TEXAS A&M UNIVERSITY
Engineering

Aerial Pathfinding Reconnaissance
Status Update

Jason Gilman, Max Griffith, Mark Johnson, Dilanka Weerasinghe

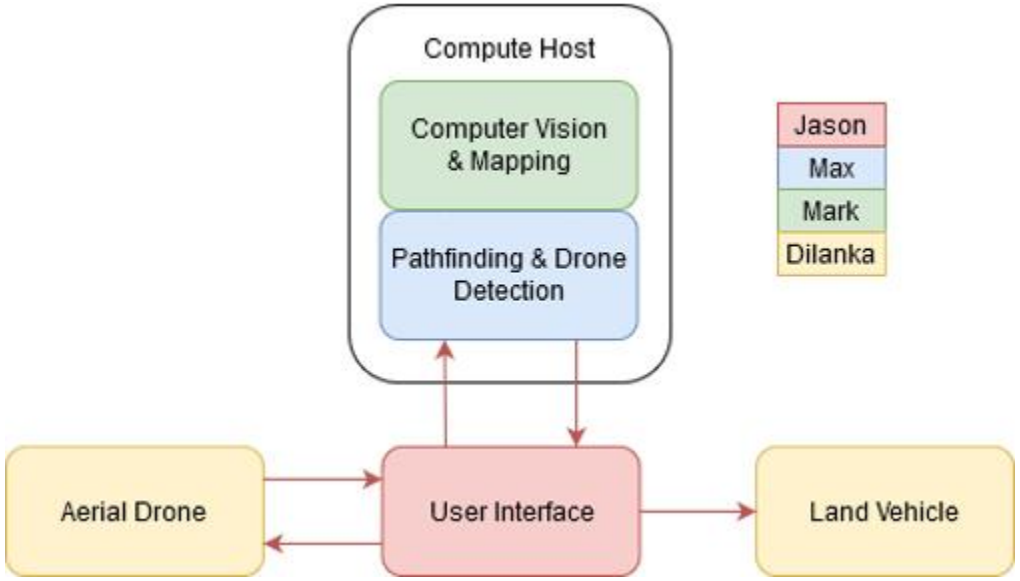
Overview

TEXAS A&M UNIVERSITY Engineering

Goal: Use aerial drone footage to find a safe path for a land vehicle.

Team Members and Responsibilities:

- Dilanka Weerasinghe *(Data Collection & Drone Control)*
  - Automated drone control and collection of aerial footage
- Mark Johnson *(Computer Vision & Mapping)*
  - Production of an obstacle map from drone videos
- Max Griffith *(Pathfinding & Drone Detection)*
  - Determination of vehicle starting location and route
- Jason Gilman *(Device Networking & UI)*
  - Creation of user interface and network interconnect



