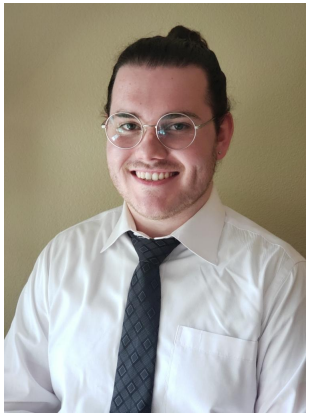
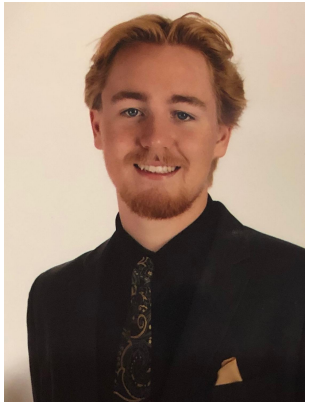
Fire Scout

A Modern Take on Fighting Wildfires

Team Fire Scout

Team Leader	Release Manager	Recorder	Hardware Researcher	Interface Manager
				
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Mentor

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- Graduate Teaching Assistant

Client

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- Client Assistant
- 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
  - 4.2 million acres burnt
  - 33 direct lives lost
  - Indirect deaths of 1,200+
  - $10 Billion total economic loss

Analysis

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

Solution

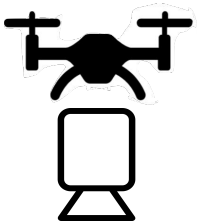
- Unmanned Aerial Vehicles (UAVs)
  - Remove humans from fire
  - Provide real-time data
  - Implement AI

- Onboard Hardware
  - Nvidia Jetson Nano
  - HD and thermal cameras
  - Image processing algorithms
  - SDR communication

