CALIFORNIA STATE UNIVERSITY
BAKERSFIELD

Project Phoenix

A Novel Protective Device for Early Wildfire Detection on Overhead Power Lines

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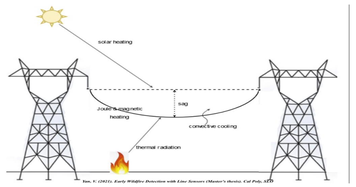
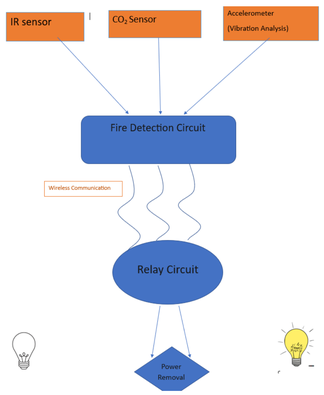
Abstract:

California has experienced devastating wildfires caused by short circuits between high voltage transmission lines and non-insulated structures. To prevent the ignition of further wildfires, we propose a novel protective device that wirelessly transmits digital signals from sensors on a line mounted device(MCU1) to a circuit breaker (MCU2), which controls a digital relay that deenergizes the shorted transmission line. The system uses two Arduino boards, equipped with an MPU6050 accelerometer, an MQ135 air quality sensor, and an IR flame sensor module detector. The accelerometer collects vibration data of the power line, and changes in the vibration spectrum are displayed in real-time. A set point for the change in spectrum is defined to trigger the digital output from MCU1 and wirelessly transmit it to MCU2 to trip the digital relay when the power line sags beyond a certain point indicative ofabnormal thermal radiation.

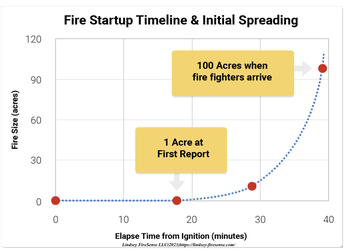
Transmission Line Sag due to Thermal Radiation



Project Block Diagram



Fire Startup Timeline & Initial Spreading



Objective:

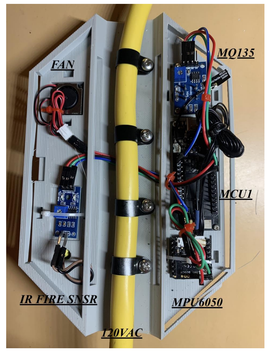
- To design and build a line mounted fire detection device capable of providing remote circuit DE energization.
- To assess the system's performance under perpendicular wind forces.
- Methods: Design of a vibration spectrum analyzer and system test via FFT analysis.

Assembly:

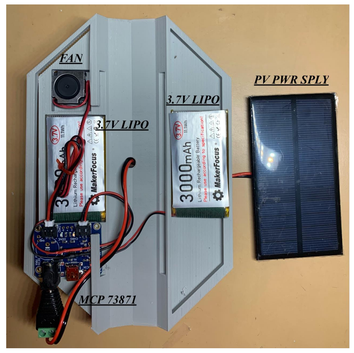
Developed a line vibration, IR, and CO2 monitoring system.
CAD designed 3D printed system enclosure.
Components include:

- Two Arduino UNO Rev2 Wifi microcontrollers
- Cooling: micro fans on either half of the enclosure
- Power Supply: (7V PV supplying 2 series 3.7V LiPoly and MCP73871 charging module)
- MPU6050 accelerometer
- MQ135 air quality sensor
- IR flame sensor module
- Chladni Plate
- Wave Vibration Generator
- 100 MHz BW resolution digital oscilloscope
- 15MHz arbitrary waveform generator

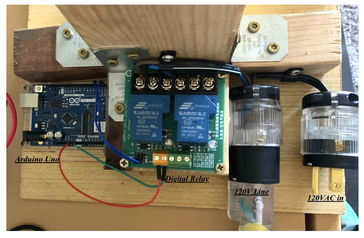
Lower Enclosure



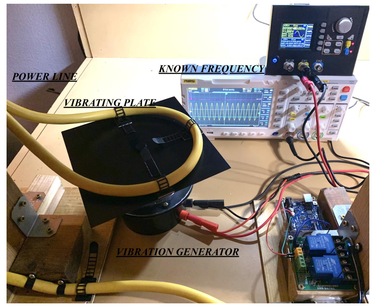
Upper Enclosure



Power Relay Circuit



Test Bed & Wind



To verify the functionality of the proposed protective device, a system test will be conducted using a Chladni table and vibration generator with a function generator to induce known vibrations in the power line. The FFT output will be displayed in real-time to ensure the device can accurately detect abnormal vibration patterns indicative of potential wildfires. Wind correction will be implemented by monitoring the accelerometer data and filtering out the frequency components that correspond to wind effects. The filtered data will be used to adjust the trip point of the device, ensuring that it is triggered only by vibration patterns indicative of abnormal thermal radiation on the power line, resulting in a more accurate and reliable detection system.

Test Signal

Test Signal and FFT