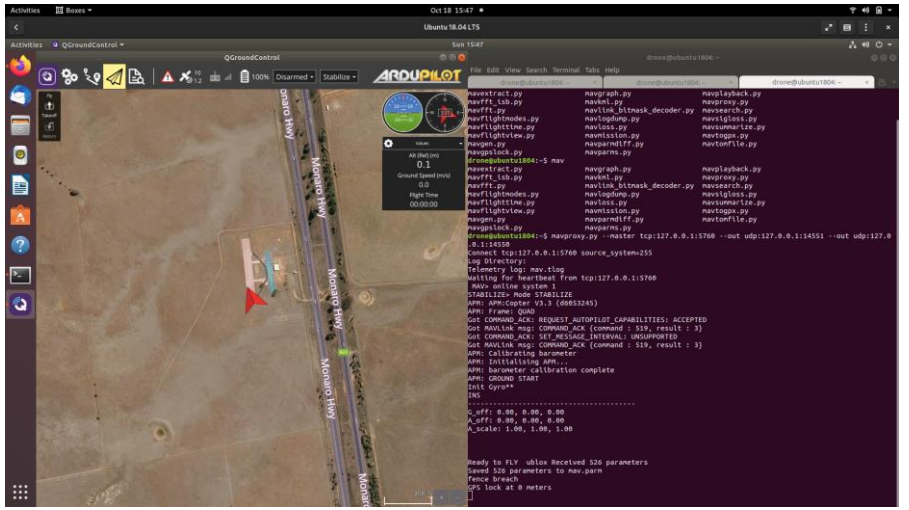
System Block Diagram

Data Collection & Drone Control

TEXAS A&M UNIVERSITY Engineering

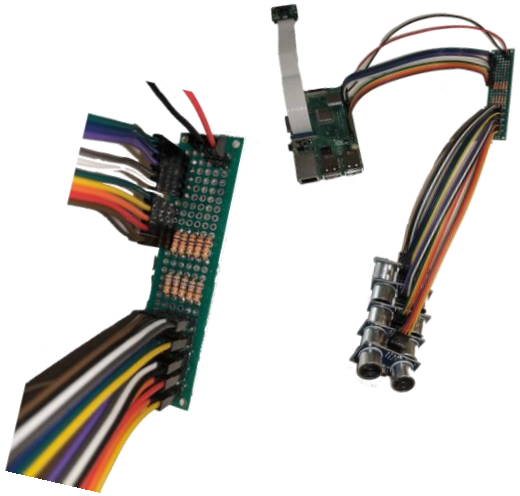
Stages Complete:

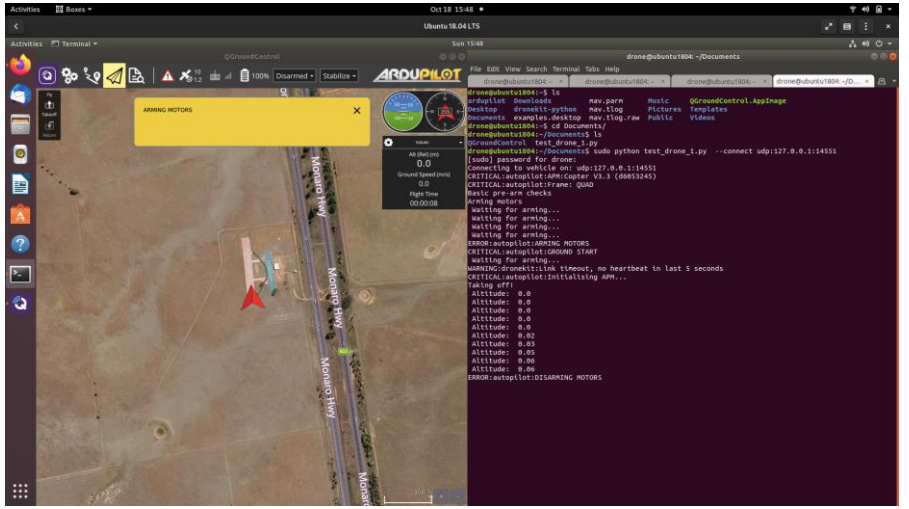
- Stand alone electronics
  - Programmed individually and working
  - Preboard header for sensors working with all sensors.
  - PiCam records interval video and records to a datasheet with video name and time; working on gathering location data from the drone.
- Drone
  - Drone simulator Running
  - Program will arm drone and perform safety check
  - Can monitor drone SITL at time intervals



Stages Remaining:

- Fix simulation issues with GPS location
- Mount sensors to the drone
- Integrate data collection into Waypoint program.





Computer Vision & Mapping

TEXAS A&M UNIVERSITY Engineering

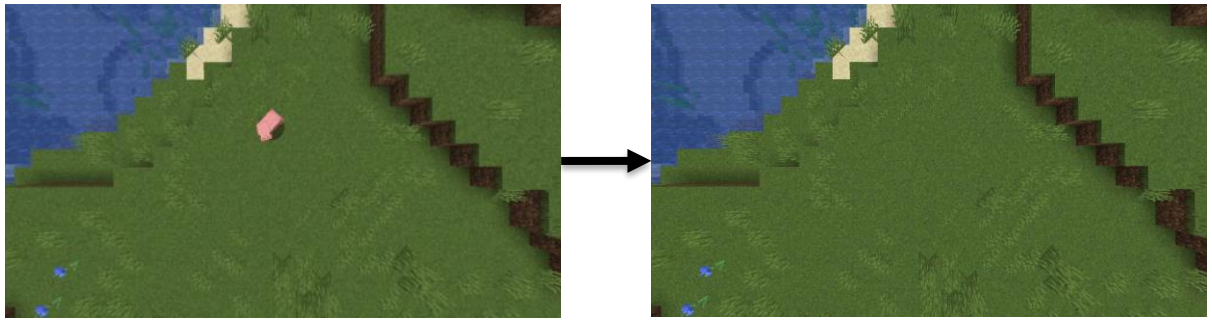
Stages Complete:

- Moving Object Removal
  - Working as intended.
- Image Stitching
  - Requires more data points than we want to take.
  - Workaround: Leverage assumptions about the path.
- Depth Map Inference
  - Likely need to tweak parameters depending on data.
  - Workaround: Provide user an interactive way to do so.

Stages Remaining:

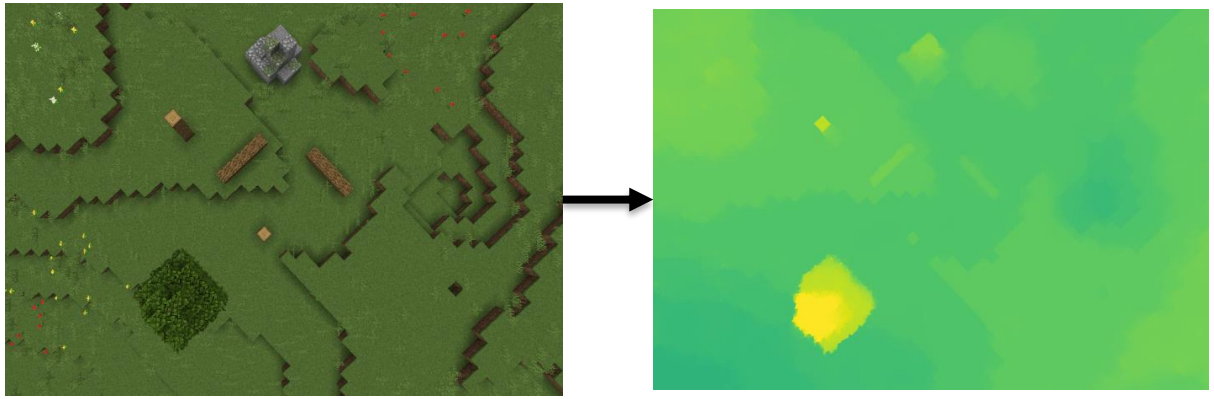
- Depth Map Stitching
  - Most important (and difficult) stage of the pipeline
- Gradient Field Derivation
- Obstacle Delineation

Demo: Moving Object Removal



Input Video | Output Image

Demo: Depth Map Inference



Input Image (Left Eye View) | Output Depth Map

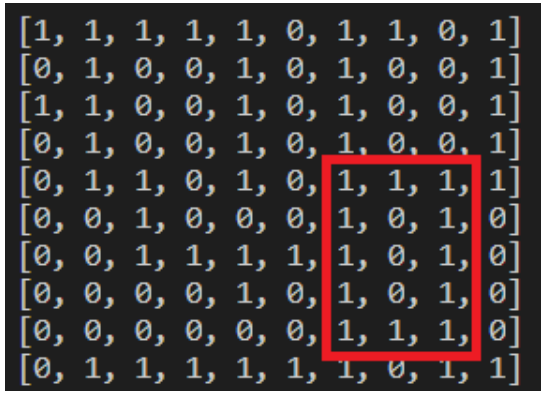
Pathfinding & Drone Detection

TEXAS A&M UNIVERSITY Engineering

Stages Complete:

- Finding straightforward path
  - Working as intended
  - Paths not taken for final path are marked as invalid (0)
- Edge cases and error handling
  - Edge cases such as finding cycles have been fixed (infinite loops)
  - Errors such as invalid start/end locations and impossible paths

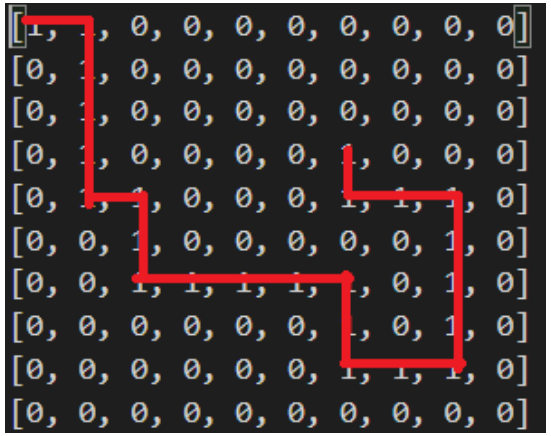
Cyclic Path:



