EARLY WILDFIRE DETECTION AND PREDICTION FOR VULNERABLE COMMUNITIES

THE PROBLEM

- WILDFIRES INCREASINGLY THREATEN SMALL RURAL COMMUNITIES, WHERE RESPONSE TIMES ARE SLOWER.
- EARLY-WARNING SYSTEMS ARE UNAVAILABLE WHERE THEY ARE NEEDED MOST.
- **DETECTION COMES TOO LATE**; SMOKE AND FIRE EXPOSURE DRIVES SERIOUS HEALTH RISKS.

Wildfire in Oaxaca

GUIRA

OUR MISSION

- DELIVER JUSTICE BY PROTECTING HEALTH WITH EARLIER DETECTION.
- ALERT AUTHORITIES FAST AND SUPPORT TIMELY, SAFER EVACUATIONS.
- BUILD ACCOUNTABLE ALERTS FOR VULNERABLE COMMUNITIES

“EVERY LIFE MATTERS”

GUIRA

SOLUTION

WILDFIRES ESCALATE FAST IN VULNERABLE RURAL AREAS—WHERE RESPONSE IS DELAYED AND SMOKE HARMS HEALTH—GUIRA IS BUILT TO CREATE TIME FOR ACTION.

WE DO THIS BY FLYING A DRONE OVER HIGH-RISK ZONES AND ANALYZING THE VIDEO FEED WITH AI TO DETECT EARLY SMOKE/FIRE SIGNALS, ATTACH PRECISE LOCATION CONTEXT, AND TRIGGER RAPID NOTIFICATIONS.

THE RESULT IS A FIELD-READY PROTOTYPE THAT SENDS GEOTAGGED ALERTS TO RESPONDERS.

ENABLING SAFER EVACUATIONS AND FASTER ACTION.

PROTECTING LIVES AND HEALTH

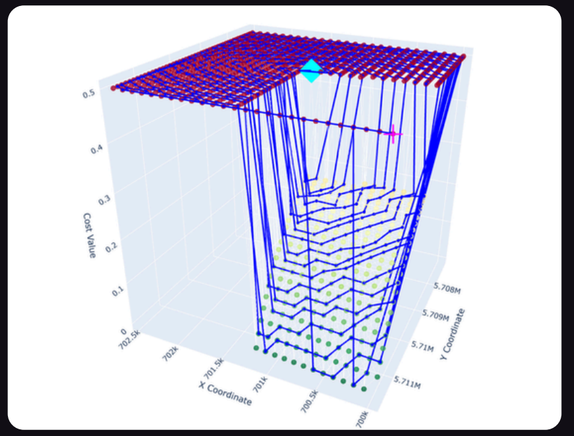
A rural community reacting to a wildfire

GUIRA

ITERATIONS THROUGH COMMUNITY COLLABORATION

- **ORIGIN IN COMMUNITY**
  - INSPIRED BY WILDFIRE IMPACT IN THE SIERRA NORTE OF OAXACA
  - LOCAL STORIES REVEALED THE HUMAN COST OF DELAYED RESPONSE
- **COLLABORATIVE PROCESS**
  - FORMED A TEAM OF CLASSMATES TO ADDRESS THE PROBLEM TOGETHER
- **LEARNING THROUGH FEEDBACK**
  - TESTED EARLY VERSIONS WITH BRIGADE MEMBERS AND RESEARCHERS
  - FAILED INITIAL DEMOS AND INCORPORATED DIRECT FIELD FEEDBACK
  - A* ALGORITHM INSPIRED BY A VIDEO GAME, REFINED BY MATH TEACHER COLLABORATION
  - SHIFTED PRIORITIES BASED ON REAL FIREFIGHTER NEEDS
- **VALUES DRIVING ITERATION**
  - LISTENING BEFORE DIRECTING
  - HUMILITY IN FAILURE
  - RESPONSIBILITY TO VULNERABLE COMMUNITIES

