Sun Tracking Solar Panel

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1 Introduction

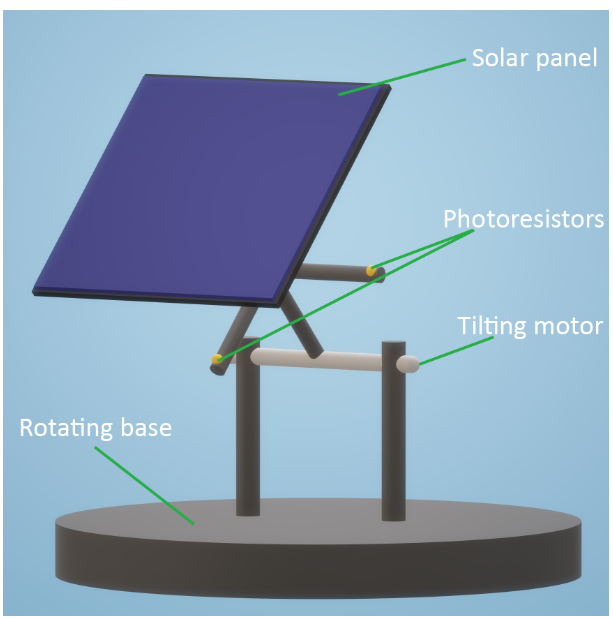
1.1 Problem

Stationary solar panels do not produce the maximum amount of energy possible at all hours of daylight. Setting up stationary solar panels requires an optimum tilt angle to be found as well as an angle to face the average position of the sun in the sky. These angles have to be calculated depending on the latitude and longitude at the panel's location.

1.2 Solution

Our solution to maximize energy production is for a sun tracking solar panel. The panel will move to face all directions to be perpendicular with the sun. It will use photoresistors behind the solar which will try to minimize the light in their view, sending movement data to server motors to move the panel, until completely shaded when the panel is perpendicular with the sun. No calculations have to be made; the user just has position it roughly facing where the sun will rise in the morning for first-time setup. Our panel will also send power data directly to a webapp, so the user can see how much power is being generated and used by the panel during the course of a day.