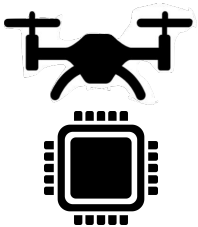
The Process

1. **Pilot** Flies the Drone

2. Drone Finds Fires



3. Drone Processes Fires

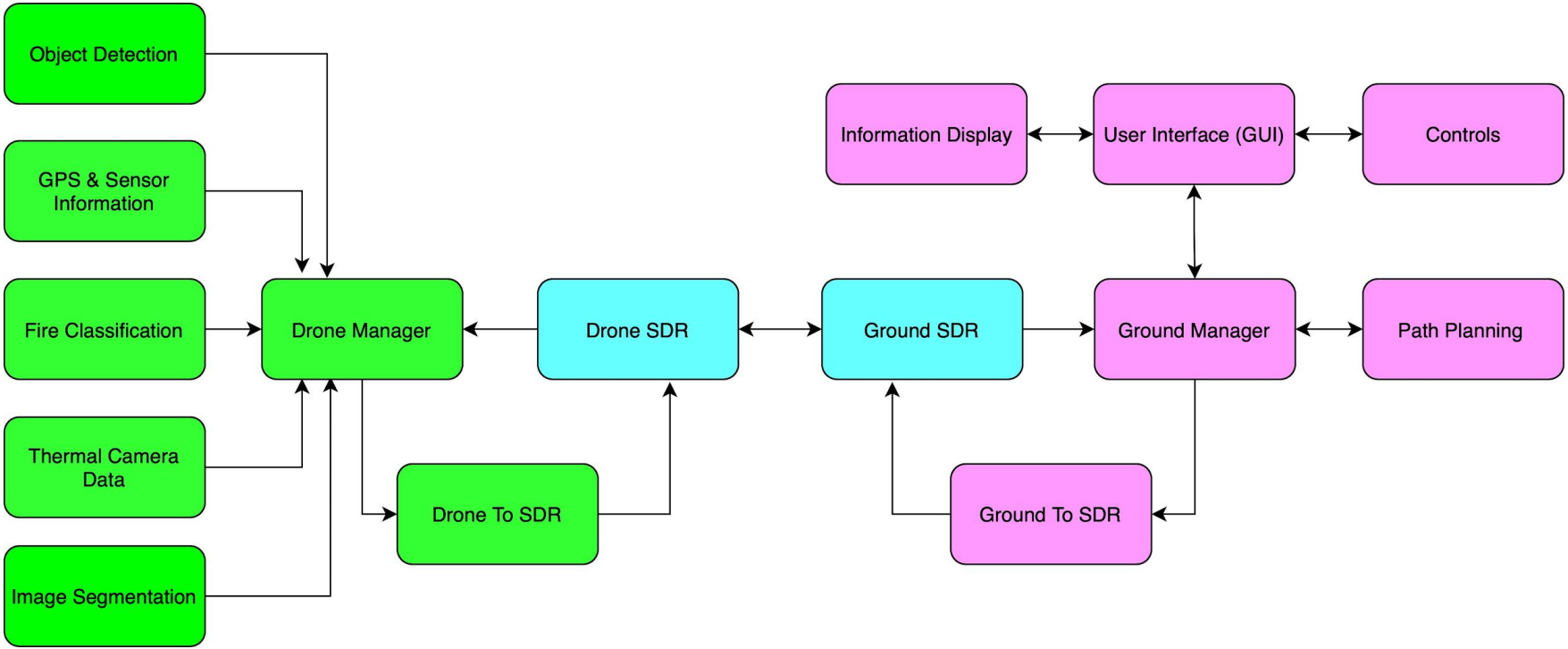


4. Drone Sends Data to **User**

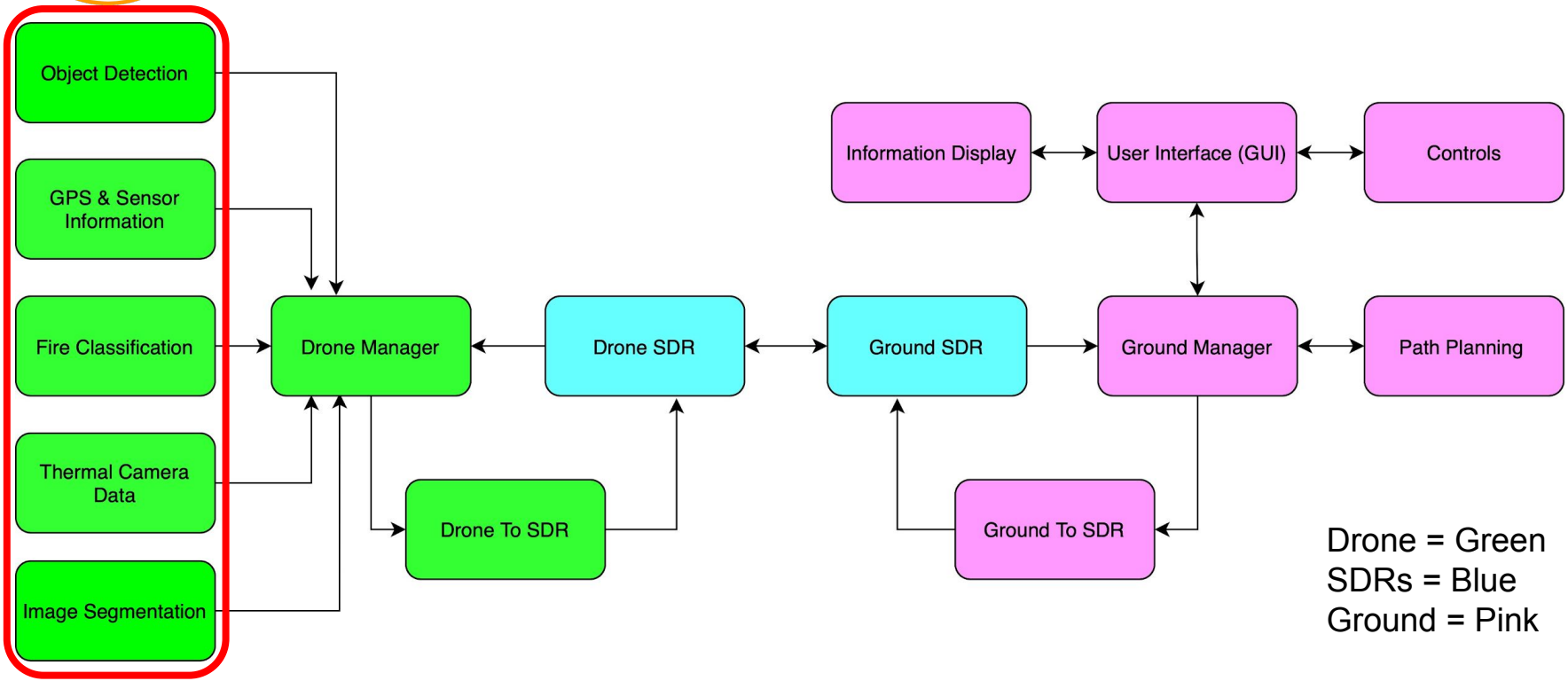
Requirements

- DJI Phantom 3 Pro or DJI Matrice 200
- Nvidia Jetson Nano
  - Image Classification
  - Object Detection
  - Image Segmentation
  - Path Planning
- HD Camera
- FLIR Vue Pro R Thermal Camera
- SDRs
- GUI

