# NB-IoT Power Line Obstruction Detection

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ELECTRICAL & COMPUTER ENGINEERING

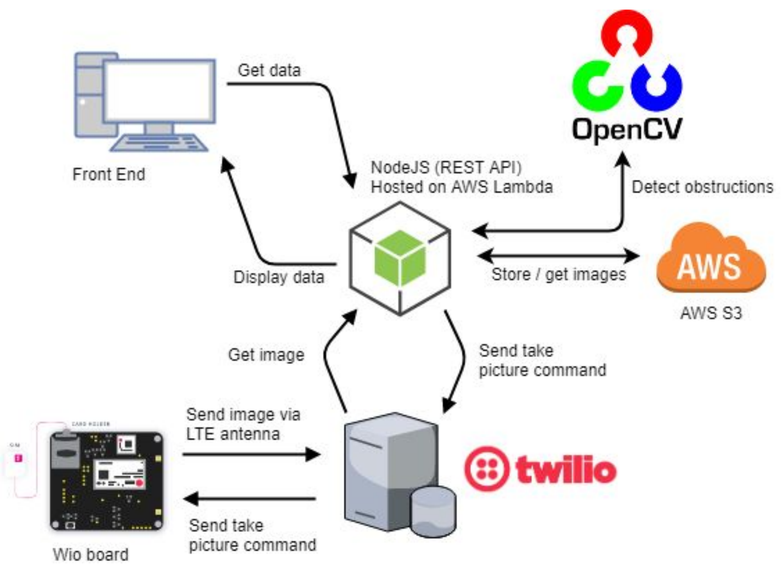
## Introduction

Every year in the Western United States, wildfires kill dozens of people and cause billions of dollars of damage. Sometimes these fires are caused by powerlines shorted by foreign obstructions. These powerlines often run through remote areas that are difficult to monitor manually.

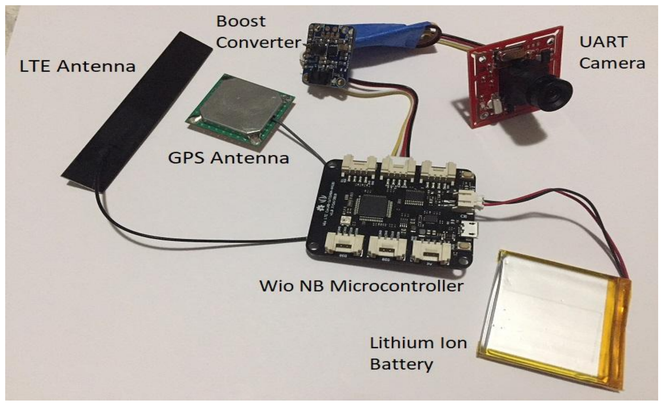
This project's goal is to utilize NB-IoT (Narrowband Internet of Things) technology to cheaply monitor these lines and prevent fires. It offers a low cost device that detects obstructions within range of a power line and remotely communicates that information to end users.

## System Requirements

1. Communications must be done via T-Mobile's NB-IoT network.
2. Data consumption must not exceed 2 MB per month.
3. Overall transmission rate must not exceed 10 packets per hour.
4. Identify obstructions within a 1-foot radius of a power line.




## Embedded Architecture



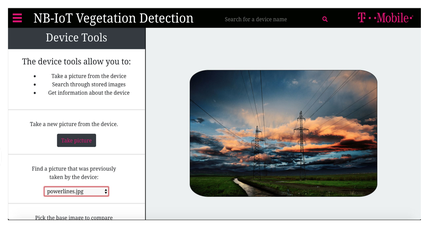

## Software Tools

### Web Development:

- React
- NodeJS (Rest API)
  - Express
  - Serverless
- Twilio Commands API
- AWS (Server/ Storage)
  - Lambda
  - S3
- OpenCV (Image Processing)

### Embedded:

- Arduino / C++
- Twilio Breakout SDK
- Wio NB Arduino Library



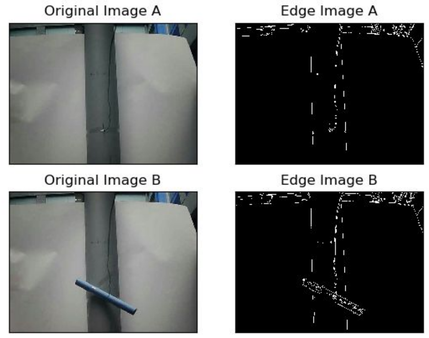

## Communications

The messages from the MCU to the front-end is a multi-stage process that:

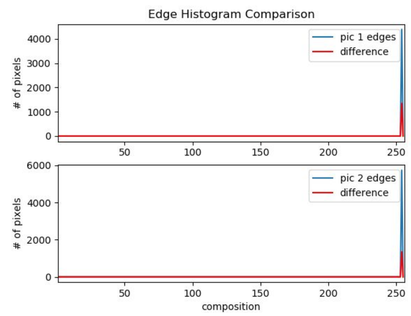
1. Encodes 640x480 JPG images, GPS location data, and device ID into Base64 format and sends them to Twilio's servers as multiple 140 byte "commands."
2. Pulls the commands from Twilio's Command API endpoints using AWS Lambda.
3. Decodes the Base64 commands back into JPG images and stores them on AWS S3 to be accessed later.

## Obstruction Detection

The OpenCV Python library was used to process images and identify obstructions. OpenCV's edge detection algorithm converts the RGB picture into a binary image, with edges in white and all other pixels in black.




From here, we can sum up each picture's edge pixels and return the percent difference of the two pictures. If the percentage exceeds a certain value then we set the obstruction variable to true.




## Conclusion

The device accomplishes its purpose of providing electric companies a cheap way to monitor power lines for any obstructions that could cause electrical wildfires. It does so by providing the following features:

- a user-friendly front end interface
- redundant web-based data storage
- custom embedded camera drivers
- low cost, low-bandwidth communication via NB-IoT network