Smoke during road trip



We could’nt upload the correct GPS and topology data

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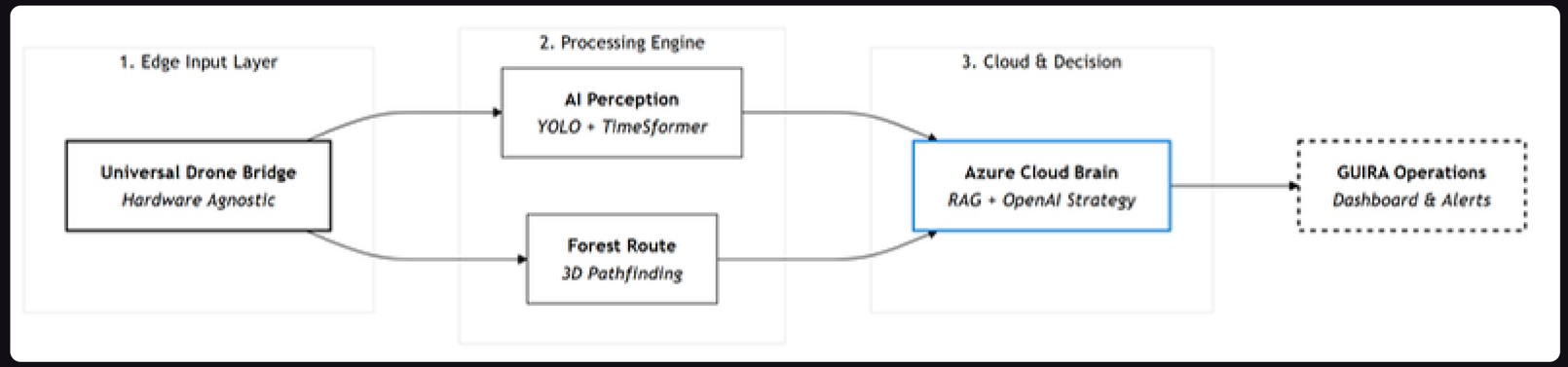
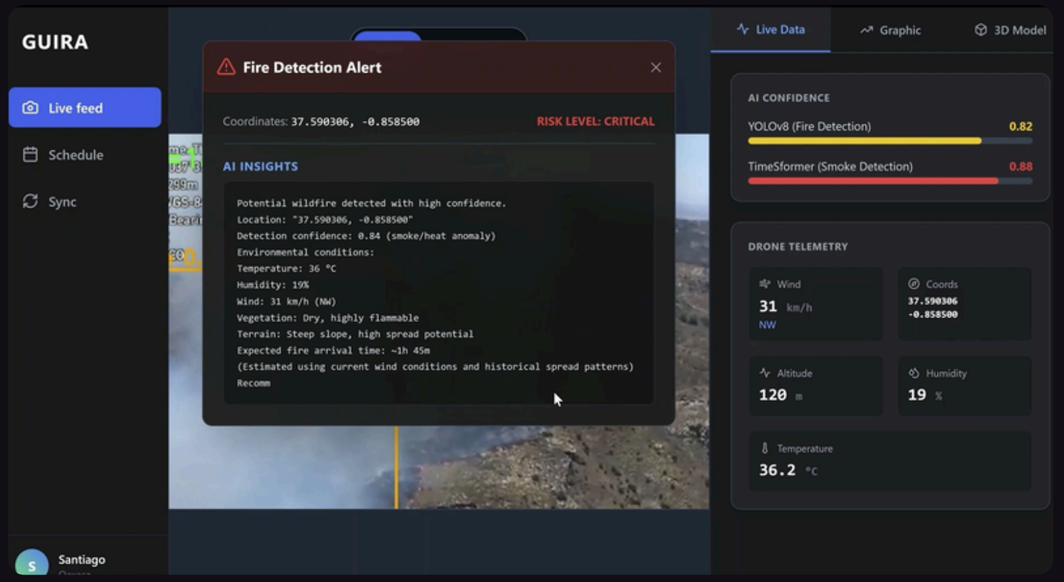
ARCHITECTURE GENERAL



- **EDGE LAYER**
  - HARDWARE DRONE INTEGRATION
  - SECURE INGESTION OF VIDEO AND TELEMETRY DATA
- **INTELLIGENCE LAYER**
  - COMPUTER VISION MODELS FOR WILDFIRE UNDERSTANDING
  - SPATIAL REASONING AND ROUTE COMPUTATION
  - MODELS TRAINED AND DEPLOYED USING **AZURE MACHINE LEARNING**

- **CLOUD ORCHESTRATION (AZURE)**
  - CENTRAL COORDINATION OF AI SERVICES
  - CONTEXT AGGREGATION FROM LIVE AND HISTORICAL DATA
  - DECISION SUPPORT GENERATED WITH AZURE OPENAI
- **DELIVERY LAYER**
  - UNIFIED OUTPUT FOR ALERTS, PRIORITIES, AND PLANS
  - DESIGNED FOR FAST AND RELIABLE FIELD OPERATIONS



