AUTONOMOUS SOLAR TRACKING UMBRELLA

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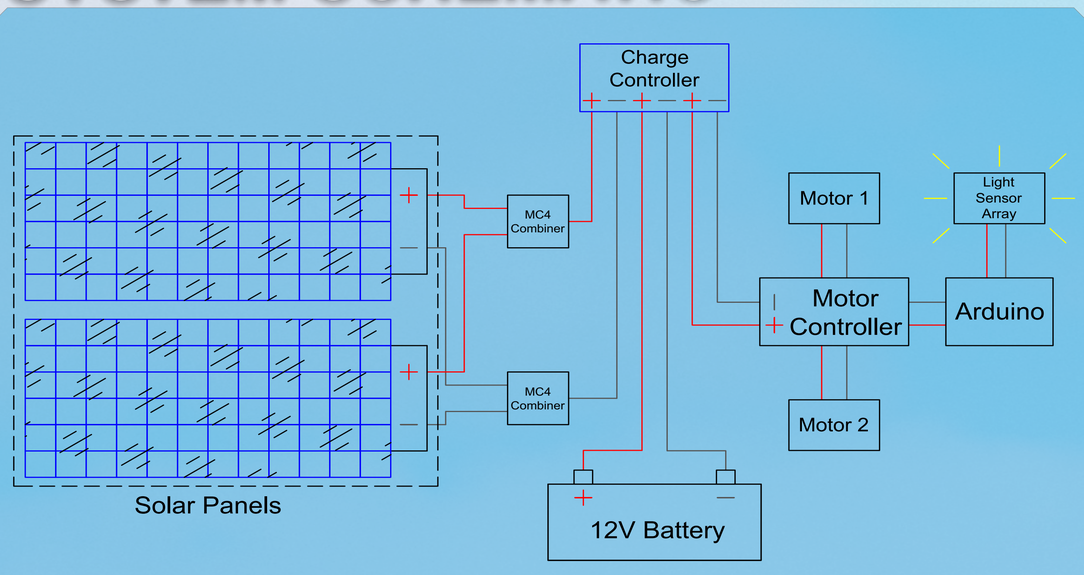
DESIGN OVERVIEW

The Autonomous Solar Tracking Umbrella is a unique redesign of the simple patio umbrella that utilizes solar tracking technology and photovoltaic panels in an effort to reduce ultraviolet radiation exposure. Using the energy harnessed by the PV panels, the umbrella can tilt in the direction of the sun's position to maximize the area of shade and energy generation. In a world that has an increasing need for energy, the Autonomous Solar Tracking Umbrella will find a home in the hands of any environmentally conscious consumer.

OBJECTIVES

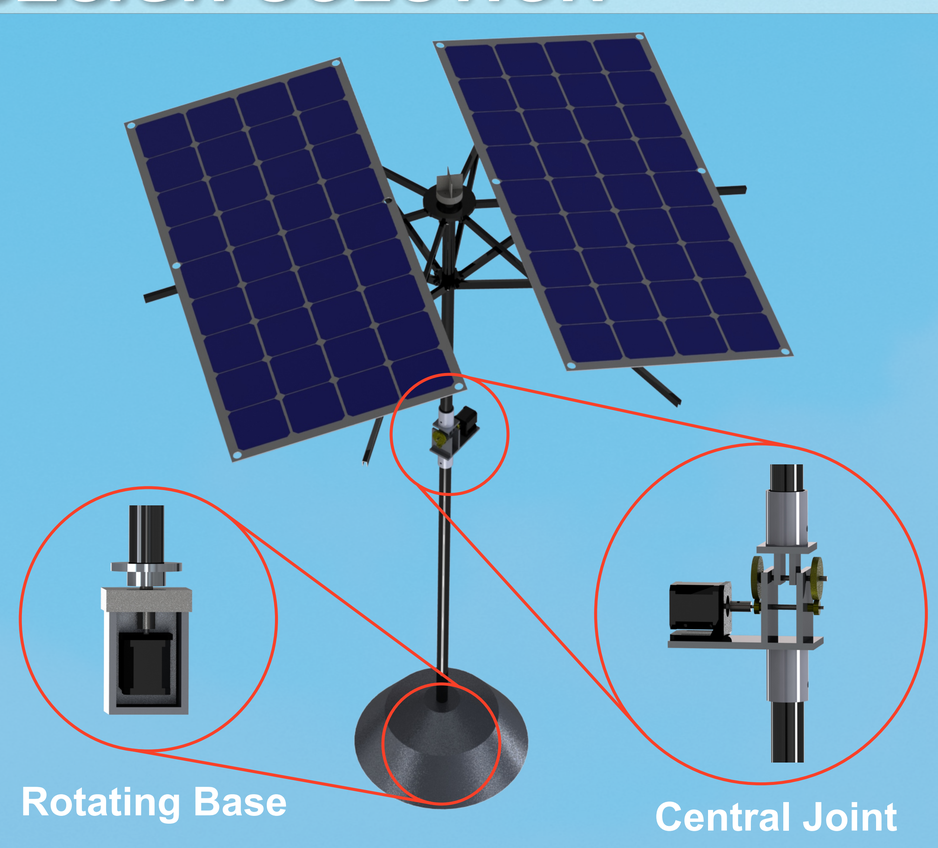
- Provides user consistent shade throughout daylight hours to maximize comfort and convenience while minimizing sun exposure
- Design a fully self-sustaining device that utilizes only green energy as an initiative to incorporate renewable energy conversion systems into simple devices
- The device aims to be a single self-contained unit with detachable joints for ease of maintenance and solar panels mounted atop the canopy