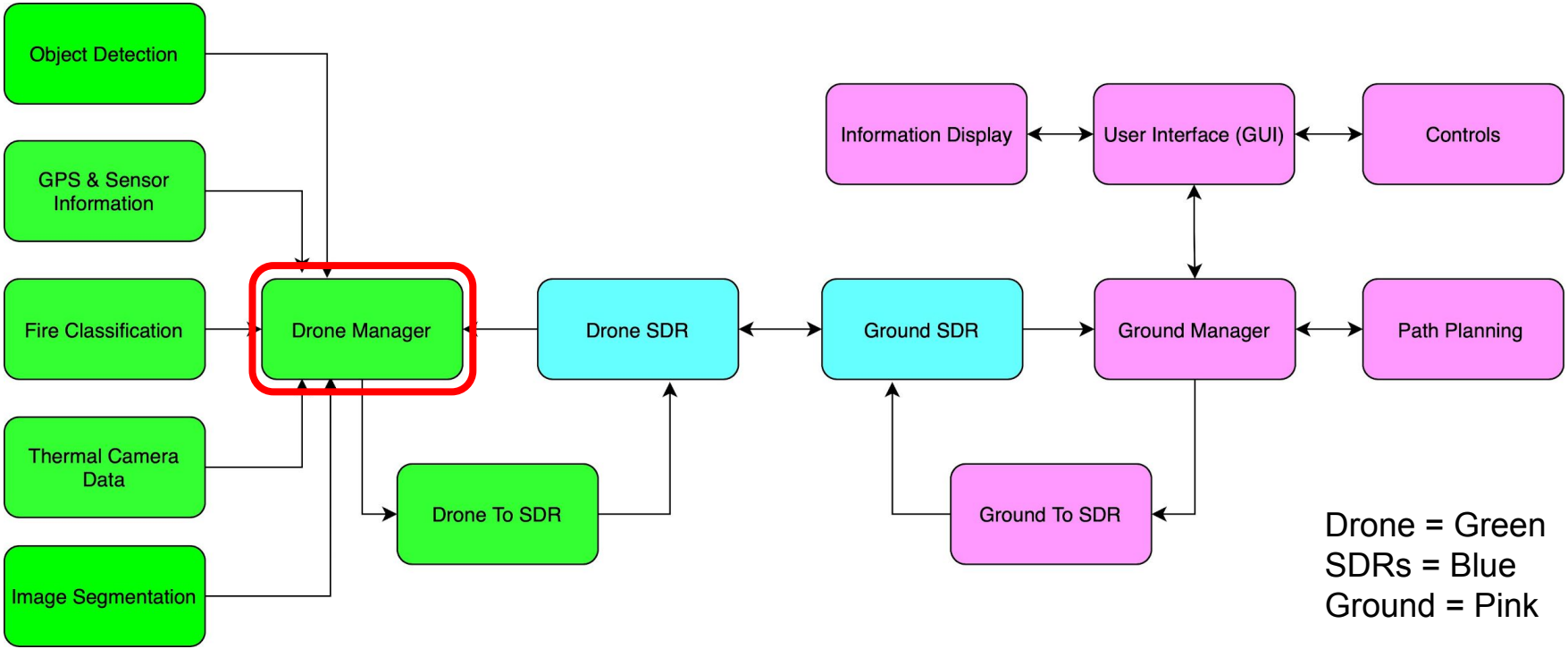
Architecture



Architecture



Architecture



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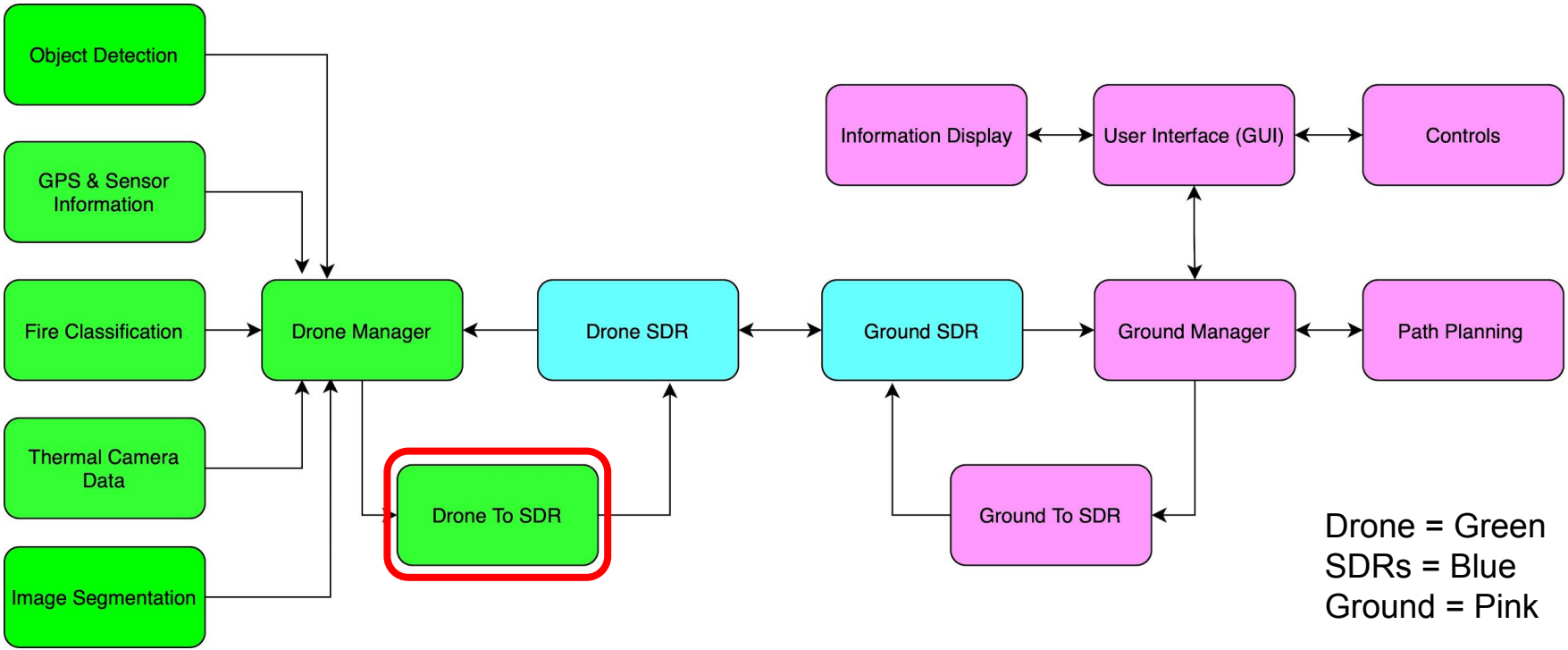

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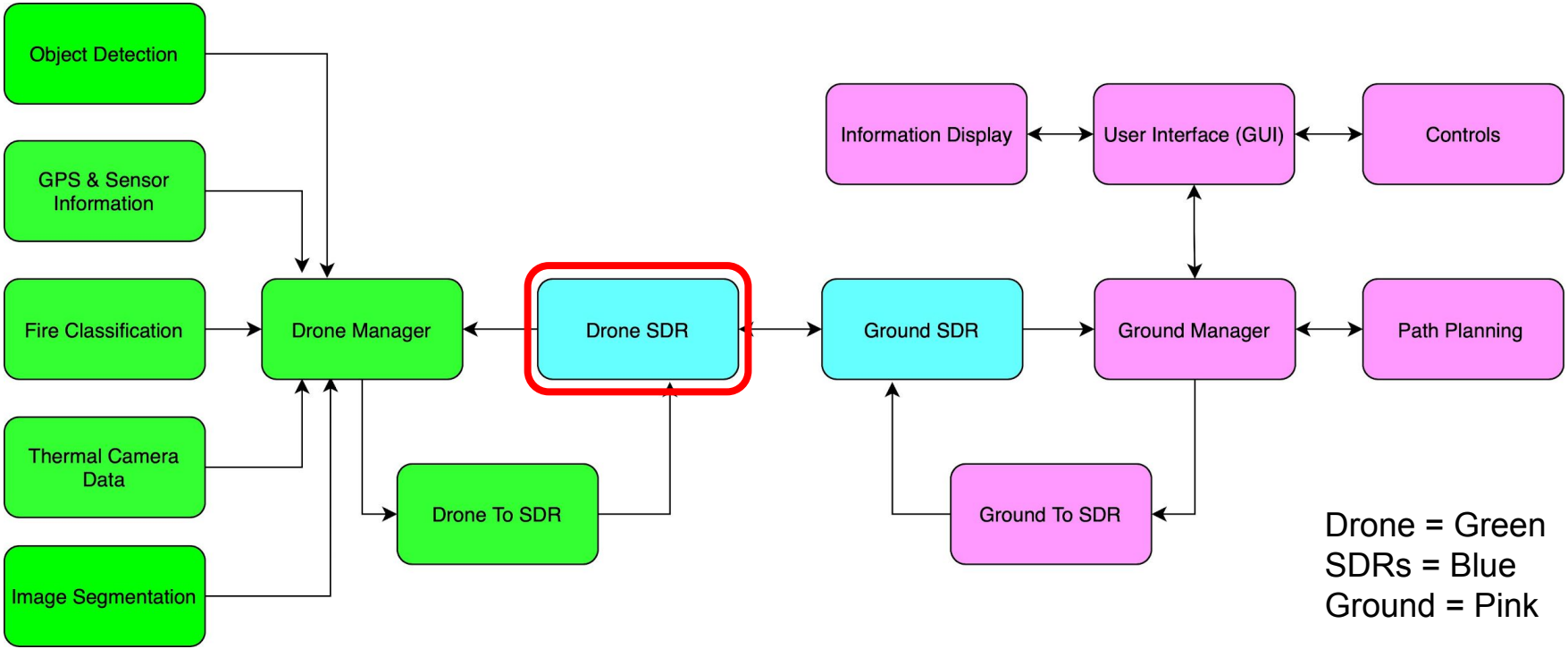

