

Solar Shade

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Project Overview

The Solar Shade is a personal solar battery charger and single-axis tracker meant to control a patio umbrella.

- A Buck Converter uses Maximum Power Point Tracking (MPPT) to maintain a 12V output voltage at the Solar Panel.
- A Stepper Motor turns the Solar Panel towards the direction of most sunlight as determined by two Light Dependent Resistors.
- MPPT and Solar Tracking algorithms are implemented on an Arduino Nano.

The goal of this project is to keep the user shaded throughout the day while increasing the efficiency of the solar charger.

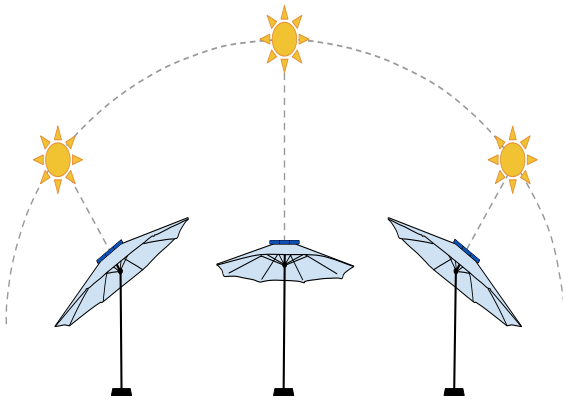


Figure 1: Solar Shade project concept art showcasing how solar tracking would control the position of an umbrella.

Results

Power Harvesting:

- Integrated voltage and current sensors with Arduino to correctly read Solar Panel voltages and currents.
- MPPT algorithm functions appropriately in simulation.
- Successful implementation of a high frequency buck converter with minimal ripples at the output.

Solar Tracking:

- Correctly determined the direction of most sunlight and turned motor clockwise or counterclockwise as appropriate.
- Implemented limits on angular position.
- Implemented a "Nighttime Protocol" allowing for the motor to return to a neutral position after sunset.

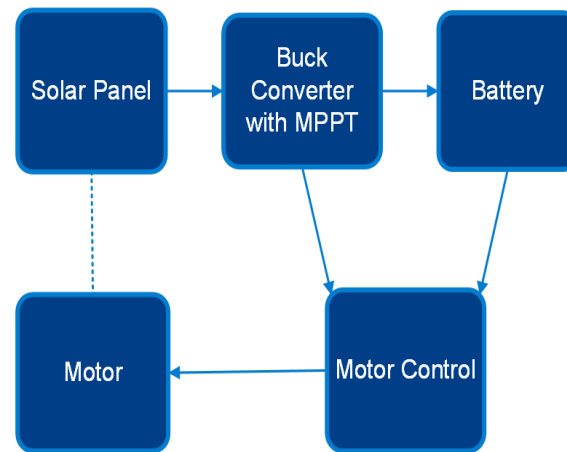


Figure 2: Project Block Diagram; solid arrows indicate circuit connections and the flow of power. The Motor Control can get power from the battery or directly from the output of the Buck Converter.

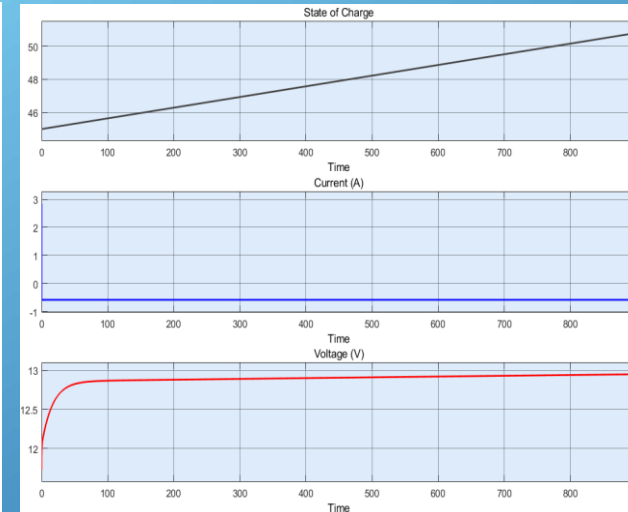


Figure 3: Results of Buck Converter simulation in MATLAB showing the SOC of battery and the voltage and current at the battery over 15 minutes. Irradiance was set to 1000 W/m^2 .

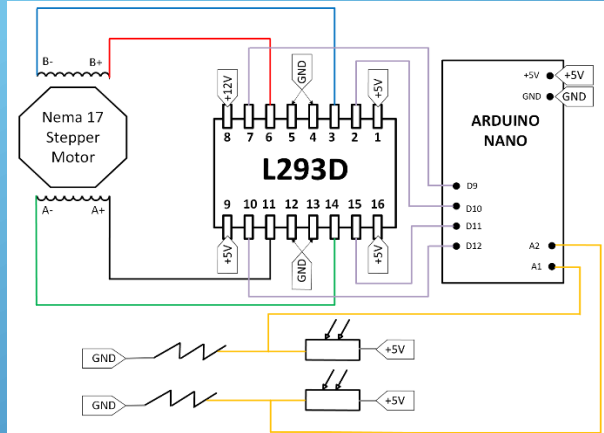


Figure 4: Solar tracking circuit diagram

Future Work

- Implement state-of-charge charge control.
- Implement Buck Converter in hardware with optimal control that is robust to disturbances.
- Adding a position sensor to the motor control circuit.
- Adding more LDRs to the motor control circuit.
- Scale project to bigger power ratings.

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