SYSTEM SCHEMATIC



The design schematic highlights the two solar panels wired in parallel, connected to the charge controller which is subsequently routed to the control system array and back to the 12V battery.

DESIGN SOLUTION



Design Specifications

- Design features two motors working in unison to provide optimal solar tracking and maximum shade
- Central joint mechanism features a drive train with a gear ratio of 3 to slow down the turning speed allowing for even more precise movement
- Design offers a large range of motion in two axes:
  - Central joint: ±15° from centre position
  - Rotating base: 360° range of motion
- Solar tracking achieved through a light detection array that relays data to the micro controller so that it can accurately adjust the motor positions

TESTING & RESULTS

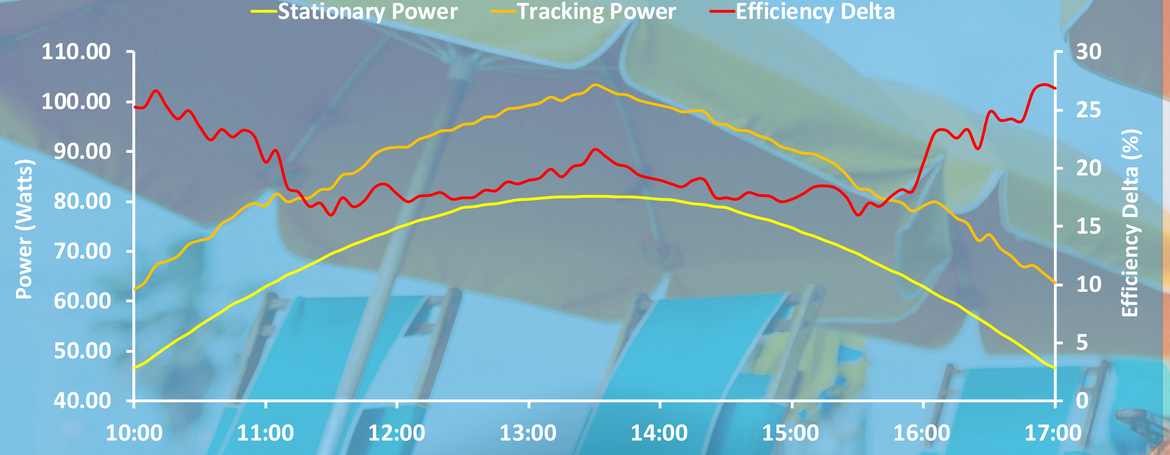
Testing Parameters

- Tested on roof of Thornbrough building in clear weather conditions with temperature limits of: T_{High} = 4°C, T_{Low} = -4°C
- Two tests were performed in stationary and tracking modes
- Solar Noon occurred at 13:32

Results

- Maximum power generated during testing in tracking mode was 103W
- Minimum power generated during testing tracking mode was 62.3W
- Efficiency increased 20-30% based on time of day when comparing Stationary vs Tracking trials
- Maximum efficiency delta peaked at approximately 27% at dusk/dawn

Power Generated & Efficiency Delta for Ideal Conditions



CONCLUSION

The prototype has shown that the possibility for an autonomous self-sustaining umbrella that uses green energy is achievable. It was possible to incorporate most of the aspects that were theorized in the design phase into the prototype design. However, the tilt of the device offers less range than what had been designed for due to motor failure. Overall, the Autonomous Solar Tracking Umbrella is a proven concept that fulfills its purpose to both provide shade and energy generation.

Future Work

- Integrate a mechanism that opens/closes the umbrella canopy when adequate/inadequate levels of sunlight are detected and an emergency close feature when wind speeds are too high
- Find better uses for the excess power generated from the device such as a small device charging hub, solid state cooling, or a relay outlet to connect to a power grid

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Environmental

Mechanical