Guira environment

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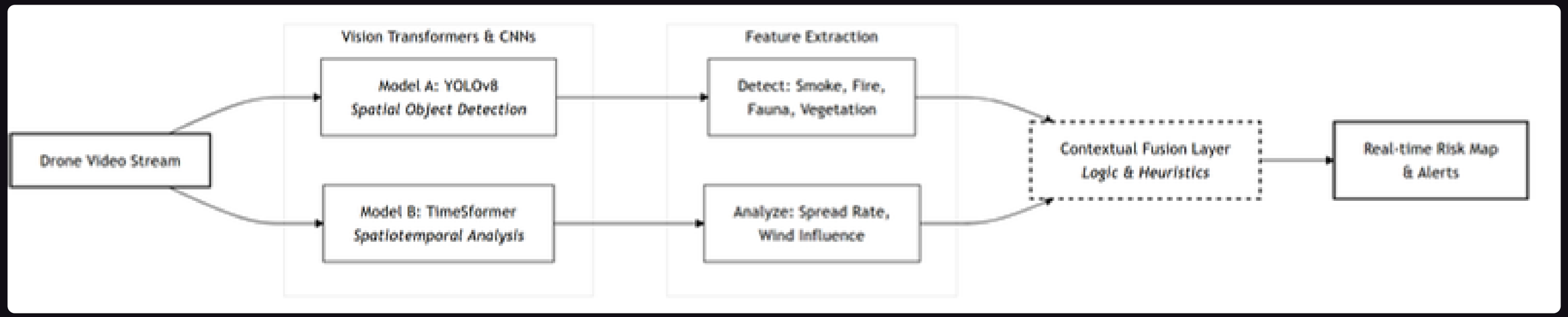
ARCHITECTURE AI PERCEPTION LAYER



- DRONE VIDEO STREAMS ARE PROCESSED IN REAL TIME
  - **YOLOV8** DETECTS FIRE, SMOKE, VEGETATION, AND FAUNA IN EACH FRAME
  - **TIMESFORMER** ANALYZES TEMPORAL PATTERNS TO CONFIRM SPREAD BEHAVIOR
- MODELS ARE TRAINED AND DEPLOYED USING **AZURE MACHINE LEARNING**
- OUTPUTS ARE FUSED INTO A REAL-TIME WILDFIRE RISK MAP

YOLO in real time

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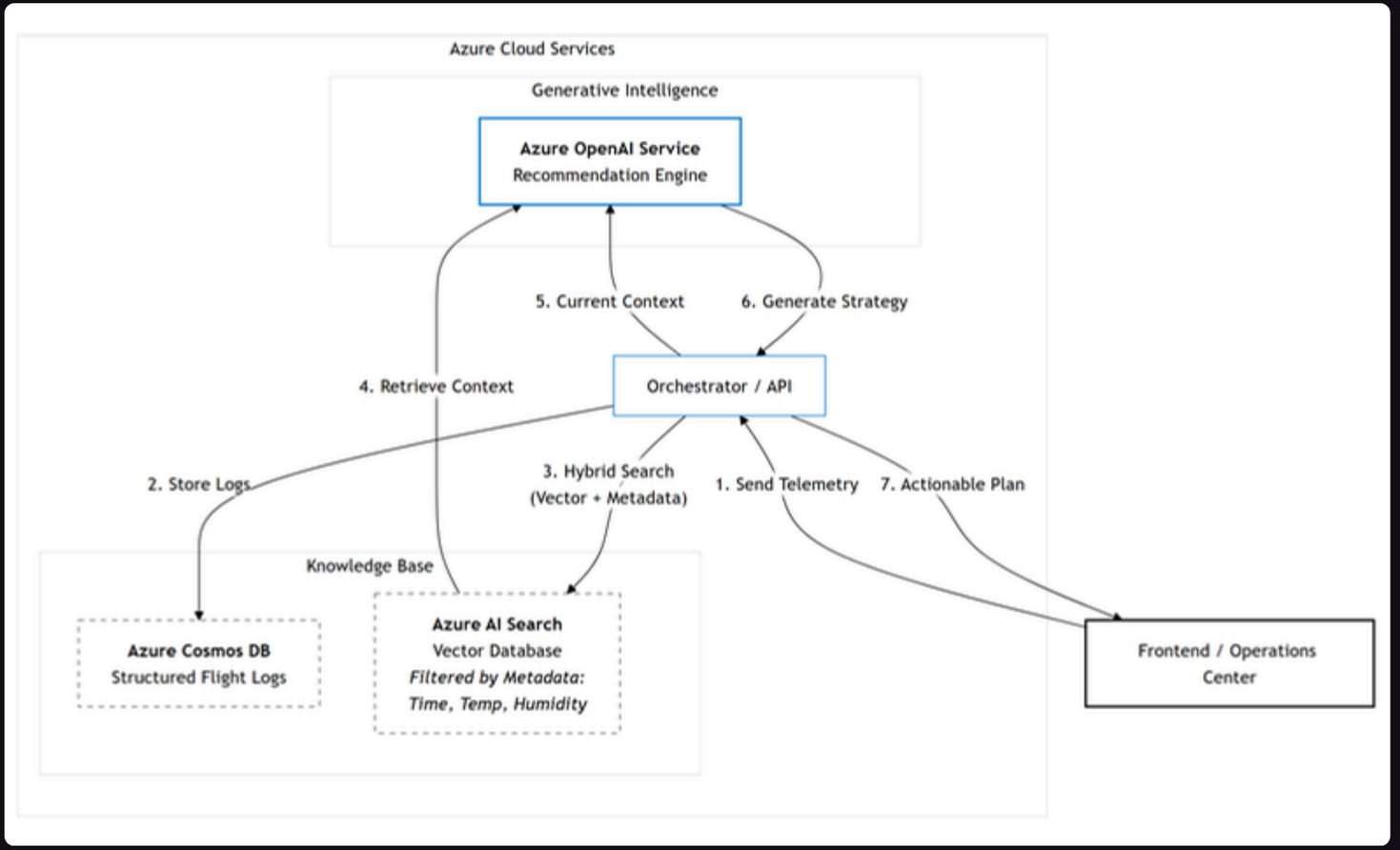
ARCHITECTURE CLOUD INTELLIGENCE & DECISION SUPPORT



