



Fire Scout

A Modern Take on Fighting Wildfires



Team Fire Scout

Team Leader

Release Manager

Recorder

Hardware Researcher

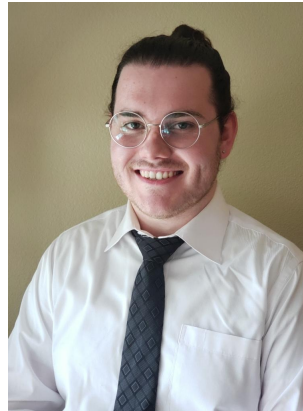
Interface Manager



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Nick
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Klawitter



Mentor

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- Graduate Teaching Assistant





Client

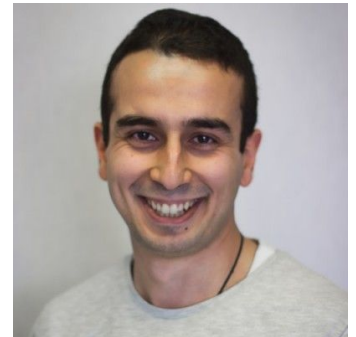
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- Ph.D. Candidate At NAU
- Graduate Research & Teaching Assistant





Problem

Fires

- Unpredictable
 - USA 2019 - **4,664,364 acres**
 - USA 2018 - **8,767,492 acres**
- California 2020
 - 4,194,148 million acres burnt
 - 9,177 fires
 - Indirect deaths of 1,200+
 - \$10 Billion total economic loss

Analysis

- Not real-time
- Information gap
- Expensive
- Risk human lives



Solution



- Unmanned Aerial Vehicles (UAVs)
 - Remove humans from fire
 - Provide real-time data
 - Implement AI
- Onboard Hardware
 - Raspberry PI or Jetson Nano
 - HD and thermal cameras
 - Image processing algorithms
 - SDR communication



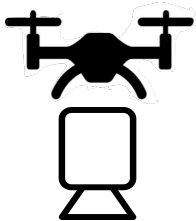


The Process

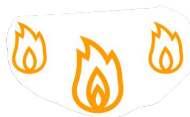
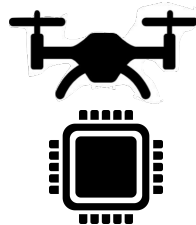
1. Pilot Flies the Drone