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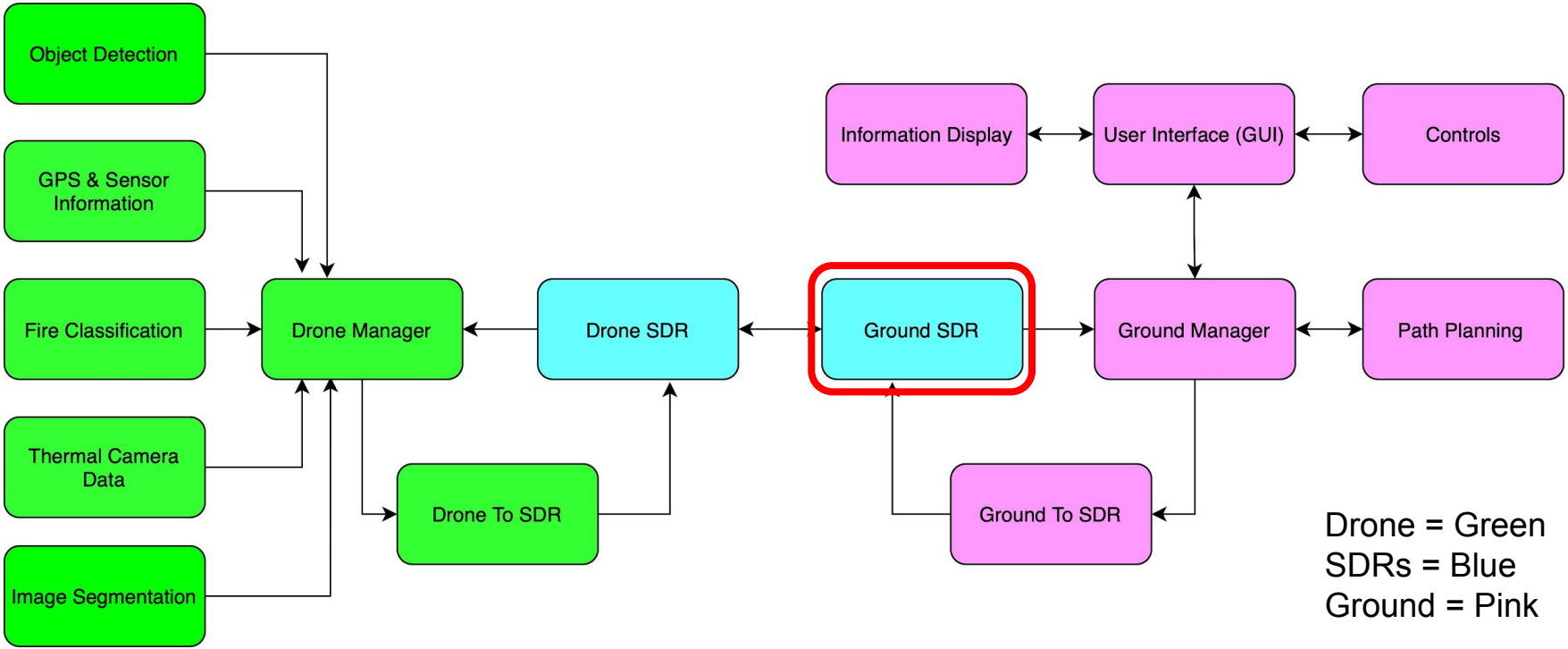