- **AZURE MACHINE LEARNING** RUNS AND SCALES OUR AI MODELS
- FLIGHT LOGS AND TELEMETRY ARE STORED IN **AZURE COSMOS DB**
- HISTORICAL AND CONTEXTUAL DATA IS INDEXED IN **AZURE AI SEARCH**
- **AZURE OPENAI** GENERATES RISK EXPLANATIONS AND ACTION RECOMMENDATIONS
- OUTPUTS ARE RETURNED AS **CLEAR, ACTIONABLE BRIEFS** FOR RESPONDERS

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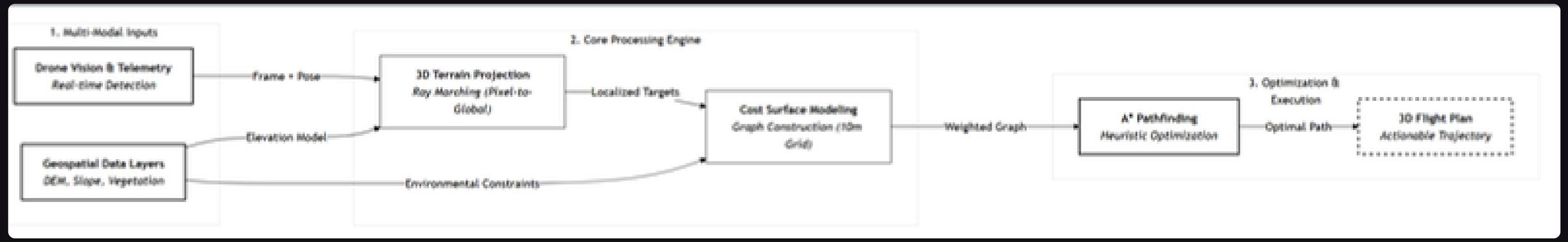
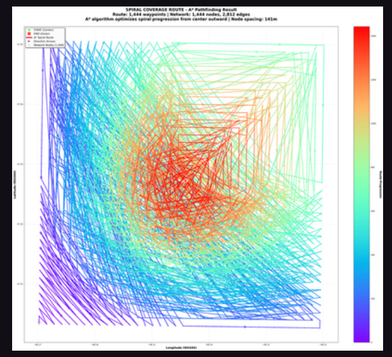
ARCHITECTURE FROM MAPS TO SAFE ROUTES

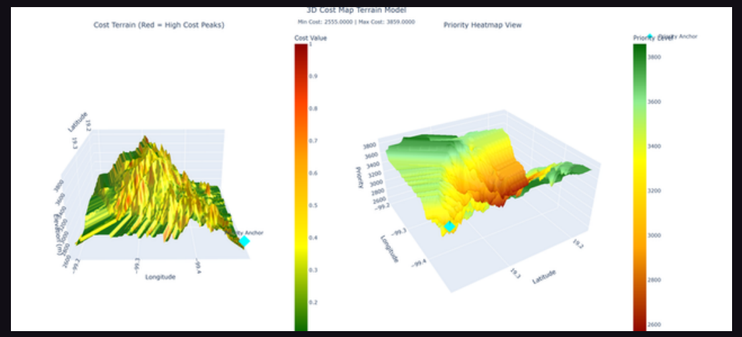


Satelite area selection

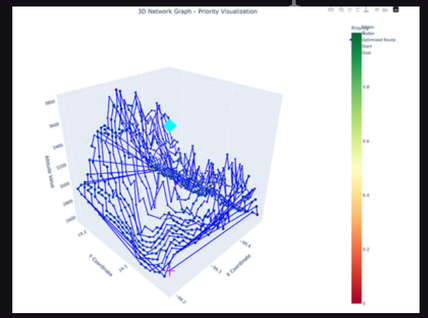


Spiral A* algorithm route

- COMBINES TERRAIN, VEGETATION, AND RISK DATA
- CONVERTS MAPS INTO A NAVIGABLE GRID
- ASSIGNS MOVEMENT COST BASED ON SLOPE AND DANGER
- COMPUTES THE SAFEST AND MOST EFFICIENT ROUTE
- OUTPUTS ROUTES AND PRIORITY MAPS FOR OPERATIONS