2. Drone Finds Fires



3. Drone Processes Fires

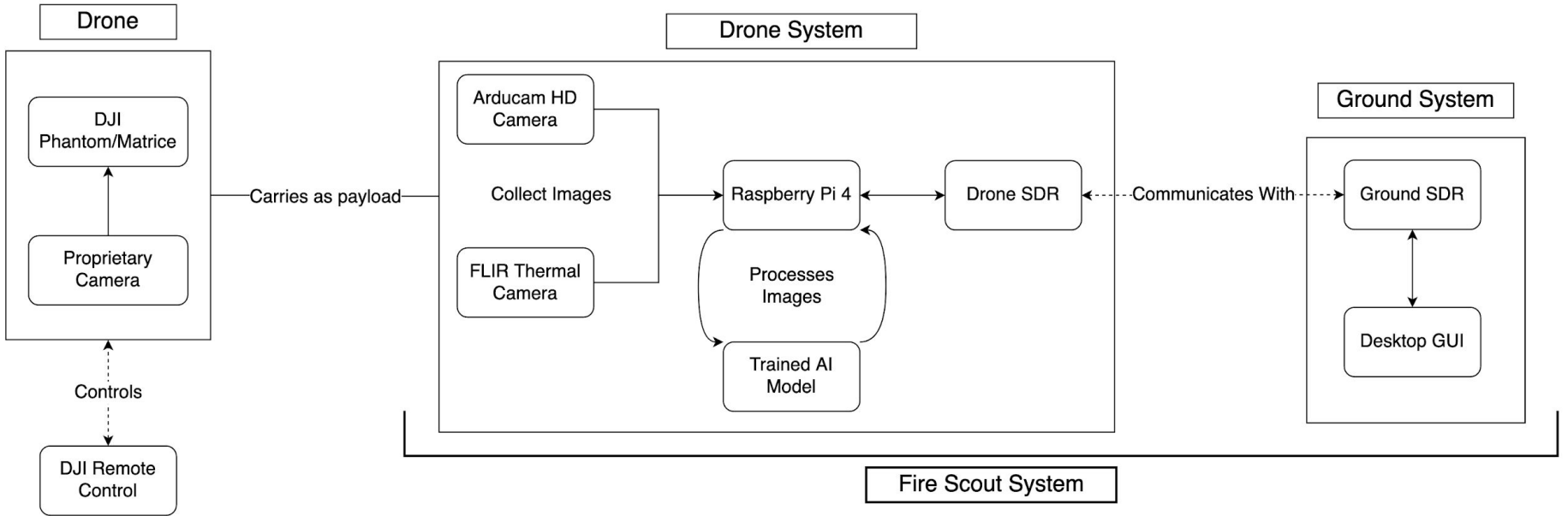


4. Drone Sends Data to User





The (Detailed) Process





Fire Analysis

1. Image Classification

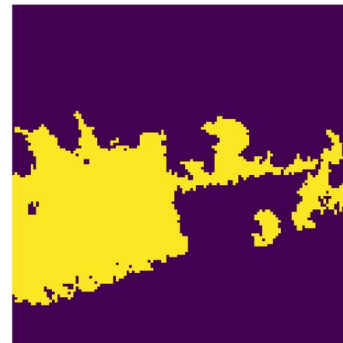
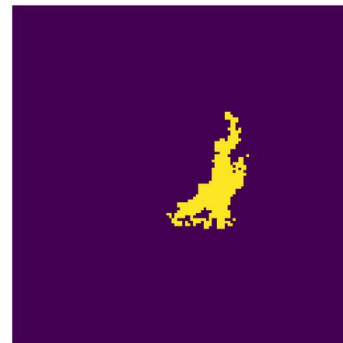
- Is* there a fire
- Onboard the drone

2. Image Segmentation

- What* is the fire?
- Desktop or onboard

3. Fire Path Planning

- Where* will the fire go?
- Follow and stay ahead
- Onboard the drone

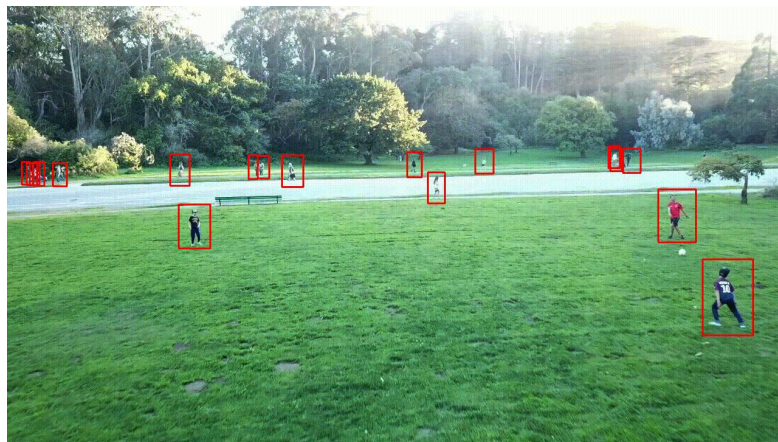




Object Detection

4. Detect People and Trees

- Through classic image analysis techniques
- Through CNNs





Data Communication

5. Sends Data to Desktop GUI

- a. Receives data while the drone is in the air
- b. Communicates via SDR



6. Control Fire Scout from Desktop GUI

- a. Communicate what data will be delivered via SDR
- b. Offers configurability for end-user



Constraints



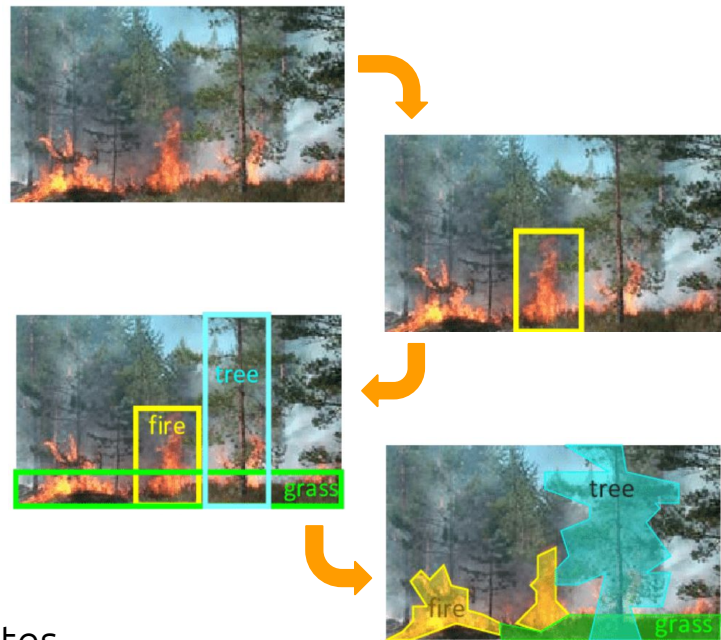
- Drones provided: Matrice 200, Phantom 3 Pro
- Electrical Engineering team
 - SDR
 - Mini-computer mounting
- Data Collection: Cannot fly drones over fires at will





Analysis Breakdown

- Classifies Fires
 - *Is* there fire?
 - CNNs
 - Future: drone flies to fire automatically
- Segments Fires
 - *What* is the fire?
 - CNNs
 - Runs on drone or desktop
 - Depends on Pi's power
- Plan the Fires Path
 - Show on the GUI arrows and cardinal coordinates
 - Future: drone can follow the fire automatically





