

FPL Image Recognition for Pad Mounted Equipment

VDR5
Team 304

The Team



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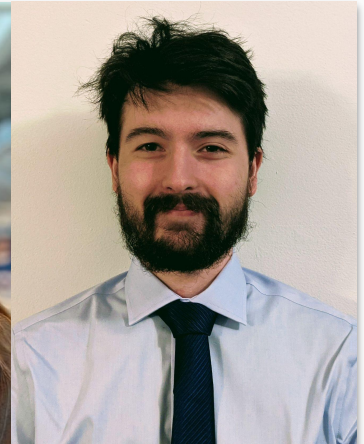
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The Problem



Presenter: Sam Hammermaster

Objective

- Design a method for identifying pad-mounted transformers that have detected a faulty current using computer vision.
- Hardware and software solution



Targets

Beacon (hardware)

Quick Installation



No Interference



Weather Resistant



Integrated with FCI

Inexpensive



Computer vision (software)

Video & Images



50 ft Detections



Varying Visibility/
Obstacles



80% Accuracy

Solution - Hardware

- Beacon that moves up and down to indicate fault
 - LED as a backup when fault occurs
- Firmly attached to the top of transformer and tamper proof design
- Minimal power usage
- Other options
 - Lever on side, thermal strip, radio signal

Final Rating	
1	0.2467
2	0.1017
5	0.4127
6	0.0949

Mount an external LED on the top of a stainless steel lever attached using rivets and powered by the transformer and infrared video input with YOLOv5 algorithm

Solution - Software

- Image recognition model that can identify transformer, beacon, and state of beacon
- Model runs on drone footage from FPL Air

YOLO



Image collection

- ~1,300 images taken so far
- One type of transformer (box model)
- Different lighting, obstructions, angles, and distances
- Taken with phones but converted to standard size



Labeling... and more labeling

- ~1,300 images labeled for transformer, beacon up, and beacon down
- Every picture manually labeled by drawing a box around each respective object
- Open-source labeling software
- Each image has a corresponding text document with labeling information



Training The Model

- **YOLOv5**
 - Free and open source machine learning algorithm
- **Google Colab**
 - Free compute with high end GPUs
- **Roboflow**
 - Free data organization tool

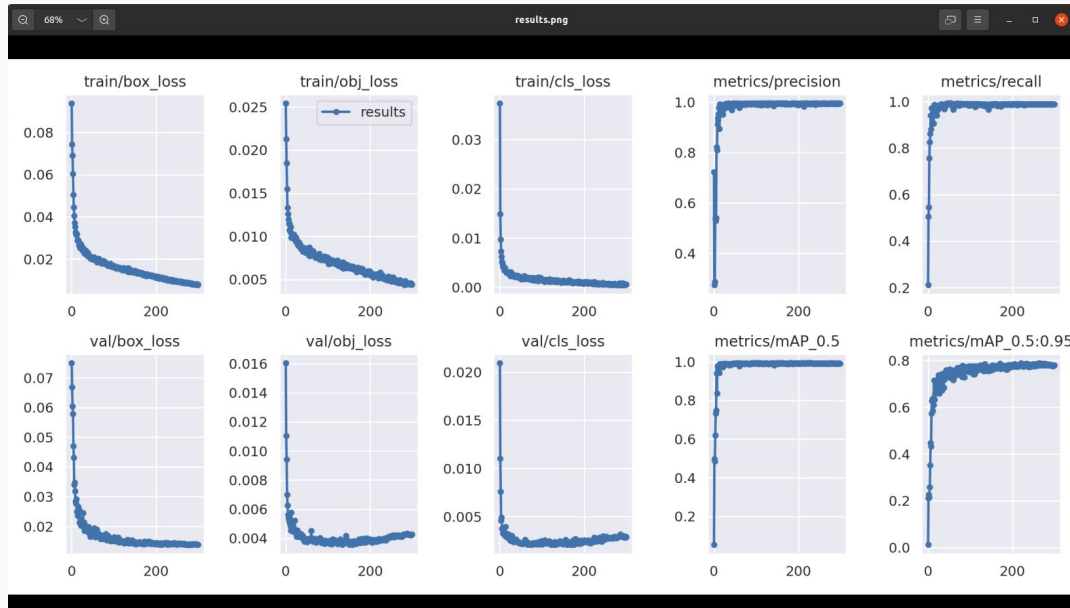
YOLOv5



Preliminary Model Results



Preliminary Model Results



Presenter: Gage Irwin



Synthetic Images

- 30+ photorealistic scans of different transformers
- 1000+ unique 360 images for backgrounds from Google maps








