Fall Project Use Case Scenarios #1 – <Collaborative Edge-Cloud Machine Learning For Wildfire Detection>

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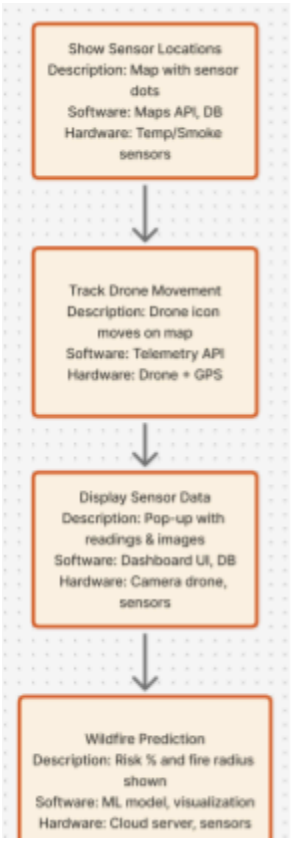
Updated Visual Representation of Project

Use Case Scenarios

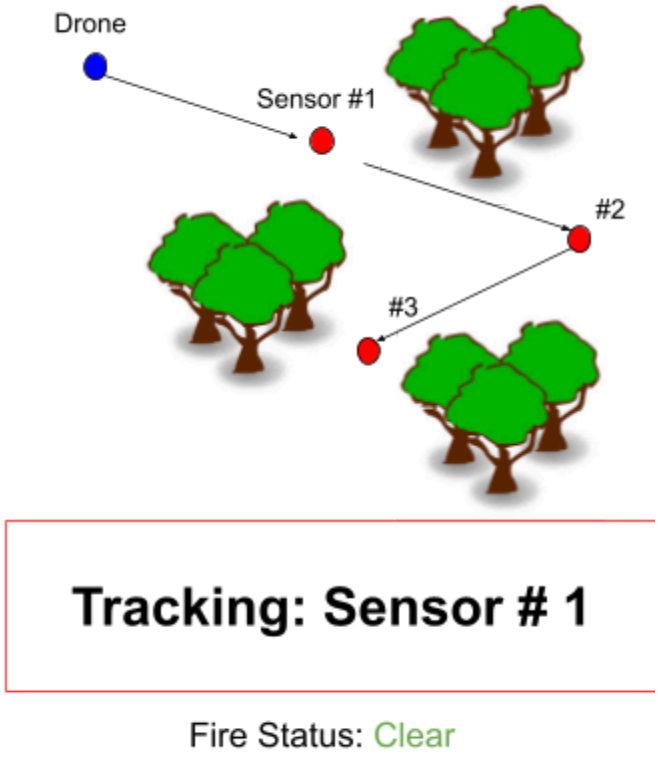
1. Building the Dashboard

- Purpose: Provide users with a real-time overview of wildfire risk.
- Functionality:
    - Displays the locations of sensors on a map.
    - Shows live drone movement as it passes over sensor regions.
    - Pops up recent sensor data and images when the drone is in range.
    - Predicts and visualizes the likelihood and radius of a wildfire.
- Value: Enables early detection and situational awareness for wildfire management teams.



Designed by:

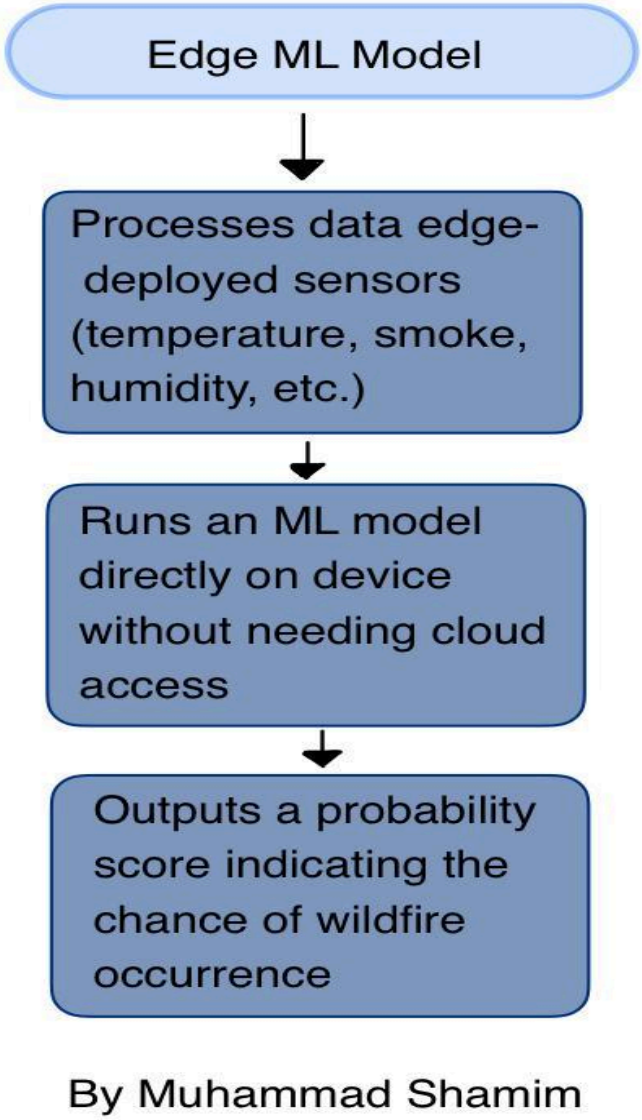
Zayd Salem



2. Edge ML Model

- Purpose: Perform localized, real-time predictions at the sensor/drone level.
- Functionality:
    - Processes data from edge-deployed sensors (temperature, smoke, humidity, etc.).
    - Runs an ML model directly on the device without needing cloud access.
    - Outputs a probability score indicating the chance of wildfire occurrence in that region.

- Value: Reduces latency, works in remote/no-network areas, and provides immediate insights for faster response.