Cost terrain map and Pirority heatmap



Route visualization 3d

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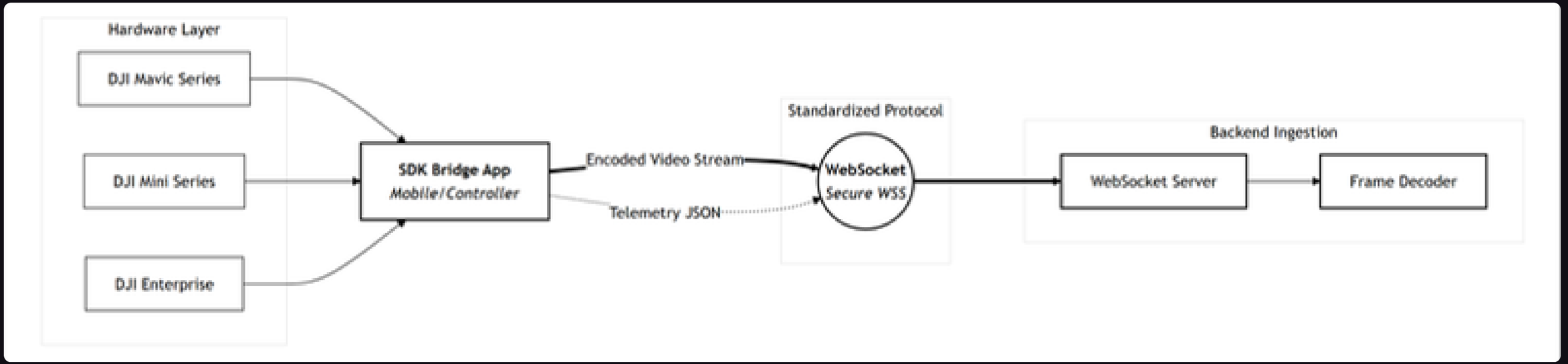
ARCHITECTURE UNIVERSAL DJI DRONE CONNECTIVITY



- SUPPORTS CONSUMER, ENTERPRISE, AND CUSTOM DRONES
- USES A STANDARDIZED WEBSOCKET SECURE (WSS) PROTOCOL
- DECOUPLES DRONE HARDWARE FROM BACKEND INTELLIGENCE
- STREAMS ENCODED VIDEO AND TELEMETRY IN REAL TIME
- ENABLES DEPLOYMENT WITHOUT MODIFYING EXISTING DRONE FLEETS

Drone sync interface

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PROTOTYPE

REAL-TIME MONITORING

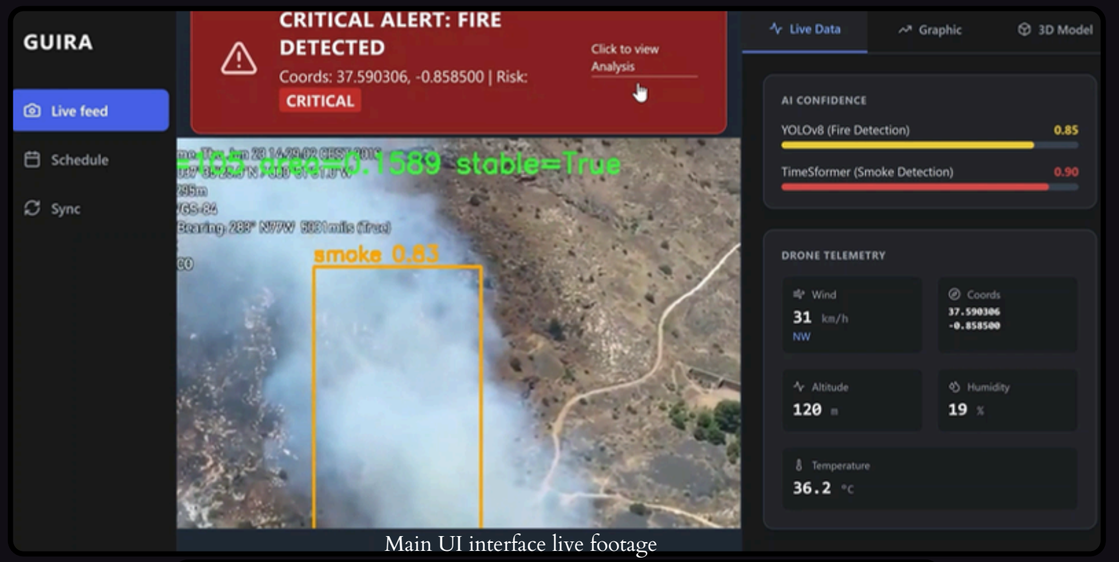
- LIVE DRONE VIDEO WITH AUTOMATED FIRE AND SMOKE DETECTION
- VISUAL ALERTS HIGHLIGHTED DIRECTLY ON THE VIDEO FEED