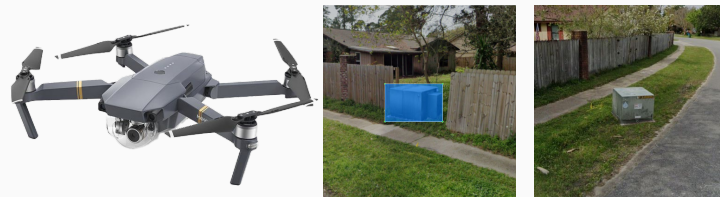
Synthetic Image Examples



Future Training

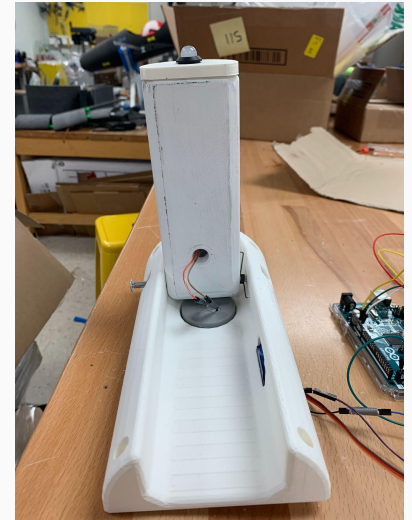
- Model Size Selection
- Increase Number of Images
- Increase Image Variety
- Maintain Label Accuracy
- Incorporate Background images
- Test other Training Settings

				
Nano YOLOv5n	Small YOLOv5s	Medium YOLOv5m	Large YOLOv5l	XLarge YOLOv5x
4 MB _{FP16} 6.3 ms _{V100} 28.4 mAP _{COCO}	14 MB _{FP16} 6.4 ms _{V100} 37.2 mAP _{COCO}	41 MB _{FP16} 8.2 ms _{V100} 45.2 mAP _{COCO}	89 MB _{FP16} 10.1 ms _{V100} 48.8 mAP _{COCO}	166 MB _{FP16} 12.1 ms _{V100} 50.7 mAP _{COCO}



Design Choices

- Overall shape of device intended for safety and weatherproofing
- RGB LED was chosen for future proofing
- Wires are fed through waterproof grommet



Final Design

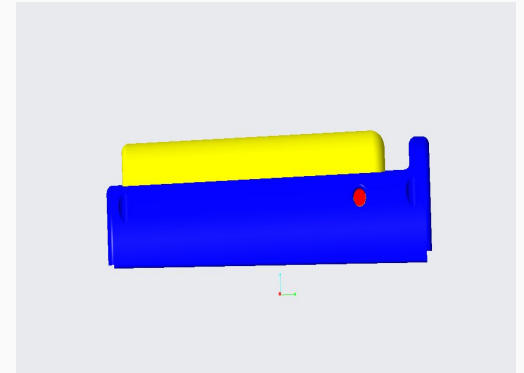
After cost analysis it was decided that instead of making the device out of metal we decided to switch to injection molding.

The ability to quickly mould the plastic in all the intricate curves would keep us in the target price range of \$100 per device.

The material will be some variation of polypropylene because of its high yield strength.

Final Design

- The lever arm will be in a down position in its standard state
- The LED on the end of the lever arm will also be unpowered in this position
- Once the device has received the signal the device will move to the upward position



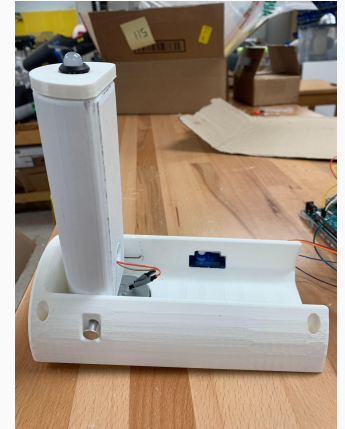
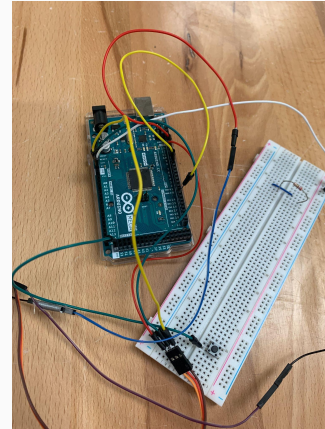
Device in its standard state

Final Design

When the arduino in the picture receives power from the battery the release mechanism activates.

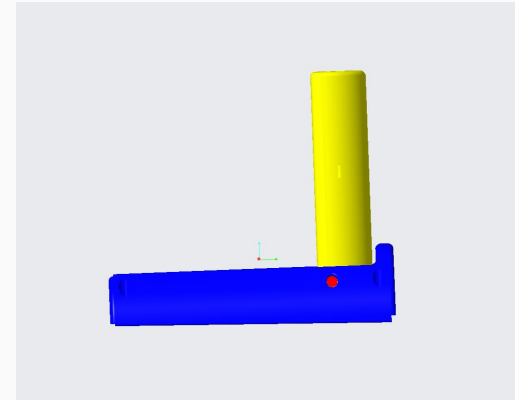
The arduino sends a signal to the micro servo to rotate the key 90 degrees which will let the spring bring the lever up.