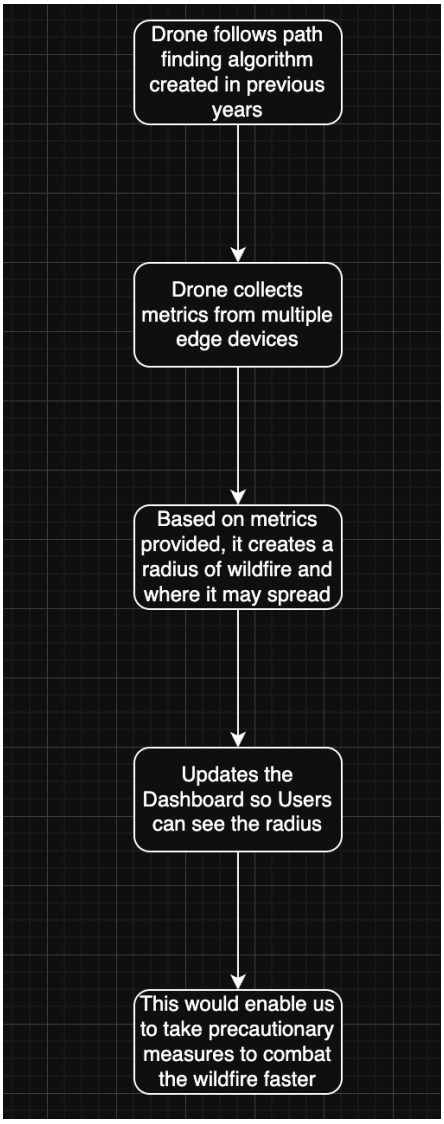


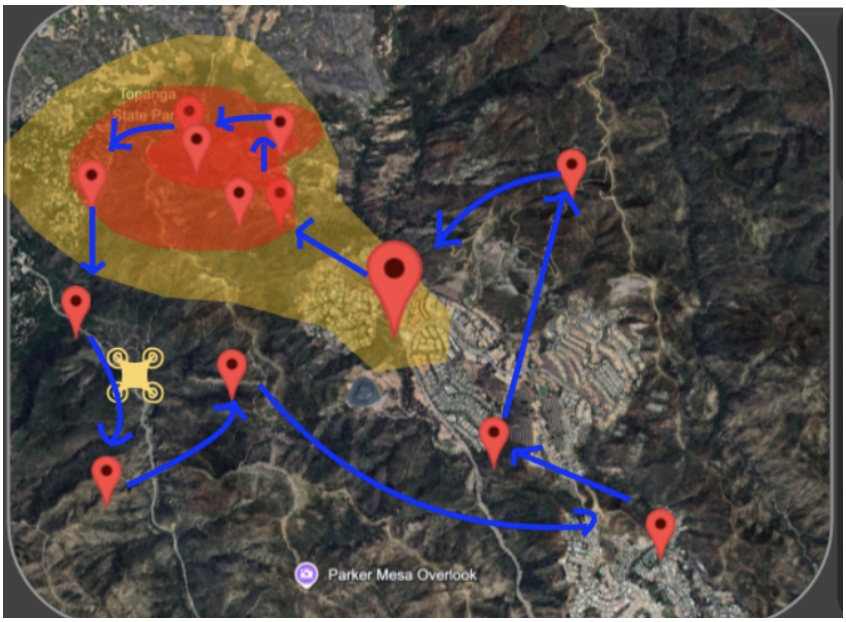
3. Drone Based Visual Confirmation and Image Classification.

- Purpose: Wide range of applications, such as following wildlife in remote areas where they must be studied routinely (ex. Nearly extinct animals), and Military Applications where spotting targets with accuracy is imperative.

- **Input:** Drone camera captures terrain images along edge node route.
- **ML Role:** Classifies images as potential identifications, matches.
- **Output:** Alerts control center if images taken meet level of accuracy required (80%+)
- **Usefulness:** Provides visual proof to supplement edge node predictions.