1.3 Visual Aid

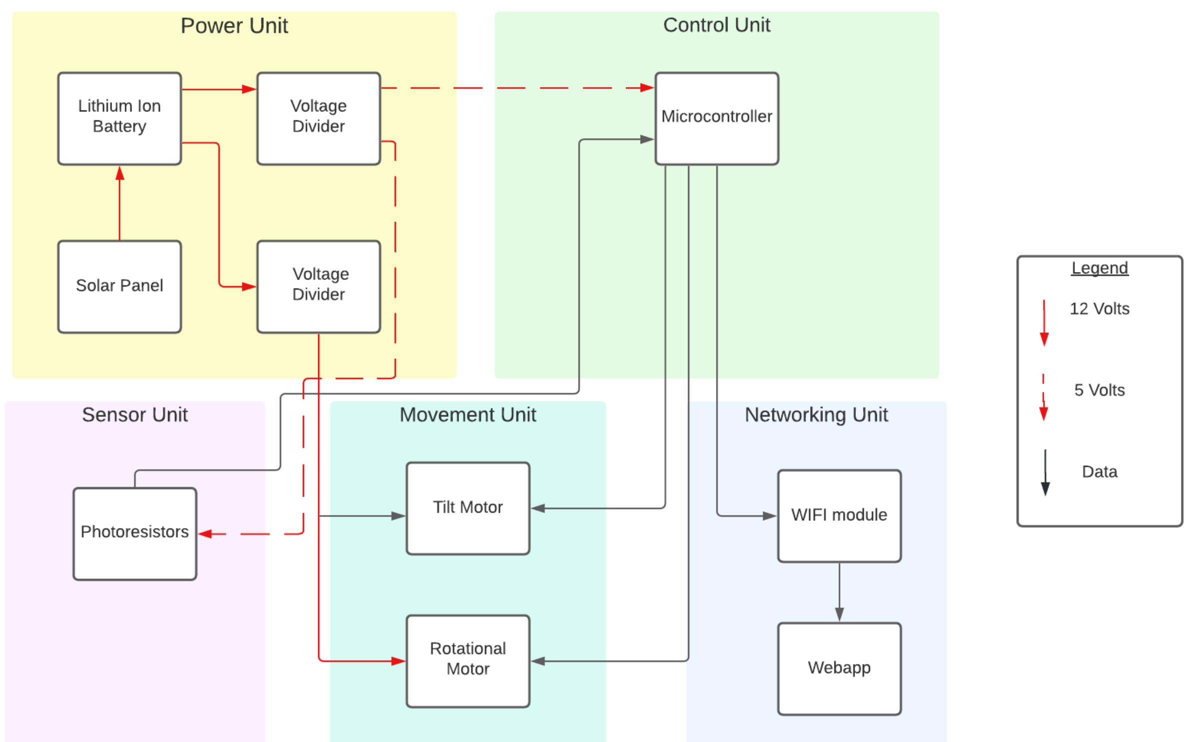


1.4 High level requirements:

- The panel must utilize the photoresistors to be perpendicular to the sun at all hours of the day to maximize energy production. It will perform a 180° tilt at nighttime to reset it for the morning.
- The panel must generate and store power in a battery which it will use to power its functions, while still producing more net power than a stationary solar panel.
- The panel must send a stream of data including the power generation and efficiency to a webapp which will display live graphs and data.

2 Design

2.1 Block Diagram



2.2 Power Unit

2.2.1 Battery

The battery powers the motors, microcontroller, and photoresistors. The solar panel charges the battery while the battery powers the rest of the system.

Requirement: Power Converter converts battery voltage to appropriate voltages for controller, photoresistors, and motors

2.2.2 Power Converter

The power converter will create the required voltages for our circuit to operate, 5V for the microcontroller and 12V for the motors. The power converter will also power the photoresistors.

Requirement: The power converter must convert energy from the battery to power the motors and microcontroller, as well as send power to the photoresistors.

2.3 Control Unit

2.3.1 Microcontroller

Takes data from photoresistors and calculates which motors will need to move and what direction, then outputs this data to the movement unit to move the solar panel to the correct angle. Sends power generated data to the wifi module.

Requirement 1: The microcontroller must be able to accurately calculate the optimal position to move the solar panel to.

Requirement 2: The microcontroller must be able to send the power generated data to the wifi module.

2.4 Sensor Unit

2.4.1 Photoresistors

Changes resistance based on the position of the solar panel and sends this data to the microcontroller

Requirement: The resistance of the photoresistors should be max at optimal position of the solar panel.

2.5 Movement Unit

The movement unit contains the motors required to move the solar panel to the correct position. The movement unit receives the correct position from the microcontroller.

2.5.1 Rotational Motor

This motor will rotate the base of the panel to maintain the optimal position during the day.

Requirement 1: The motor must be able to move within +/-5% of the position calculated by the microcontroller

Requirement 2: The motor must be able to move the panel to all possible positions

2.5.2 Tilt Motor

This motor will tilt the solar panel to ensure the panel maintains the optimal angle towards the sun.

Requirement: The motor must be able to move within +/-5% of the position calculated by the microcontroller

2.6 Networking Unit

2.6.1 Wifi Module

SOC which will connect to wifi to communicate power generated data from the microcontroller.

Requirements: The Wifi module must communicate power data to the webapp.

2.6.2 Webapp

Communicates with the system via the Wifi module. Show live graphs and data of the power consumed and generated by the panel system.

Requirements: The webapp must show accurate live data from the panel.

2.7 Tolerance Analysis

The greatest challenge to the successful completion of this project is the energy cost to power the controller and motors. The energy cost may exceed the power produced by the solar panels, resulting in an energy drain. To prevent this we have to choose a large enough panel and a battery with enough capacity to consistently power the electronics in the system. Also, the pole, the panel and photoresistor array will need to not be too long to overload the motor. We will either need to find a motor with sufficient torque and holding power or greatly minimize the distance between the photoresistors and the panel.

3 Ethics and Safety

Lithium Ion Battery to used to store the power can be dangerous

Solar Panels are expensive

Section 1.1 of the IEEE Code of Ethics states: “to hold paramount the safety, health, and welfare of the public, to strive to comply with ethical design and sustainable development practices, to protect the privacy of others, and to disclose promptly factors that might endanger the public or the environment” [1]. This relates to our project because we will be working with lithium ion batteries and electrical power. We will uphold Section 1.1 of the Code of Ethics and make sure to follow safety procedures with our battery. Also, we will keep in mind the sometimes questionable ethics of solar panels. Polysilicon, a key component of solar panels, has a lot of poor environmental and labor practices where it is mined [2]. Also, the recycling of solar panels makes them not as ideal for environmental sustainability as most think [3].

References

[1] “IEEE Code of Ethics.” IEEE, https://www.ieee.org/about/corporate/governance/p7-8.html.

[2] Gudmundsen, Jacob, et al. “There Are Ethical Concerns Surrounding Solar Energy.” Mackinac Center, https://www.mackinac.org/the-ethical-concerns-surrounding-solar-energy.

[3] Taylor, Vanessa. “The Complicated Ethics of Solar Power.” Mic, Mic, 26 Oct. 2021, https://www.mic.com/impact/solar-power-ethics-sustainability/amp.