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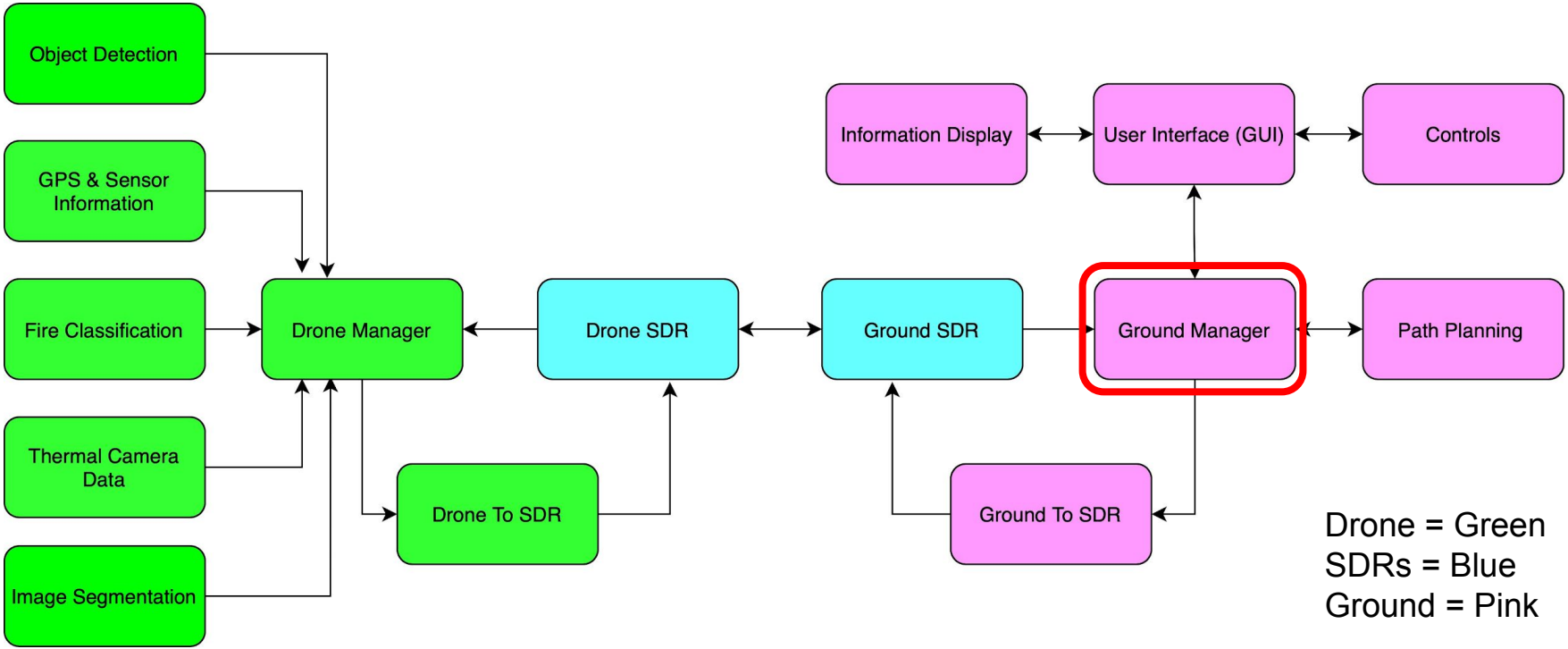
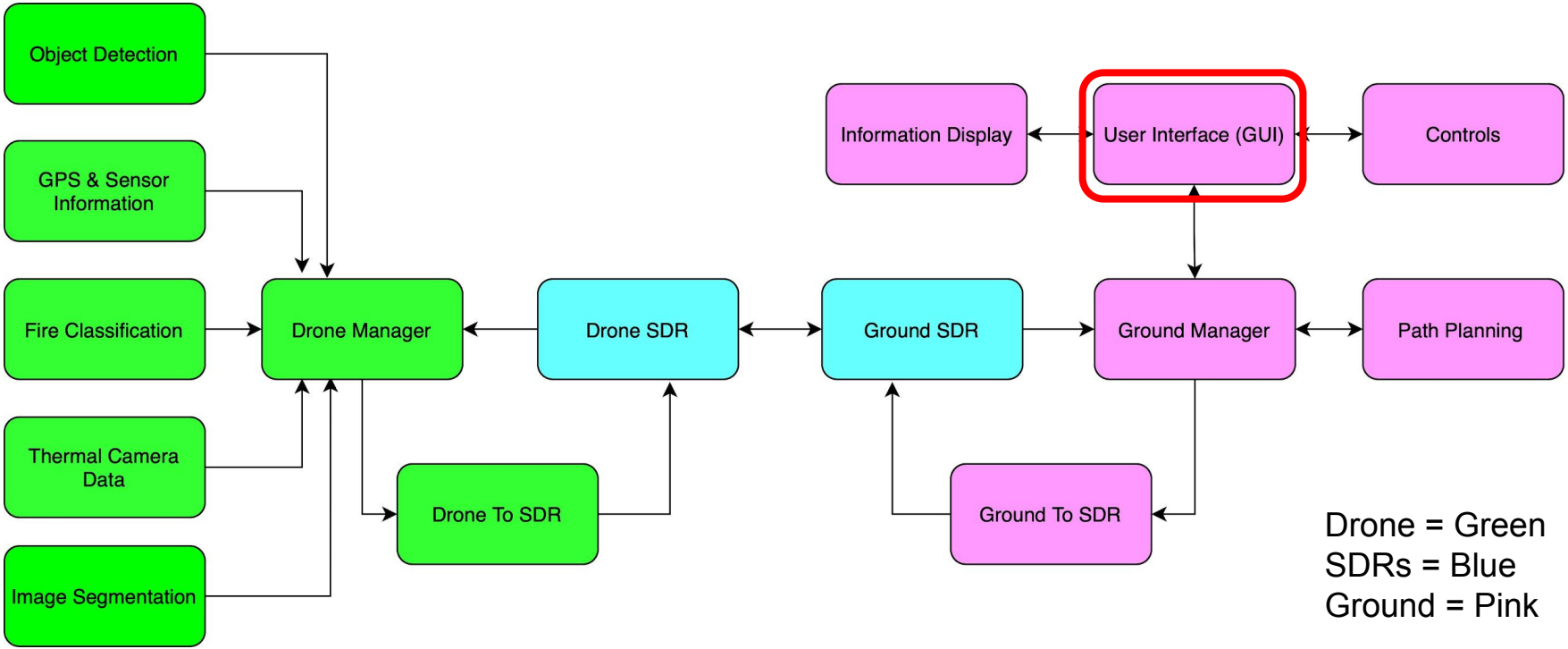


Architecture

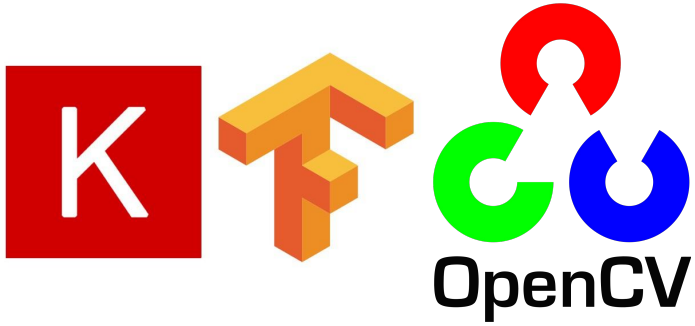


Implementation

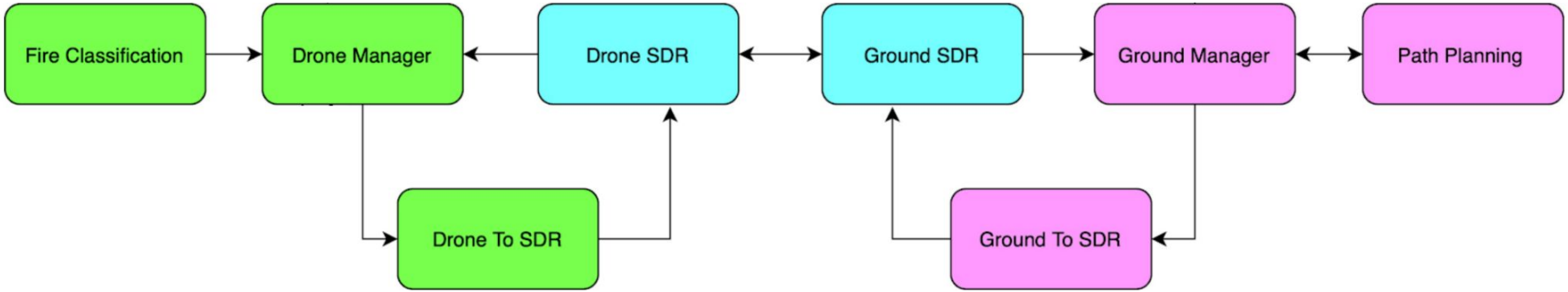
- **Drone System**
  - Run AI models
  - Gather info from sensors
  - Pass it to the SDR
- **SDRs**
  - Relay information
  - Working with the Electrical Engineers
- **Ground System**
  - Display info
  - Present user with drone System Controls

