# InsulatorVision Pro

## Team: Boulder Dynamics | Sponsor: LineVision, Inc.

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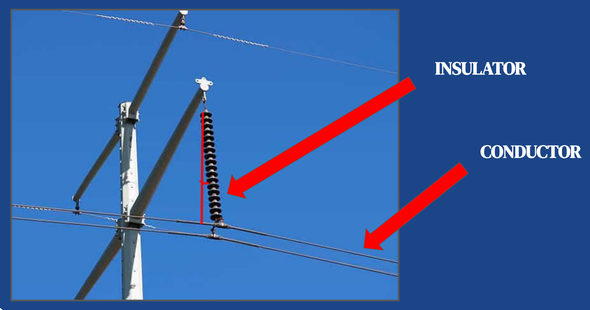
## The Problem

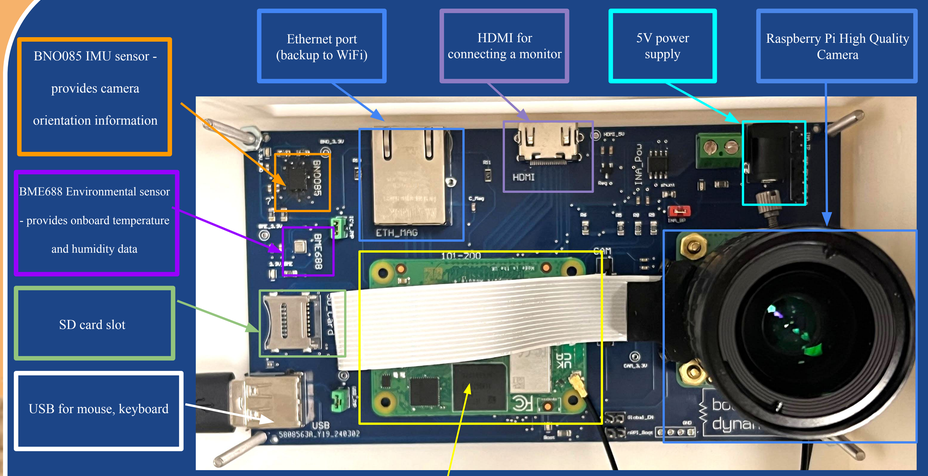
As the demand on power grids increases, the cost and time required for replacing or building new transmission line towers pose significant challenges. LineVision's Dynamic Line Rating algorithm optimizes power line efficiency by monitoring line temperatures influenced by various factors, including wind.




## The Solution

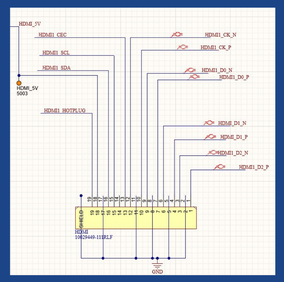
Utilizing computer vision, our product is meant to provide a cost-effective alternative to LineVision's current LiDAR system to monitor transmission line insulators in real-time. This process can be described with the following steps:

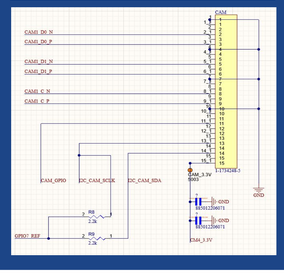
- Gather Image Data (Take Photos)
- Perform Computer Vision Algorithm to Isolate Insulator
- Determine Relative Angle Changes of Target Insulator Using Trigonometry
- Export Angle Data to LineVision to Dynamically Allocate Power

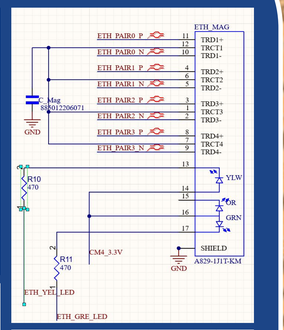




## Hardware Design

- Ethernet
  - Four differential pairs, each 100Ω
  - Gigabit data rate
  - On board phy corrects frequency for SI
  - Intra-pair skew within 4 ps
  - Intra-pair skew within 30 ps
- HDMI
  - Four differential pairs, each 100Ω
  - 4k60p, max data rate 4.95 Gb/s
  - Intra-pair skew within 1 ps
  - Intra-pair skew within 2 ps
- Camera
  - Three differential pairs, each 100Ω
  - Data Rate = Resolution (pixels) × Frame Rate × Bits per Pixel
  - Data Rate ≈ 887.04 Mbps (megabits per second)
  - Intra-pair skew within 4 ps
  - Intra-pair skew within 20 ps



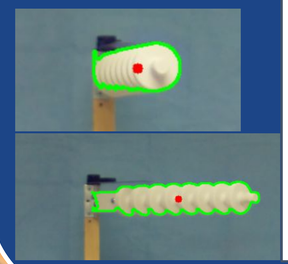


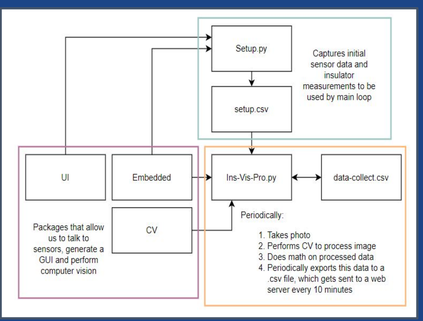




## Software Design

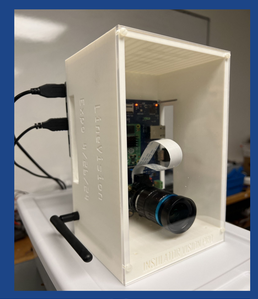
- Using OpenCV for Computer Vision and CustomTkinter for UI Design
  - CV Algorithm utilizes RGB-thresholding and edge-detection
- Multithreaded application to run CV algorithm, math module, and export routine concurrently

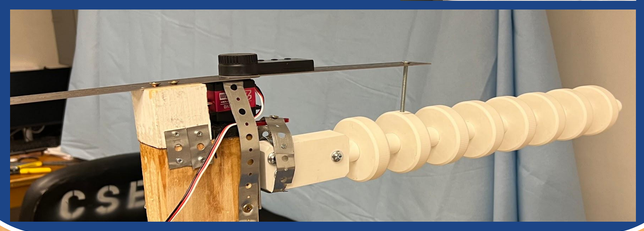


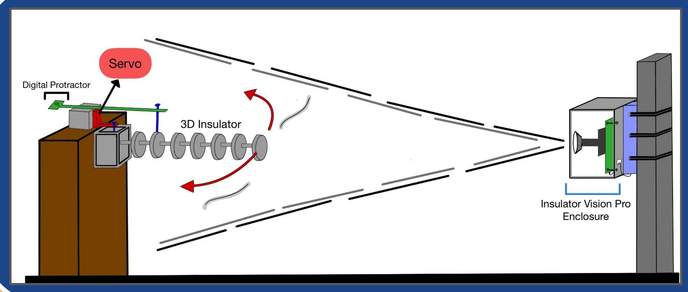



## Mechanical Design

- 3D-printed enclosure - custom-made holes for antenna and cable management.
- Acrylic panel for camera to look out of.
- Insulator arm is also 3D-printed. The arm is set to specific angles using a servo motor, which are verified using a digital protractor.








## Key Features:

### Status Monitoring:
- Temperature & Humidity Sensors
- Camera Orientation

### Computer Vision:
- RGB-thresholding
- Edge-detection
- LiDAR alternative

### Visualization:
- Thingspeak
- CV Algorithm Output

## Acknowledgments:

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