Risks and Feasibility

Risks

- Simultaneous need to learn and implement working AI
- Limited data for ANNs
- Pi can not process enough data
- Fire recognition is still a newer technology

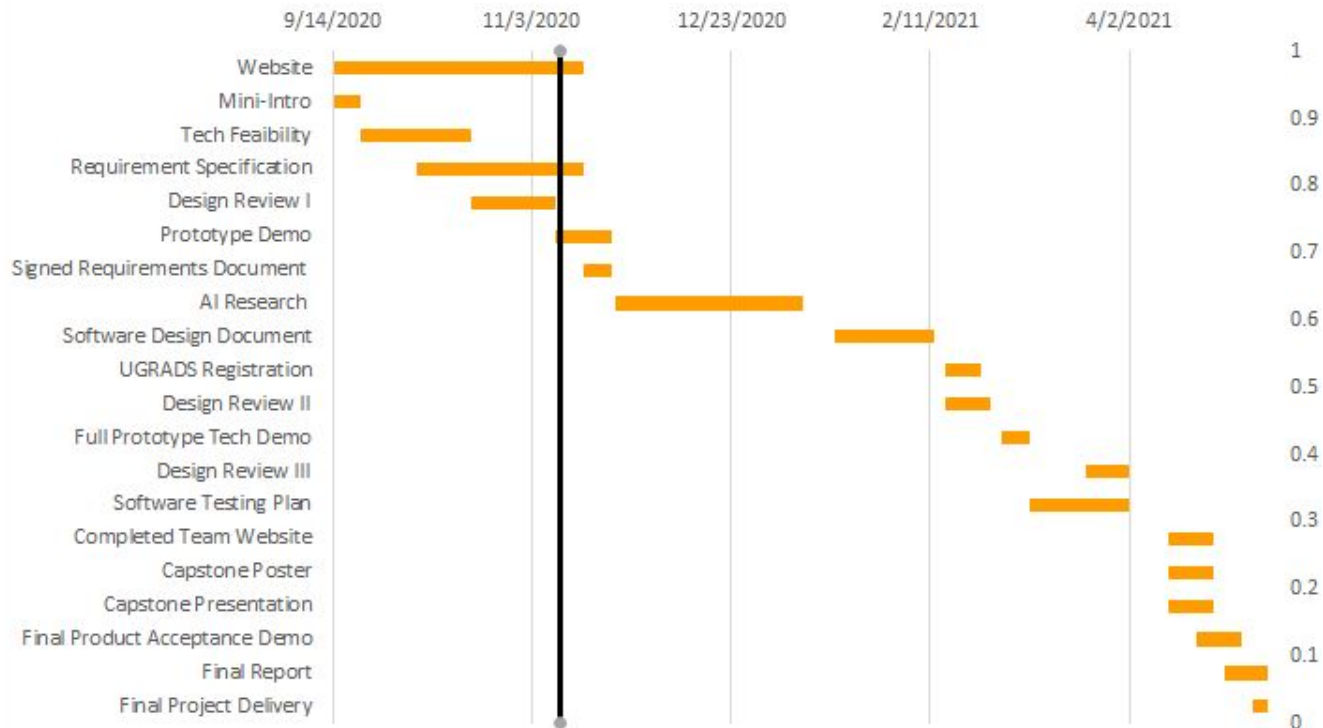
Feasibility

- All software has been developed at some point, by someone
- All hardware has been used at some point, by someone
- Combination is possible



Schedule

Fire Scout's Current Development Schedule



Conclusion



In Summary:

- New wildfire analysis is critical
- UAV fire analysis is safe + efficient
- Solution Vision
 - Fire Analysis
 - Object Detection
 - Data Communication
- Gather more data over winter break
- Start development next semester



Sources

<https://www.nbcnews.com/mach/science/drones-are-fighting-wildfires-some-very-surprising-ways-ncna820966>

<https://www.fire.ca.gov/stats-events/>

<https://news.nau.edu/afqhah-career-award/#.X5pfIFBIB3g>

<https://www.sfchronicle.com/california-wildfires/article/Hidden-cost-of-wildfire-smoke-Stanford-15595754.php>

<https://blog.skygate.io/how-to-detect-a-single-tree-from-a-drone-imagery-of-a-dense-forest-de190f64cdb7>

<https://nanonets.com/blog/real-time-object-detection-for-drones/>

<https://www.dji.com/matrice-200-series>

<https://abc7news.com/california-wildfires-cost-of-cal-fire-stanford-wildfire-research/6897462/>

https://www.nifc.gov/fireInfo/fireInfo_stats_totalFires.html

https://www.researchgate.net/figure/Comparison-between-image-classification-object-detection-and-instance-segmentation_fig6_334418384

<https://www.spiedigitallibrary.org/conference-proceedings-of-spie/10649/106490B/Wildland-fires-detection-and-segmentation-using-deep-learning/10.1117/12.2304936.short?SSO=1>