Stages Remaining:

- Program movement of drone
  - Giving instructions to the drone to follow
- Programming drone path from a map input
  - Bulk of project, formatting the map input for the algorithm
    - This means creating a new "pixel" of size drone dimension from an area of map pixels

Cyclic Path Solved*:



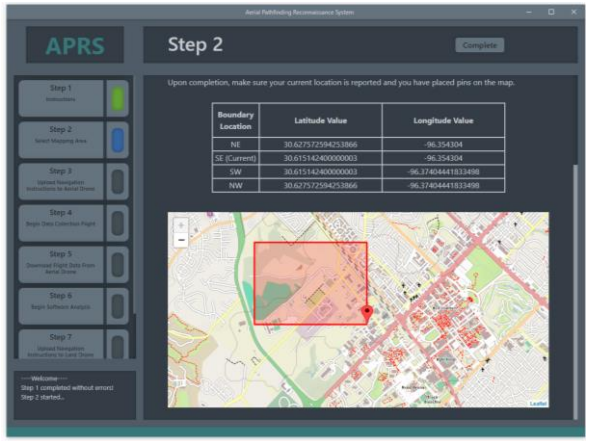
*The starting location is [0,0] and the ending location is [3,6]

Device Networking & UI

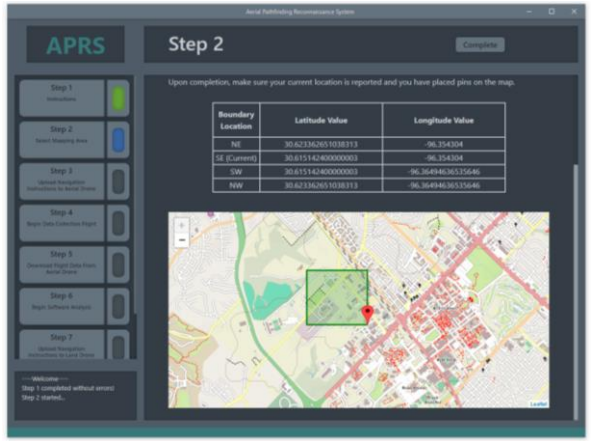
TEXAS A&M UNIVERSITY
Engineering

Stages Complete:

- Desktop application architecture and UI logic
  - React Front-end compiled into .exe format
  - Python Back-end for serving assets and software analysis functions
  - User input standardization, error handling, and status updates for each stage of the system
- Area of operation mapping functionality
  - User plots area to be mapped by the aerial drone
  - Creates navigation instructions for aerial drone using Lat-Lng-Elevation waypoints



Mapping functionality: invalid area



Mapping functionality: valid area

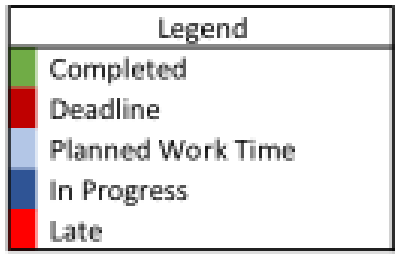
Stages Remaining:

- Implement server architecture on aerial and land drones
- Establish communication between desktop app and drones

