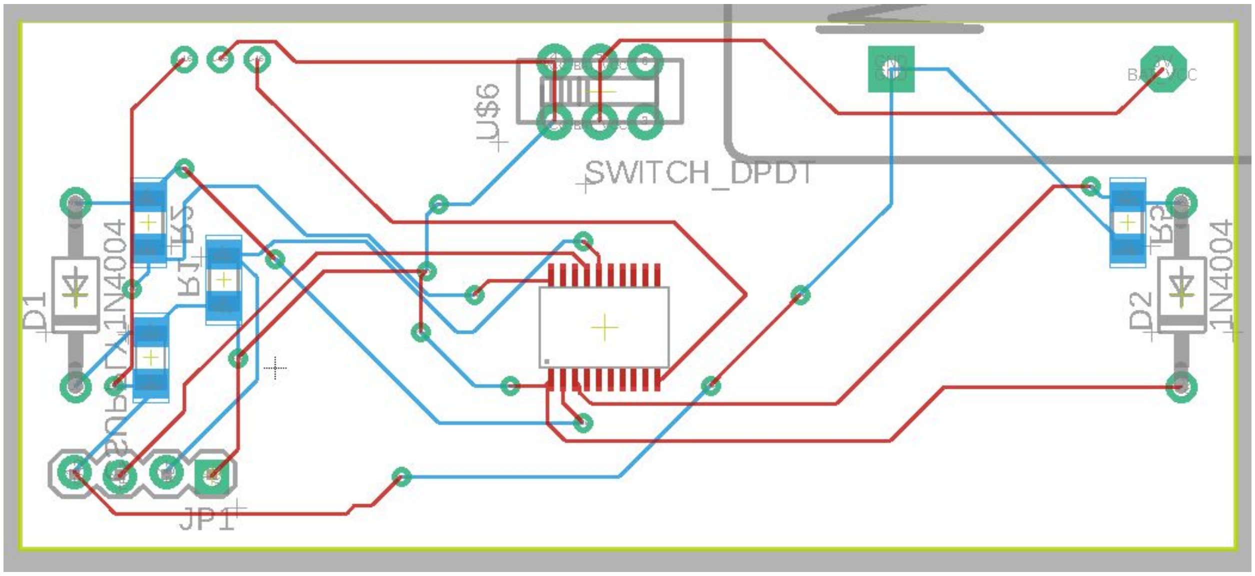


Two photoresistors are connected to the microcontroller MSP430's pins P1.0 and P1.1, which are selected as input pins for the ADC10 module. This converts the analog light signal detected by each photoresistor into a digital value.

The servo motor is connected to P2.2, which is set to PWM mode. This is because the position to be achieved by the servo motor is determined by a PWM signal. The digital light values detected by the photoresistors are compared and used to determine the frequency of the PWM signal. Since the solar panel is connected to the motor, the tilt of the solar panel depends on the difference between the two digital light values and which photoresistor light value is larger.

A battery provides power to the circuit and a switch turns the current in the circuit on and off. Various resistors and capacitors are included in the circuit to limit the current and suppress high-frequency noise in power supply signals.

PCB Design



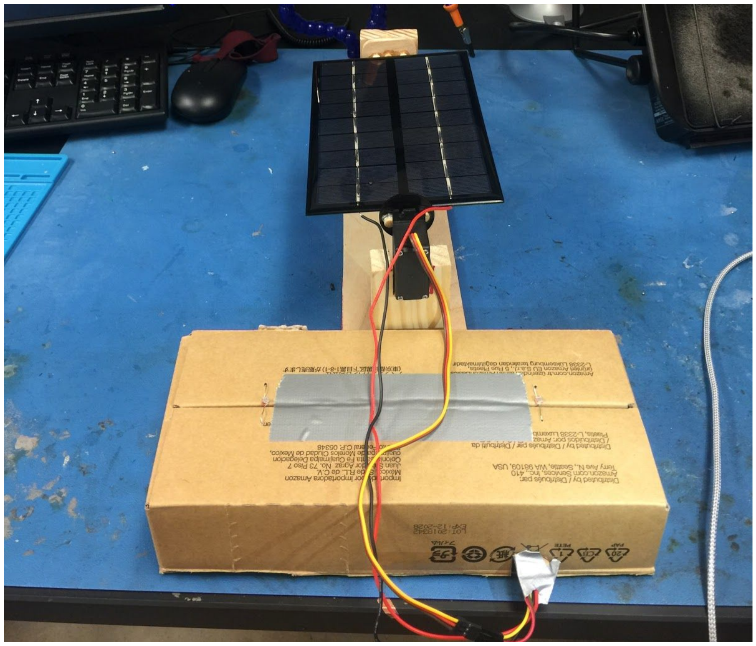
One photoresistor is placed on the right side of the board and the other is placed on the left side. We connected the servo motor to the via on the upper left corner of the board.

Code

The logic behind our light-tracking solar panel is implemented in the code. There are two main parts: light-sensing using two photoresistors and servo motor control using a PWM signal. In our code, we compared the digital light values of the photoresistors. If the digital light signal sensed by the right photoresistor is greater than the light signal sensed by the left photoresistor, the servo motor rotates to the right and stops at an angular position determined by the difference between the light values. If this difference is greater than 360, the motor rotates completely in the direction of the right photoresistor. The same logic is followed when the digital light signal sensed by the left photoresistor is greater than the light signal sensed by the right, except that the motor now rotates in the direction of the left photoresistor.

Results, Challenges, and Potential Improvements

Overall we were very impressed by our results. The solar panel is extremely responsive, and it is able to register the angle with a good amount of sensitivity. The servo also rotates quickly and immediately to changes in light. However we faced numerous challenges in creating the system. We struggled with our changing PCB design. We made several improvements to our circuit design, but we were not able to order a new PCB in time. Because of this, we aired wired many of our components and removed some of the components from the PCB. Finally, one more challenge we faced was what seemed to be a broken solar panel. It did not register a voltage reading in the several configurations and settings that we tried to measure. Our potential improvements include the need to have the solar panel power the whole circuit. Again, this was a challenge we faced due to what seems to be a broken solar panel. We had circuits in place to allow this 9V solar panel power our circuit and we believe that had we order a working solar panel, then we could have powered our board with it. Furthermore, we think we could improve the board to include a board to display how long it had been charging, or some other external features to interact with.



More pictures are available in the presentation slides