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# Aerial Pathfinding Reconnaissance

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# Background

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Observation: Autonomous vehicles suffer from a variety of issues:

- Ground vehicles rely heavily on expensive sensors.
- Aerial drones lack meaningful capacity.

Solution: Combine strengths with a hybrid approach.

# Overview

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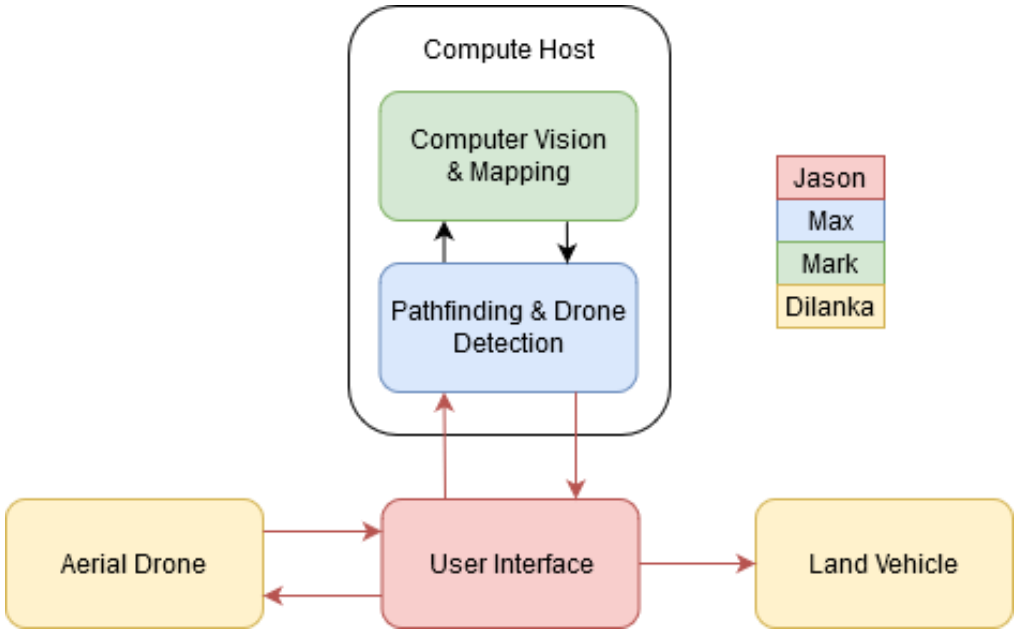
To prototype this relationship, we have developed this architecture:

Four distinct elements

- Aerial drone
- Land drone
- User interface
- Compute host




Goal: Use aerial recon to navigate an otherwise-blind vehicle.

# Data Collection & Drone Control

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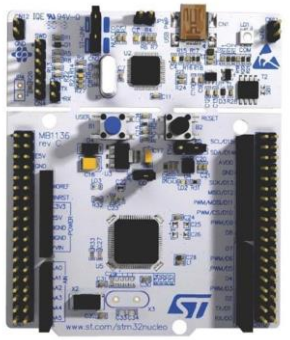
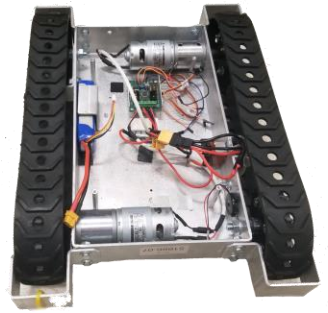
- Microcontroller
  - Use stm32 to control Pixhawk flight controller and onboard mapping sensors.
  - Subsystem will gather telemetry and imaging data to relay to desktop application.
  - Using ArduPilot Mission Planner to monitor drone and set path.
  - After processing Land drone will follow path.

Ultrasonic sensors for object avoidance



stm32 Nucleo with to Pixhawk controller

# Computer Vision & Mapping

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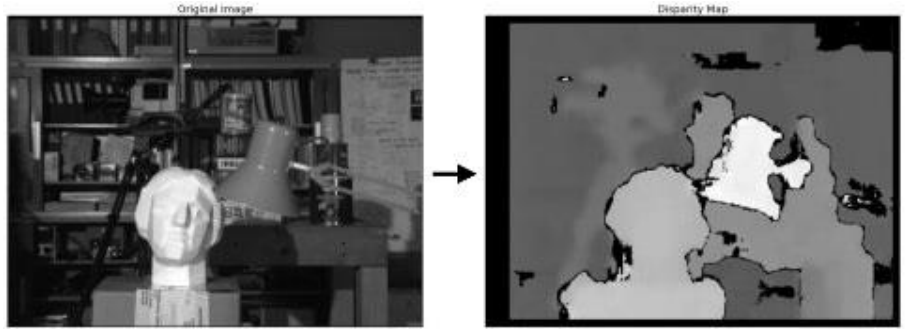
Four step approach:

1. Filter out moving objects
2. Infer depth from stereographic views
3. Derive an elevation differential field
4. Delineate obstacles by vehicle parameters


Focus is on *avoiding* a pure ML solution. Why?

- Reduces runtime compute cost
- Allows for configurability

  (No black-box design!)






*Images adapted from OpenCV documentation*

# Pathfinding & Drone Detection

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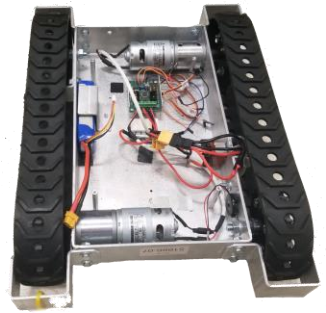
- Input Boolean map
- Input Color Image
- Search image for drone and decide distances of indices
- Design greedy algorithm to specify path taken by drone
- Use specified path to send drone instructions for land movement

| | | | |
|---|---|---|---|
| 1 | 1 | 0 | 1 |
| 1 | 1 | 1 | 0 |
| 1 | 0 | 1 | 0 |
| 0 | 0 | 1 | 1 |



Why greedy algorithm?

- Save runtime cost of program

# Device Networking & UI

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- UI integrated into desktop application
- Communication through wireless local area networks
- Optional utilization of TAMU GPU servers

# Execution & Validation Plans

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- Execution plan divided into week by week milestones
- Unit tests created for validation plan

| Subsystem | Week 7<br>5-Oct-20 | Week 9<br>19-Oct-20 | Week 11<br>2-Nov-20 | Week 14<br>23-Nov-20 |
|---|---|---|---|---|
| Data Collection & Drone Control<br><br>Dilanka | Finalize and order parts | Aerial and land drones built | Data retrieval from aerial drone | Autonomous drone flight |
| Computer Vision & Mapping<br><br>Mark | Estimate depth on path sections | Merge depth estimates with map | Derive gradient field from elevation map | Implement obstacle delineation |
| Pathfinding & Drone Detection<br><br>Max | Increased python coding skills | Error handling for path detection | Program movement of land drone | Land drone path mapped and instructions created |
| Device Networking & UI<br><br>Jason | Basic client/server interaction | Flight mapping functionality | Communication with drone servers | Package software/create installer |



**High-level milestones adapted from Execution Plan*

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# Questions?