AI-DRIVEN INSIGHTS

- CRITICAL EVENTS TRIGGER AI-GENERATED SUMMARIES
- CLEAR EXPLANATION OF WHAT IS HAPPENING, WHY IT MATTERS, AND URGENCY
- RISK EVOLUTION INDICATORS AND RECOMMENDED ACTIONS

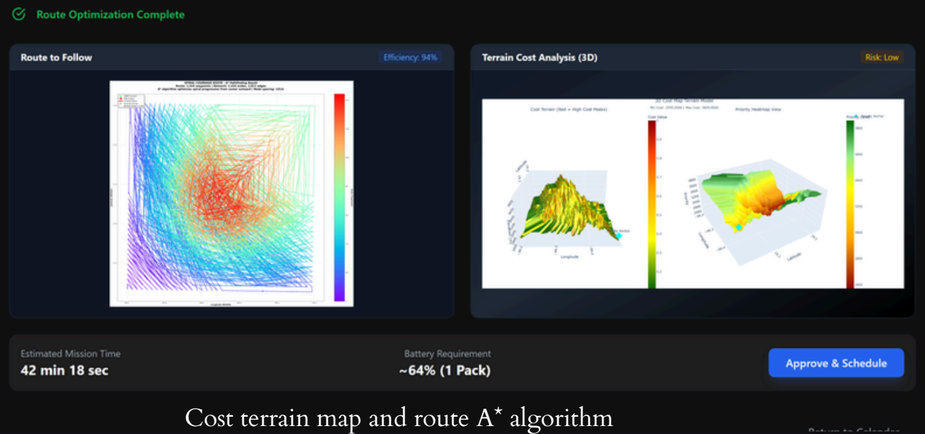
SPATIAL AWARENESS

- 3D PROJECTION OF DETECTED FIRE OVER TERRAIN
- IMPROVED UNDERSTANDING OF LOCATION, SHAPE, AND POTENTIAL SPREAD

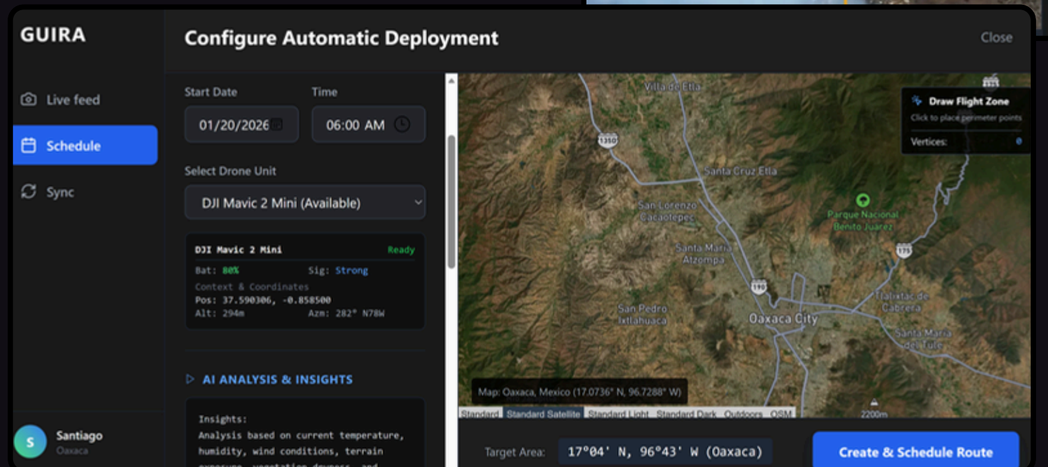


Main UI interface live footage

3d projection of forest fire area.
Video footage to 3d model



Cost terrain map and route A* algorithm