Implementation

- **Python and OpenCV**
- **Front-end**
  - Tkinter
- **Back-end**
  - Classification
    - Tensorflow
    - Keras
  - Object Detection
    - Darknet/YoloV3
  - Segmentation
    - U-Net



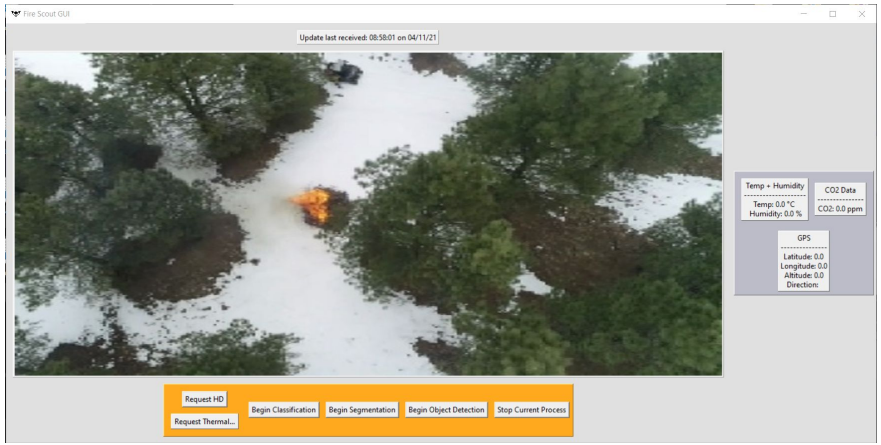
Prototype

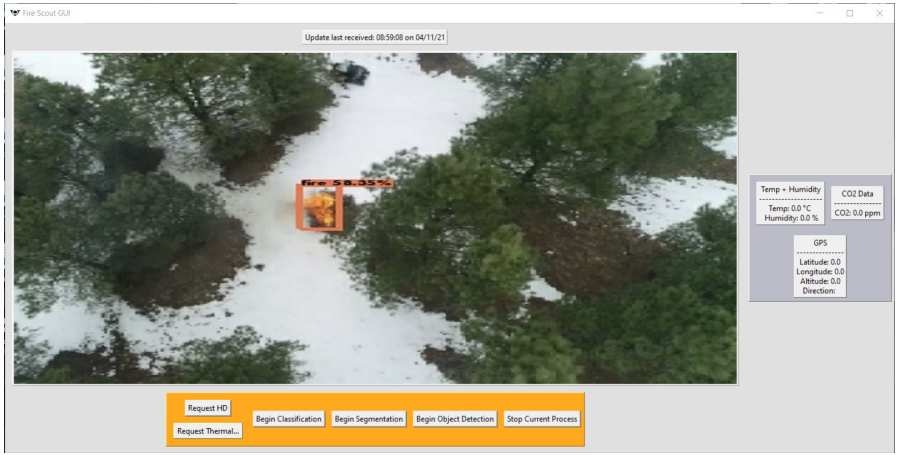

Fire Classification
Drone Manager
Drone SDR
Ground SDR
Ground Manager
Path Planning
Drone To SDR
Ground To SDR

Prototype

Drone Processes Image

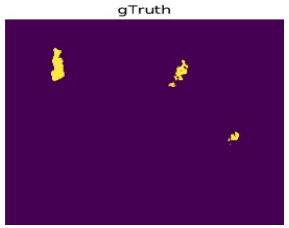
- Object Detection
  - Detection based on patterns

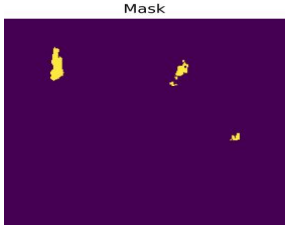




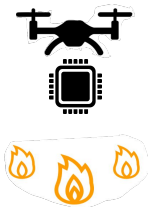
Prototype

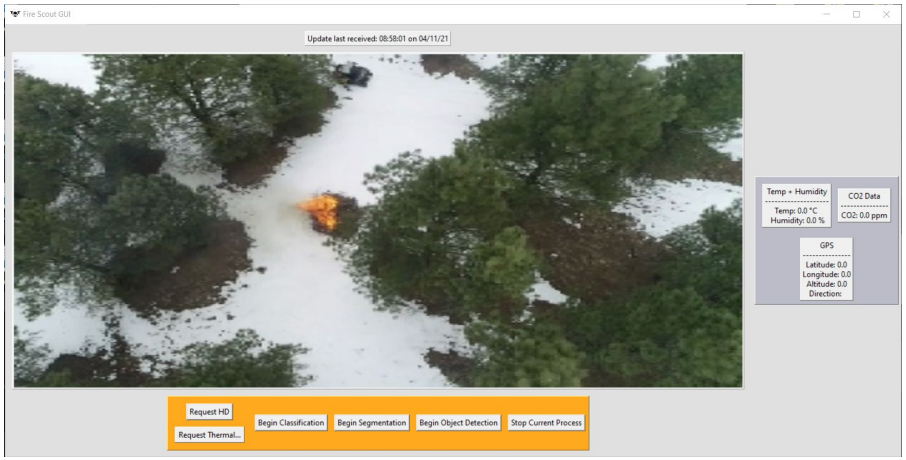
- Segmentation
  -Binary pixel level detection