The button on the breadboard will both turn off the light and rotate the key back into place.



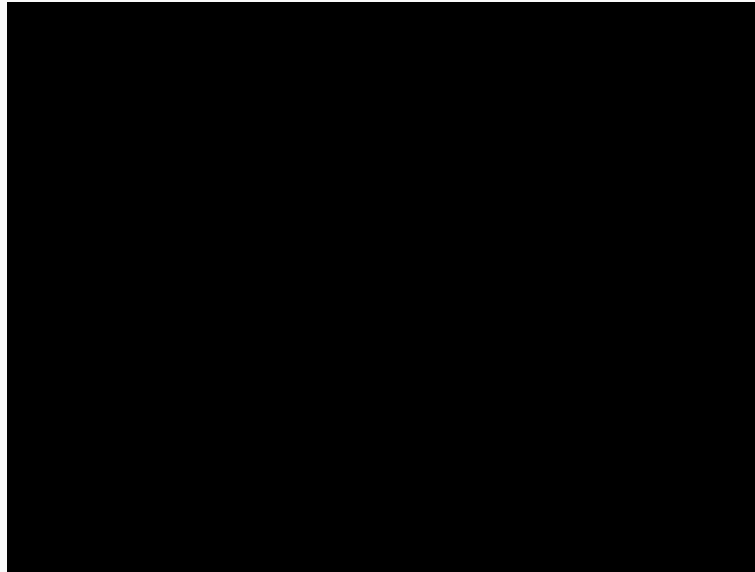
Final Design

- Once in the activated state the LED attached at the end of the will light up
- The lever will be turned up to a 90 degree angle from the transformer.



Device after it has received fault signal

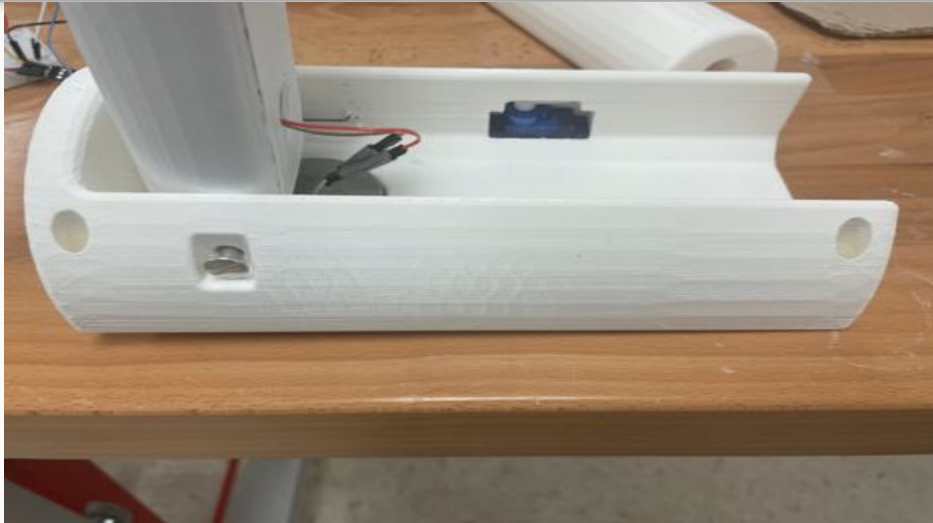
Video Demonstration



Presenter: Kent Logue



Improvements

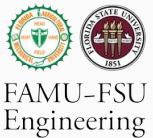


Current



Previous

Presenter: Jordan Wilkerson



Improvements cont.



Current

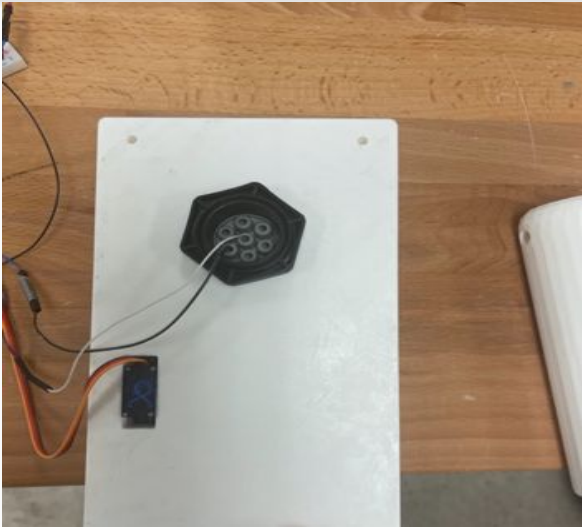


Previous

Presenter: Jordan Wilkerson



Improvements cont.



Current



Previous

Improvements cont.



Current

Previous

Presenter: Jordan Wilkerson



Lessons Learned

- Bill of materials
- Don't guess
- Work smarter not harder
- Do it the right way the first time

Questions?