Route and deployment configuration UI

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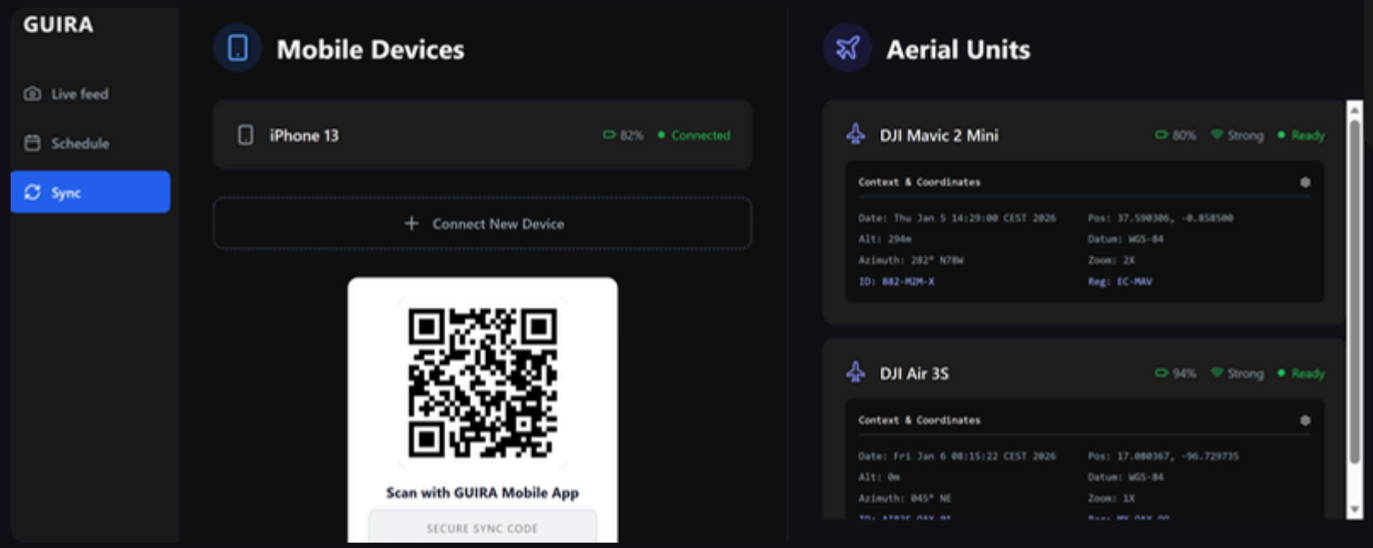
PROTOTYPE

PLANNING & PREVENTION

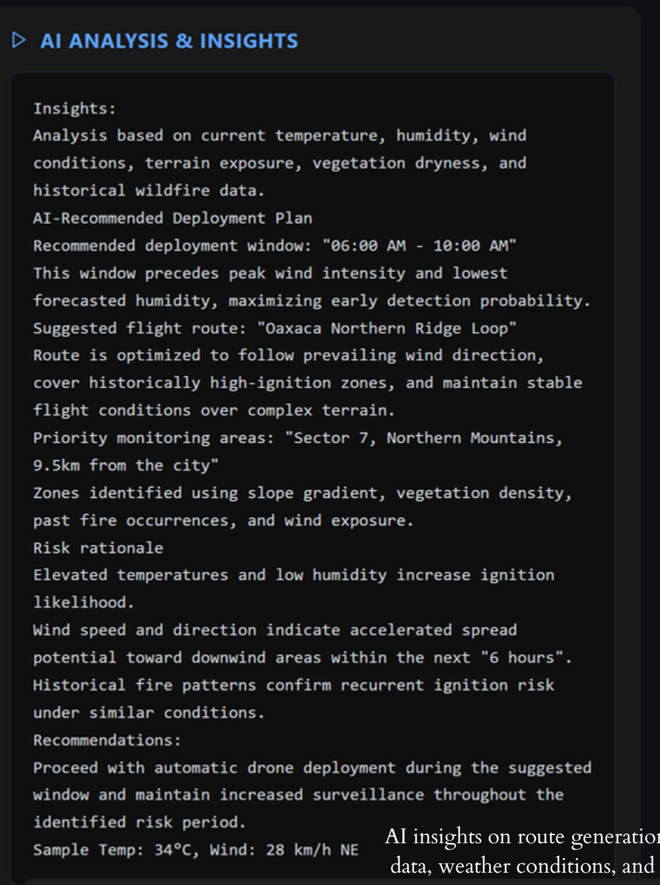
- AUTOMATED DRONE MISSION SCHEDULING
- AI-ASSISTED RECOMMENDATIONS FOR TIMING, ROUTES, AND COVERAGE
- OPTIMIZED PATHS BASED ON WEATHER, TERRAIN, AND HISTORICAL DATA

CONNECTIVITY & OPERATIONS

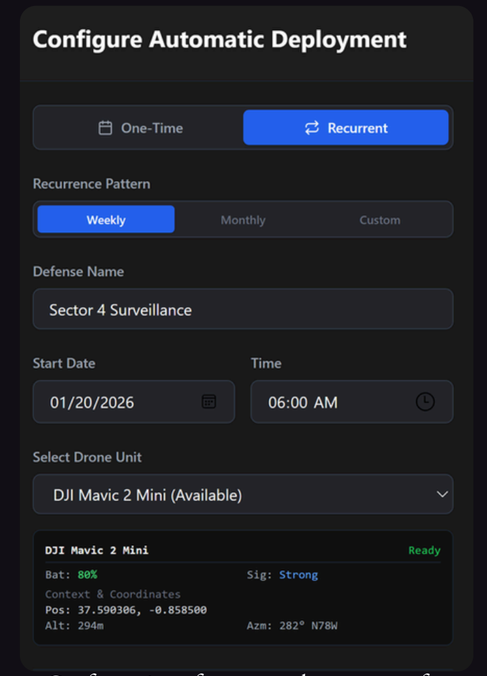
- SIMPLE DRONE ONBOARDING AND SYNCHRONIZATION
- REAL-TIME TELEMETRY AND NOTIFICATIONS ACROSS DEVICES