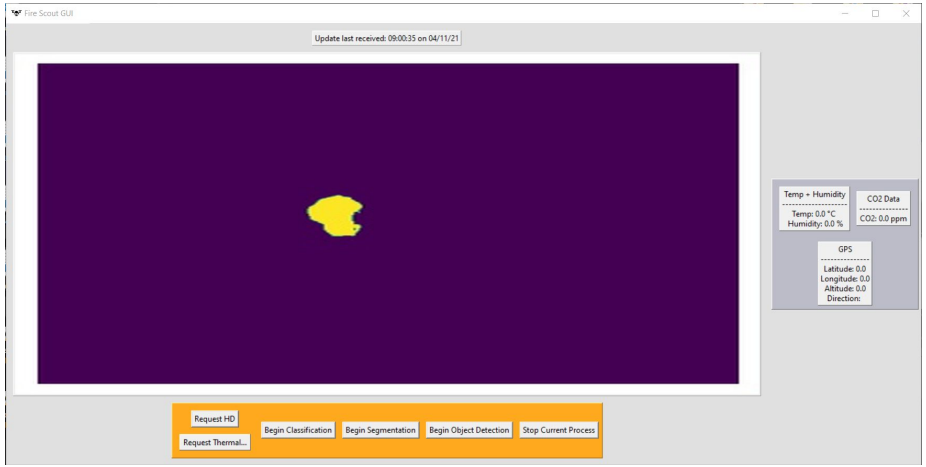




Drone Processes Image



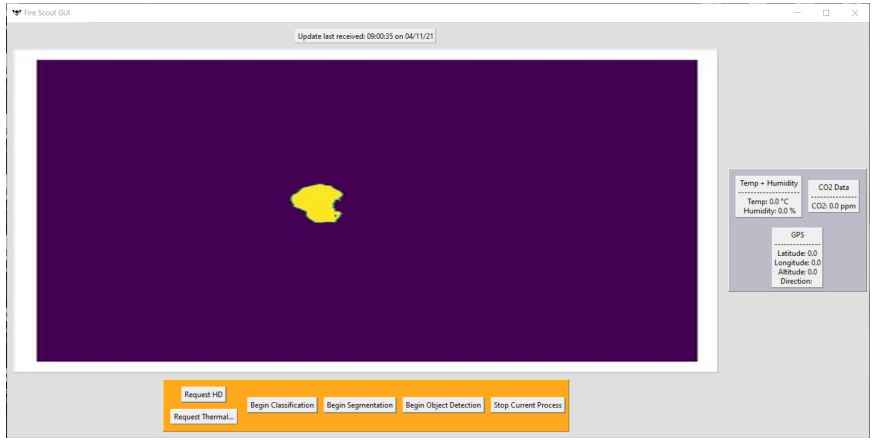


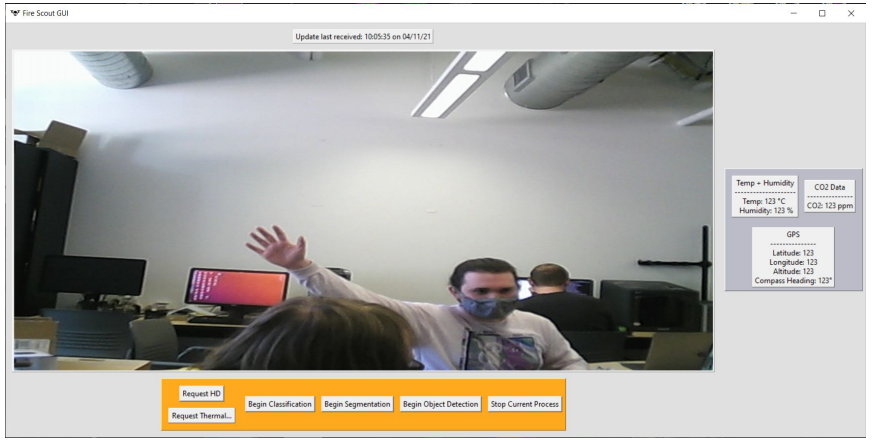


Prototype

- HD Capture

Drone Takes
HD Snapshot

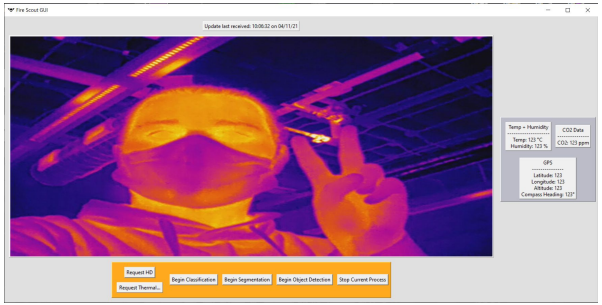


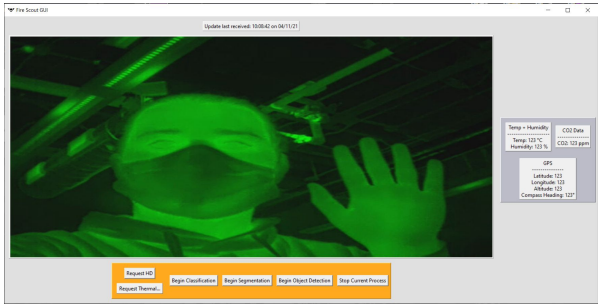


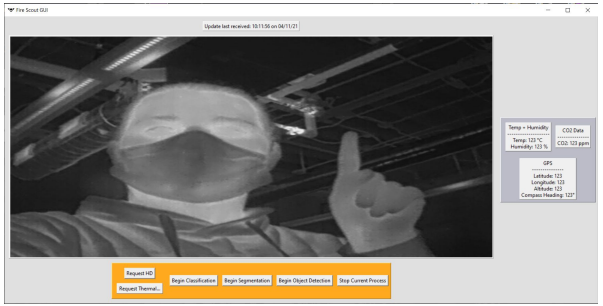
Prototype

Drone Takes
Thermal Snapshot

- Thermal



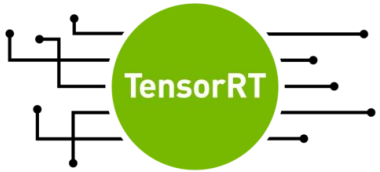




Challenges & Solutions

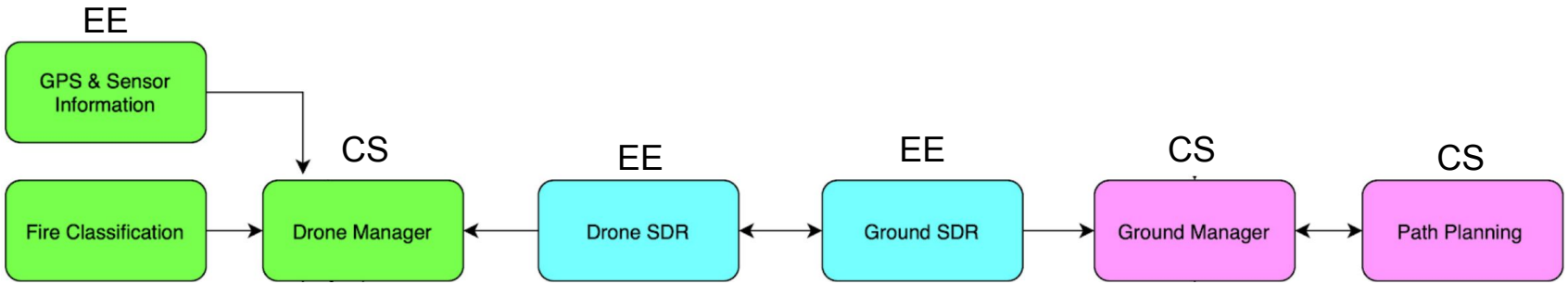
- Nvidia Jetson Nano
  - Converting models to Nvidia Jetson Nano
  - Different versions (Python, Tensorflow)
  - Lack of documentation
- SDR pipeline

- TensorRT
- Custom Models
- Reducing Model Sizes
- Virtual Environments
- Working With EE To Optimize Integration

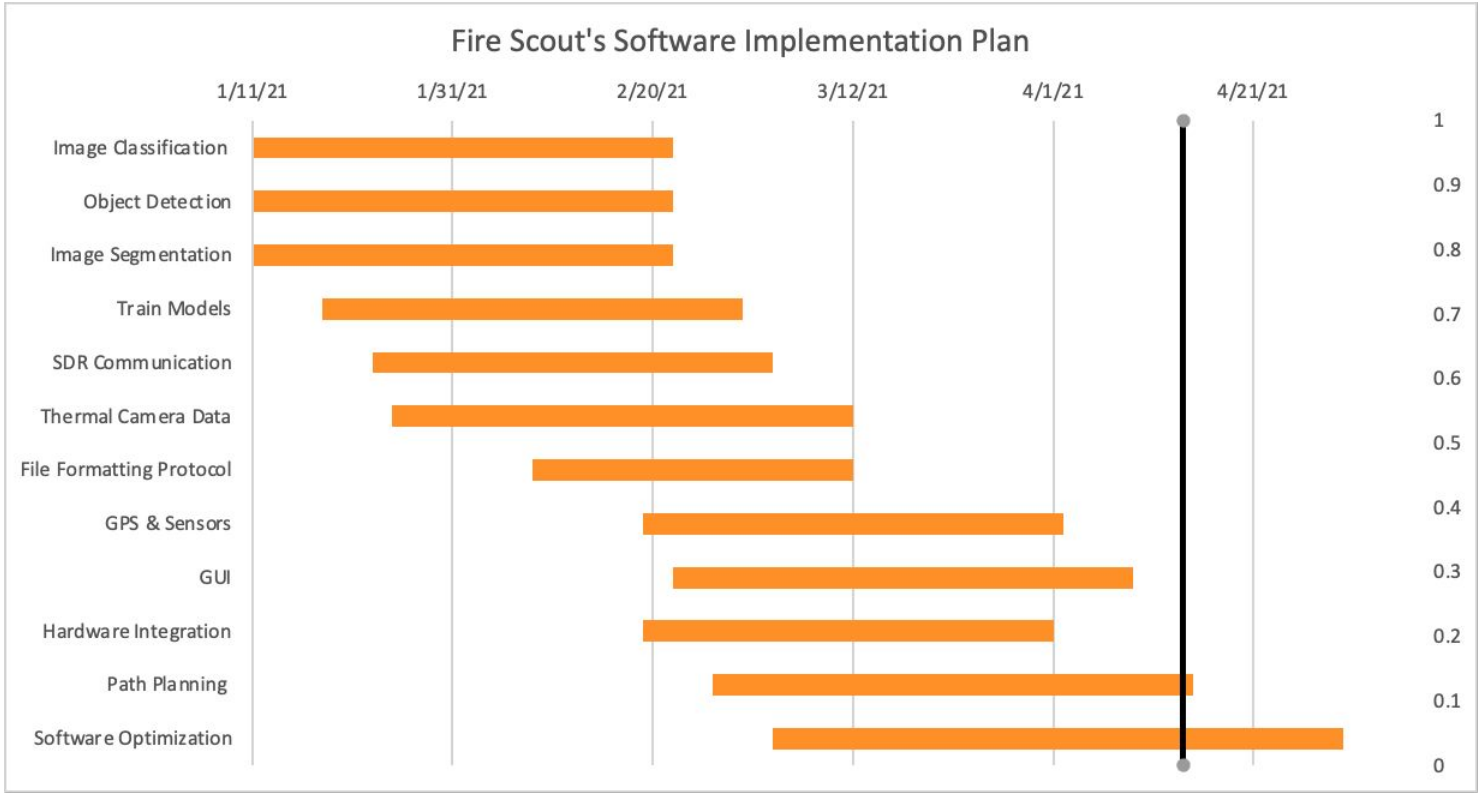


Testing Plan

- Unit Testing the classes sent through the SDR
  - Used by CS and EE
- Integration and System testing
  - CS's modules "integrate" through EE's modules
  - EE Dependent
- Usability Testing



Schedule


Fire Scout's Software Implementation Plan
1/11/21
1/31/21
2/20/21
3/12/21
4/1/21
4/21/21
Image Classification
Object Detection
Image Segmentation
Train Models
SDR Communication
Thermal Camera Data
File Formatting Protocol
GPS & Sensors
GUI
Hardware Integration
Path Planning
Software Optimization
1
0.9
0.8
0.7
0.6
0.5
0.4
0.3
0.2
0.1
0

Future Work

- AI Models
  - Improved models
  - Different frameworks
  - More datasets
  - Improved metrics
- System Architecture
- Utilize Jetson Nano’s GPU with TensorRT

Conclusion

- Fires kill and need to be fought in a unique ways
- Fire Scout saves lives and fights fires in a modern way
  - Drone System & Ground System
  - Emphasis on future developers
- Implementation of the requirements = 85%
- Project Impact
  - Project value
  - Clients overall feeling of the project

Sources

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