Flowchart created by Hussain Mahuvawala

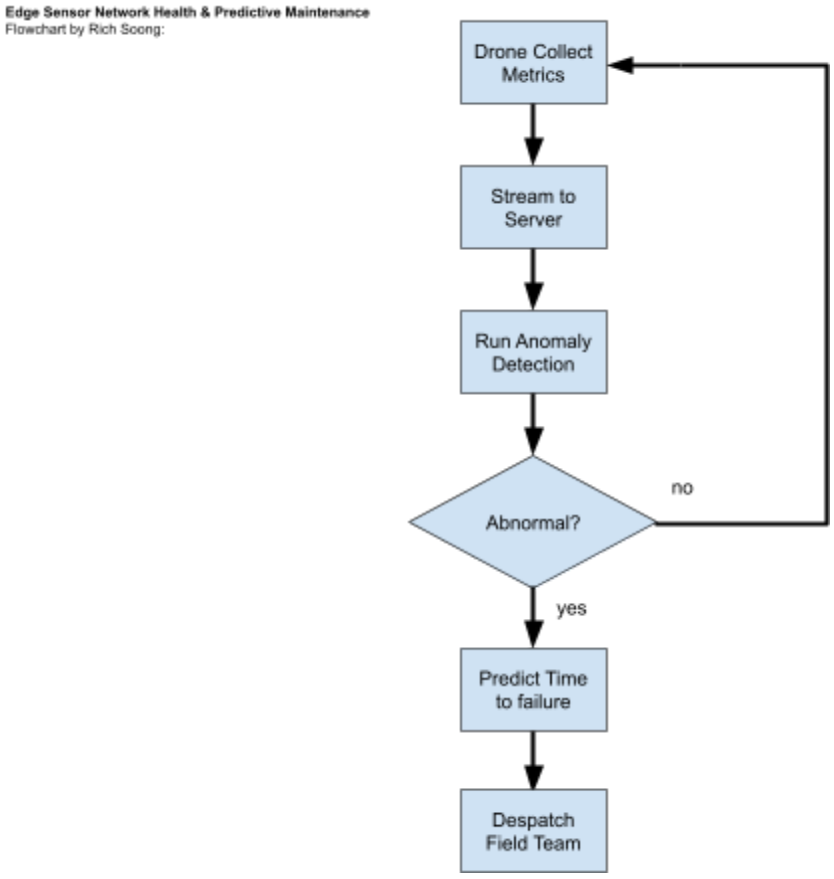




In the sketch of the dashboard above, we can see the drone following a path marked by blue arrows. Let this path be the path created by the path finding algorithm created by students from previous years. It will collect the information from the edge devices and will create a radius that the wildfire has affected and a potentially affected radius as well.

4. Edge Sensor Network Health & Predictive Maintenance

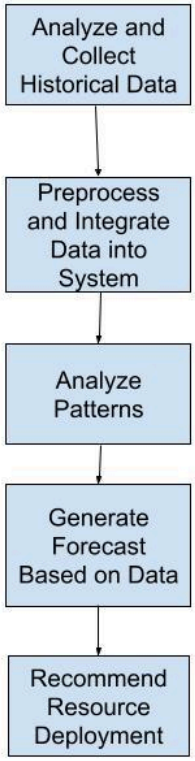
- Purpose: Ensure reliability and longevity of the distributed sensor and drone infrastructure.
- Functionality:
    - Continuously monitors sensor and drone performance metrics (e.g., battery life, signal strength, packet loss, calibration drift).
    - Uses anomaly detection algorithms to flag irregular patterns (e.g., sudden drop in transmission frequency, abnormal power draw).
    - Predicts potential failures and schedules maintenance tasks proactively (e.g., alerting field technicians before a node goes offline).
- **Value**: Minimizes downtime, reduces operational costs, and maintains the integrity of wildfire detection coverage by catching issues in the sensors before they lead to blind spots.
- Major components needed:
    - Hardware:
        - Edge sensor
        - UAV
        - Server
    - Software:
        - Anomaly Detection hardware
        - Failure prediction



5. Historical Trend Analysis & Risk Forecasting

- Purpose: Leverage past data to anticipate high-risk wildfire periods and optimize resource allocation.
- Functionality:
    - Aggregates historical sensor readings, drone imagery, and wildfire occurrence data over months/years.
    - Uses time-series and spatial analysis to identify recurring patterns (e.g., seasonal hotspots, dry wind corridors).
    - Generates risk forecasts and recommends strategic placement of drones, sensors, or fire crews for upcoming high-risk windows.
- **Value**: Enhances strategic planning and preparedness by turning raw historical data into actionable forecasts, enabling agencies to deploy resources more effectively ahead of critical wildfire seasons.

Historical Trend Analysis & Risk Forecasting by Sidhartha Shah



Timeline of Tasks and Planned WorkLoad Split for use case scenarios

Timeline of Tasks and Workload Split

Week 1 – Draft & Mockups

- Day 1–2: Research (Edge ML) – summarize methods + dummy % output.
- Day 3–4: Data (Sensor Map) – prepare GPS points + fake sensor data/images.
- Day 5: UI (Dashboard) – sketch map, pins, drone; Hardware – simulate drone path; Architecture – draft fire boundary diagram.
- Documentation – compile draft with flowcharts.

Week 2 – Integration & Proof-of-Concept

- Day 6–7: UI – add dummy data + clickable pins.
- Day 8–9: Research – connect dummy ML outputs; Hardware – overlay drone path.
- Day 10: Architecture – add fire boundary overlay; Documentation – finalize 2–4 page PDF.

Budget/Resources: $0 budget, free tools (Draw.io, Figma, Google Maps API free tier), existing laptops, dummy data/images.

Additional Comments / Concerns