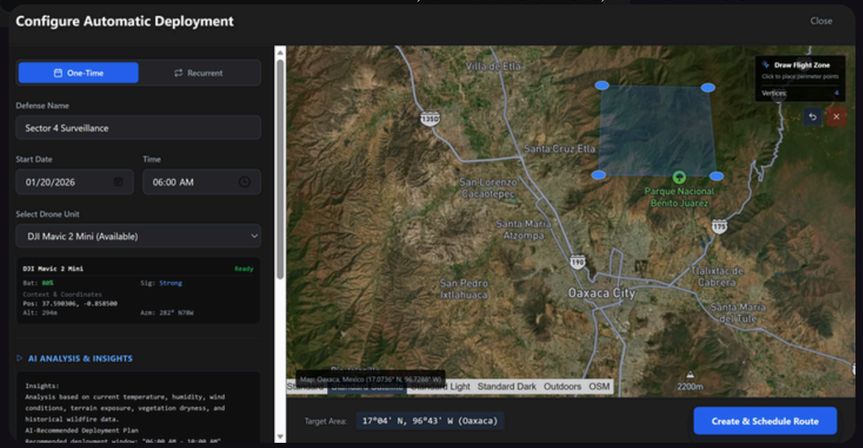
UI for connecting additional devices or drones



AI insights on route generation, using past data, weather conditions, and risk factors.



Configuration of recurrent drone routes, for automatic deployment



Selecting the area the drone needs to analyze

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MEASURABLE IMPACT

ENVIRONMENTAL IMPACT:

- ENABLE EARLIER RESPONSE TO LIMIT BURNED AREA AND LOSSES.
- PROTECT FORESTS, BIODIVERSITY, AND WATER-SOIL STABILITY.
- REDUCE LARGE-FIRE SECONDARY EMISSIONS IMPACTS, WITHOUT OVERCLAIMING.

SOCIAL IMPACT:

- REDUCE SMOKE EXPOSURE AND SMOKE-RELATED RESPIRATORY HEALTH HARM.
- GIVE FAMILIES MORE TIME TO EVACUATE SAFELY.
- PRIORITIZE UNDERSERVED COMMUNITIES WITH DELAYED DETECTION AND RESPONSE.

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OUR VISION

- START IN TLALPAN–AJUSCO (SOUTH OF MEXICO CITY), THEN SCALE REGIONAL AND NATIONAL.
- INTEGRATE WITH RESPONDER WORKFLOWS AND CLEAR ALERT HANDOFF.
- EXPAND TO RISK MAPPING AND PREPAREDNESS SIGNALS, VALIDATED SAFELY.

Photo of the Ajusco volcan

Wildfires in America

IMPACT OUR COMMUNITIES

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APPENDIX

APPENDIX A1 — HEALTH EVIDENCE (PM2.5 & WILDFIRE SMOKE)

PM2.5 = MAIN POLLUTANT OF CONCERN IN WILDFIRE SMOKEREACH DEEP INTO LUNGS • HIGHEST PUBLIC HEALTH RISK • RESPIRATORY + CARDIOVASCULAR IMPACTS • EXPOSURE-RISK FOR SENSITIVE GROUPS (CHILDREN/OLDER ADULTS/ASTHMA)

APPENDIX A2 — AZURE DOCUMENTATION (DEPLOYMENT & ENDPOINTS)

AZURE MACHINE LEARNING • ONLINE ENDPOINTS • REAL-TIME INFERENCE • DEPLOYMENTS + ROUTING • LOGS/MONITORING • REST INVOCATION

APPENDIX A3 — LEARNING & REFERENCE IMPLEMENTATIONS

CS50 (HARVARD) • FUNDAMENTALS: CORRECTNESS, DESIGN, STYLE • PROGRAMMING FOUNDATIONS (C/PYTHON/SQL/JS)

AZURE SEARCH + OPENAI DEMO (RAG PATTERN) • AZURE AI SEARCH + AZURE OPENAI SAMPLE APP

HTTPS://GITHUB.COM/AZURE-SAMPLES/AZURE-SEARCH-OPENAI-DEMO/

AIR POLLUTION VICTIMS ANNUALLY: 6.7 MILLION PREMATURE DEATHS ANNUALLY

HTTPS://WWW.WHO.INT/NEWS-ROOM/FACT-SHEETS/DETAIL/AMBIENT-(OUTDOOR)-AIR-QUALITY-AND-HEALTH#:~:TEXT=IN%202019%2C%2099%25%20OF%20THE,ASIA%20AND%20WESTERN%20PACIFIC%20REGIONS.