Florida Light and Power

Image Recognition for Pad Mounted Equipment

Updated Codes and Standards

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**Introduction**

Pad mounted transformers are common devices in residential areas, as they convert higher main-line voltages to lower voltages needed for households. Currently, when one transformer experiences a fault, all transformers connected to it must be manually inspected in order to locate where the fault has occurred. This is a laborious and time-consuming process. To address this problem, this project’s goal is to develop a hardware beacon that indicates faulted FPL pad mounted equipment. Then, to collect a sample image library and train a corresponding image recognition system to detect and locate the beacons from autonomous drone or ground vehicle footage. Related requirements are to accurately indicate faulted equipment from a distance of up to 50 feet and in various environmental conditions. Also, to securely mount a beacon to the pad-mounted equipment. Finally, to develop a real-time image recognition system to locate transformers and beacons with 80% accuracy.

**Codes and Standards**

*Wires*:

Green, green with a yellow stripe, and bare copper wires can only be used for grounding purposes. Green wire or green with a yellow stripe reduces electrical overload by redirecting excessive electricity. A ground wire can never be used as a neutral. White and gray wires are normally used as neutral conductors. White and gray wires may be repurposed as current-carrying conductors if they’re marked at both ends with tape or paint. White wires with black or red tape are hot wires and carry electricity. Shut off the circuit breaker before working with this wire. A modified white wire is not neutral. Black wires indicate a hot wire and are used to provide power in the circuit. Assume black wires are live. The circuit breaker needs to be shut off before working with this wire. Red or orange wires are secondary hot wires often used to provide secondary phase voltage in a 220- volt application, assume they are live. Shut off the circuit breaker before working with this wire. Blue, yellow, violet, and brown wires often act as the travelers to transfer power between the switches in 3-way and 4-way switch applications. Shut off power to the circuit and assume that all wires are live even if their color denotes otherwise. Always use an electrical tester to confirm that power is really off at each wire before disconnecting any wires.

*PLA/Filament*:

Poly Lactic Acid is a thermoplastic resin derived from agricultural resources such as tapioca starch. It possesses properties similar to petro based plastics. Various grades are available depending on the process i.e. thermoforming, injection molding, blown film, injection stretch blow molding, and continuous yarn and fiber. PLA contains no heavy metals or substances, complying to food migration standards. Storage at normal room temperature is suitable. It should be stored in dry conditions. Avoid high humidity, rain, and/or damp areas. Do not store at temperatures over 45 C or sub- zero. PLA can be handled safely, it is non-toxic. It is environment friendly, having a biodegradable nature and is biobased. Bacteria in soil will compost and consume the polymer of lactic acid as a nutrient and the remains are carbon dioxide, water and soil nutrients.

*Rivets*:  
Rivet standard reading example: 72AS-0402

72 - first numbers denote head style, 72 specifically represents countersunk head style.

AS - letters denote the composition and any modifications, pertaining to the material of the head and mandrel. AS represents aluminum head and steel mandrel.

04 - first 2 digits represent the diameter of the rivet head in 1/32”. 04 = 4/32” or ⅛”.

02 - second 2 digits represent the maximum grip length in 1/16”. 02 = 2/16” or ⅛”

*Corrosion*:

Stainless steel and thick hot-dip galvanized (G185 or higher) metal connectors and fasteners improve corrosion protection. Choosing metal connectors and fasteners made of the same metal and either hot-dip galvanized or stainless steel will improve performance. Metals can be protected from galvanic corrosion by applying a sacrificial metal to a metal surface. Fasteners and connectors made of similar metals prevent galvanic corrosion. Stainless steel is resistant to corrosion in salt air, and it usually lasts longer than most other materials, even in the most corrosive oceanfront situations. To eliminate the potential for galvanic corrosion, stainless steel connectors must be attached with stainless steel nails when separate fasteners are needed; otherwise, corrosion will be accelerated on the less corrosion-resistant metal and can dramatically reduce its lifespan. In coastal applications, stainless steel should be Type 304 or Type 316. Type 316 is more resistant to corrosion and should be used for stainless steel metal connectors. Some fasteners are fabricated from Type 410 stainless steel, which has more corrosion resistance than galvanized bare steel but less than Type 316 stainless steel.

