AI Based Thermal Powerline Hotspot Capstone Project

AI-Based Power Line & Tower Hotspot Detection Using Thermal Data

Dataset:

https://docs.google.com/spreadsheets/d/1E9QD-FNidcYT8-Ae5km2aQidDvIspmpp0fUcYIOkvTg/edit?usp=sharing

Capstone Overview

In this capstone, you will design an end-to-end AI pipeline to detect thermal hotspots in power lines and transmission towers using drone-based thermal inspection data. The project focuses on feature-level thermal analysis (not raw image processing), machine learning classification, and spatial risk visualization for predictive maintenance.

Dataset Provided

You are provided with a dataset that represents tile-level thermal features extracted from drone thermal imagery. Each row corresponds to a spatial tile along a power corridor or substation component.

Features include temperature statistics, hotspot density, thermal gradients, ambient conditions, and operational load indicators. Labels indicate whether a tile represents a potential thermal anomaly.

Important: You are not expected to process raw thermal images. The dataset simulates real-world outputs after thermal tiling and feature extraction.

Objectives

- Understand thermal indicators used in power infrastructure inspection

- Apply machine learning to detect thermal anomalies
- Evaluate model reliability using appropriate metrics
- Perform spatial aggregation for corridor-level risk mapping
- Interpret AI outputs for drone-based maintenance planning

Capstone Tasks

Task 1: Data Understanding

Explore the dataset and explain the physical meaning of each thermal feature and its relevance to hotspot detection.

Task 2: Machine Learning Model

Train a classification model to predict thermal anomalies. Evaluate performance using precision, recall, F1-score, confusion matrix, and ROC-AUC. Justify why accuracy alone is insufficient.

Task 3: Spatial Risk Analysis & Visualization

Aggregate predictions across spatial grid cells and generate a thermal risk heatmap representing inspection priority zones.

Task 4: Power System & Drone Interpretation

Recommend drone inspection and maintenance actions based on hotspot severity and

spatial clustering.

Task 5: Reflection

Discuss dataset limitations and propose improvements using real thermal imagery or

temporal monitoring.

Deliverable

- Jupyter Notebook with code and outputs
- Thermal hotspot risk heatmaps

- Short written technical interpretation