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MODULAR, ARRAY-MOUNTED PHOTOVOLTAIC INSPECTION ROBOT

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INTRODUCTION

Due to the exponential deployment of new PV systems in recent years, there is a pressing need for efficient array inspection methods. While drone-based methods can detect hotspots and large outages in an array, diagnostic and prognostic measurements of PV modules require stable, proximal inspection.

To enable these measurements, students were tasked with the design and creation of a robotic platform which would autonomously traverse PV arrays of various sizes/configurations, and be able to deploy various characterization tools including imaging and spectroscopic techniques.

OBJECTIVES & ADVANTAGES

Objectives

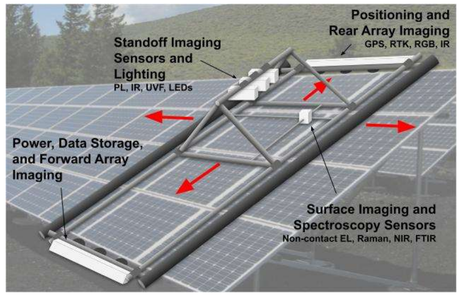
1. Automate the inspection process of the PV Arrays
2. Eventually integrate advanced imaging and sensor technologies such as:
   - Photoluminescence (PL) Imaging
   - Infrared (IR) Imaging
   - Ultraviolet Fluorescence (UVF) Imaging
   - Non-contact Electroluminescent (EL) Imaging
   - Raman Spectroscopy
   - Fourier Transform Infrared Spectroscopy (FTIR)

Advantages

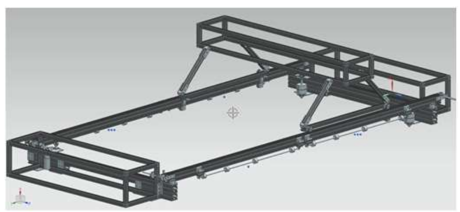
- Fully autonomous
- Can withstand long hours of operation
- No technical knowledge or license required to operate technology
- No legal permits required to operate
- Multiple characterization methods can be applied
- Easier and faster method for detection of power losses
- Greater detection range of types of faults in a PV array
- Helps monitoring PV installations over time
- Speeds up the collection of data for thermal reports and further analysis
- Scanning PV modules more frequently

MECHANICAL APPROACH

Initial Concept

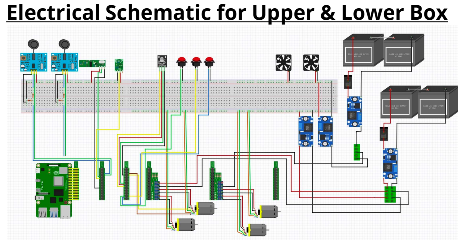


Final Design

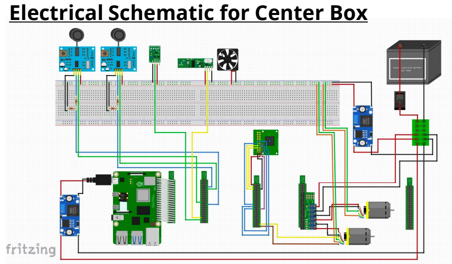


ELECTRICAL APPROACH

Electrical Schematic for Upper & Lower Box



Electrical Schematic for Center Box

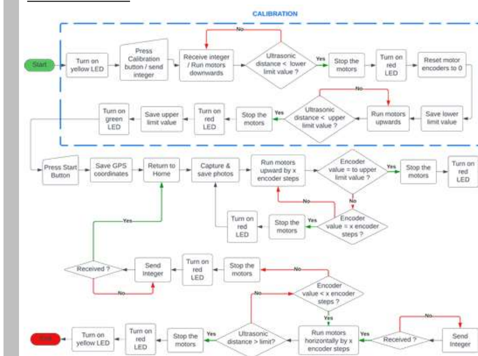


The components used were the following:

- Raspberry Pi 4
- Lithium-Ion Batteries
- Voltage regulators
- Power distribution blocks
- Motor drivers
- Port expansion boards
- Ultrasonic sensors
- DC motors with encoders
- Toggle switches & push buttons
- LED lights
- Infrared camera & HD camera

SOFTWARE APPROACH

Flowchart



- Raspberry Pi script was written in Python
- Multiple libraries and open-source python scripts were explored for the configuration of each of the electrical component

RESULTS & FUTURE WORK

Results

As a work in progress what was accomplished in this first stage was the construction of the robot and its first series of functionality test that involved the electromechanical area with the software development.

First Prototype of the Robot

Future Work

- Apply computer vision for recognition of solar module degradation
- Add mechanical modification to allow cleaning solar modules or melting snow prior to scanning
- Add imaging technologies to collect even more data
- Establish real-time data transfer to remote storage

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