The three industrial coating options for increasing corrosion resistance are:

* Epoxy-polyamide primer (SSPC-Paint 22)
* Coal tar epoxy-polyamide black or dark red paint (SSPC-Paint 16)
* Post-plate manufacture hot-dip galvanizing (zinc-based) per ASTM A153/A153M (ASTM, 2016)

*LED light installation*:

Electric-discharge and LED luminaires supported independently of the outlet box must be connected to the branch circuit with a raceway or with types MC, AC, or NM cable [410.24(A)]. When an electric-discharge luminaire or LED luminaire is surface-mounted over a concealed outlet box and not supported by the outlet box, the luminaire must be provided with suitable openings that permit access to the branch circuit wiring within the outlet box[410.24(B)]. A luminaire can be cord-connected if:

1. The luminaire is mounted directly below the outlet box, and
2. The flexible cord:
   1. Is visible for its entire length
   2. Isn’t subject to strain or physical damage[400.10]
   3. Terminates in an attachment plug, canopy with strain relief, or manufactured wiring system connector complying with 604.6(C).

These codes comply with the Articles 410 and 411 of the 2011 National Electrical Code.

*Children Safety*:

We will also implement standards used for playground safety regulations. The platform surface which the lever will be connected to, will be rounded. This will serve as a barrier for child safety, preventing attempts to deliberately pass through the device. Plastic can act as a unitary surface material, an energy- absorbing material to prevent injury to children who make aggressive contact with the device.

*Drone Standards:*

Drones are highly regulated devices because of the functionality they can potentially provide. In order to use the drone for educational purposes, we had to register the drone with the FAA under an “educational permit”. Flying a drone that is not registered can result in fines and loss of the drone. Whoever is flying the drone also needs to be a registered drone pilot with the FAA. Not being registered can also result in fines. Below are the general guidelines for flying a drone under a recreational license that is under 50 pounds:

* Always keep the drone in your visual line of sight
* Give way to manned aircraft
* Keep the drone below 400 feet
* Do not fly within 5 miles of an airport or controlled airspace
* Do not fly under the influence

*Image Recognition Standards:*

There are many ways to successfully create an image recognition model. However, there are some common practices that will aid in creating and managing the dataset. A general rule of thumb is to have as many pictures as possible in order to train and test the dataset. However, very similar pictures or repeated pictures are discouraged due to overfitting. Overfitting is when the model starts to determine that the object trying to be detected can only exist in certain similar backgrounds, so when new backgrounds are introduced, the model will not recognize the object. One standard that the team is following is the breakdown of images in our library between training, validating, and testing which will be a 70%, 20%, 10% split, respectively. Training a model can take time and computing power. In order to take less time training the model, images are typically shrunk down to a standard size of 416 x 416 pixels.

**Public Safety and Other Factors**

Our project will consist of PLA, rivets/fasteners, and a LED. Each of these parts have their own safety factors that we need to account for.

Since our project will be put on padmount transformers, which are known to be spots that children sit on or play around, we need to make sure to take into account safety of people interacting with our device. To solve this problem we have made the device rounded so there are no sharp edges and made sure that the hinge will not let people get their hands or fingers caught in it.

We will be using an LED in our device so we need to make sure that the LED brightness is not so bright that it causes the nearby wildlife or customers an inconvenience. Also the light should remain on so that there are no flashes that could also raise other concerns.

Since the device needs to be safe in the wet weather conditions of Florida we are making sure that the plastic and the metals that we use have a coating that will prevent rust. Another measure that will be used to make sure that there is no standing water, we will be making the device have a series of angled surfaces so that the water will flow off of the device.

There will be a lock and key mechanism to make sure that the device can not be pulled down and have a chance to pinch someone's fingers or hands on the way back to the reset position. Also since the device will be working off of a spring if it is brought down only partially it will spring back and could potentially hurt someone if it is not locked in place.

The device will be riveted to the device so that it is not possible for someone to remove the device with a normal screwdriver or readily available tools. We will also make the waterproof with respect to the attachment to the transformer this will prevent opportunities for shock and also damage to the transformer.