Name(s)

Brian Li; Emma Li

Project Number

J0210

Project Title

Designing and Implementing a Novel Solar Panel Tracker System Leveraging Reinforcement Learning Technique

Abstract

Objectives

As of today, the average efficiency of household solar panels is around 20%, which means only around 20% of solar energy is converted into household electricity. Our objective is to explore various techniques that not only enhance this efficiency but also are scalable for thousands of households.

Methods

Designed and constructed an intelligent solar panel tracker that adjusts the solar panel s orientations to maximize the sun ray receptance throughout a day, intelligence offered by a reinforcement learning technique that explores an optimal orientation, taking into account of the variations in the environmental factors. Placed two identical solar panels side-by-side, one mounted on our solar panel tracker; the other has a fixed position. Collected voltage measurements from both solar panels at identical time intervals between 8 AM to 5 PM each day. Repeated the same benchmark testing for several days.

Tracker system mainly consists of servo motors, Arduino board, rotational platform, and solar panel.

Results

Five trials were conducted. Daily Voltage Output Percentage Gains: 1st trial-11% ; 2nd trial-16% ; 3rd trial-22% ; 4th trial-16% ; 5th trial-21%. Average percentage gain is 17%. The positive voltage output gains show that this approach is effective.

Conclusions

This is the first ever solar tracking system that leverages a reinforcement learning technique. Our experiment data consistently shows positive voltage output percentage gains from the smart solar tracker throughout our trials. With on average nearly 20% of efficiency gain, it clearly shows that our novel approach is effective. Based on the data charts, the efficiency percentage gains in the morning and evening are greater than the daily peak temperature time window, usually centered around noontime. Also, on a warmer day, the daily efficiency percentage gain tends to be lower. This is because the fixed solar panel is positioned facing up vertically, thus likely to output close to optimal voltages during peak temperature hours. In addition, a warmer day also tends to have longer peak temperature time window. As the temperature or light intensity goes higher, both smart and baseline solar panel voltage outputs are higher, so should expect the percentage gain from tracker be lower.

Summary Statement

Our project is an intelligent solar panel tracker controlled by a centralized software based on reinforcement learning techniques for household use.

Help Received

Vina Sethi is our science teacher. My parents, Hui Li and Min Chen, helped us buy parts and taught us how to do things like C programming and building the device.