Execution Plan

TEXAS A&M UNIVERSITY
Engineering

Milestone	Assigned To	Week 1 24-Aug-20	Week 2 31-Aug-20	Week 3 7-Sep-20	Week 4 14-Sep-20	Week 5 21-Sep-20	Week 6 28-Sep-20	Week 7 5-Oct-20	Week 8 12-Oct-20	Week 9 19-Oct-20	Week 10 26-Oct-20	Week 11 2-Nov-20	Week 12 9-Nov-20	Week 13 16-Nov-20	Week 14 23-Nov-20
Understand Project	All														
Initial planning/research	All														
Draft Conops Report	All														
Source Lab Materials (Drone/Sensors)	All														
Draft FSR Report	All														
Draft ICD Report	All														
Draft Exection Plan	All														
Draft Validation Plan	All														
Prepare Midterm Presentation	All														
Design Server-Side Architecture	Jason														
Remove Moving Obstacles from Data	Mark														
Increase familiarity with Python	Max														
Implement Sever-Side	Jason														
Map Environment from Data	Mark														
Create algorithm for valid accessible path	Max														
Research/Order Parts	Dilanka/Jason														
Create error handling for inaccessible path	Max														
Implement Client-Side/UI	Jason														
Estimate Depth on Path Sections	Mark														
Research Drone SDK / stm32 / Sabretooth	Dilanka														
Add flight mapping functionality	Jason														
Research software interaction with drone	Max														
Design Aerial/Land Electrical Schematics	Dilanka														
Program manual override of drone	Max														
Testing Electrical Off Drones	Dilanka														
Merge Depth Estimates with Map	Mark														
Build Air Drone	Dilanka														
Build Land Drone	Dilanka														
Prepare Status Update Presentation	All														
Implement Server on drone	Jason														
Test Flight of Air Drone	Dilanka														
Normalize Depth Field for Drone Altitude	Mark														
Program movement of drone	Max														
Test Travel of Land Drone	Dilanka														
Communicate with server on drone	Jason														
Derive Gradient Field From Elevation Map	Mark														
Program: Data Retreival of Air Drone	Dilanka														
Test Drone Simulation Programs	Dilanka														
Test Data Retreival From Drone	Dilanka														
Implement Obstacle Delineation	Mark														
Program drone path from map input	Max														
Package Software/Create Installer	Jason														
Prepare Final Presentaion	All														
Test and modify Air system	Dilanka														
Program: Autonomous Flight of Air Drone	Dilanka														
Draft Final Report	All														
Prepare Final Demo	All														



Validation Plan

TEXAS A&M UNIVERSITY
Engineering

Legend	Complete	Incomplete

Subsystem	Test	Deadline	Status
Data Collection and Drone Control	Aerial Drone flies from Point A to Point B	8-Nov	
	Drone stops at midpoint locations on the map and records video and GPS location	8-Nov	
	Drone stops at user shutoff switch	15-Nov	
	Land Drone Moves	2-Nov	
	Drone detects obstacles in front view using Ultrasonic Sensors.	31-Oct	
	Electrical Systems Connected without Error	23-Oct	
	Drones Built and Power on	27-Oct	
Computer Vision and Mapping	Removes moving objects from videos to produce still frames of path sections	27-Sep	
	Produces a single image map of the environment from overhead views	4-Oct	
	Infers depth of a path section from an overhead stereographic perspective	11-Oct	
	Merges individual depth maps into a single depth map of the whole environment	25-Oct	
	Normalizes depth fields for altitude	1-Nov	
	Derives a gradient field from a height map	8-Nov	
	Delineates obstacle boundaries from an elevation gradient field	15-Nov	
Pathfinding and Drone Detection	Greedy algorithm for traversable path gives a valid path given a valid input	4-Oct-20	
	Create error handling for an inaccessible path	7-Oct-20	
	Manual override of drone works by controller by controller	23-Oct-20	
	Drone can move given basic commands basic commands	1-Nov-20	
	Movement of drone given from algorithnically designed path	13-Nov-20	
Device Networking and UI	Communicate with server using HTTP methods (Postman)	31-Sep-20	
	Communicate with server through UI	8-Oct-20	
	Complete intuitive UI design	8-Oct-20	
	Plot flight endpoints and return to user	15-Oct-20	
	Communicate with drone's server using HTTP methods through UI	5-Nov-20	
	Install software via encapsulated windows installer	16-Nov-20	

Key Takeaways

TEXAS A&M UNIVERSITY
Engineering

Data Collection & Drone Control

- Hardware and software components are working well individually.
- Future tasks are largely focused on in-subsystem integration and testing.

Pathfinding & Drone Detection

- Algorithm and edge cases completed for drone pathing
- Next steps are to program drone without a map input and then with a map input.

Computer Vision & Mapping

- Depth inferencing is complete, and about as accurate as we hoped.
- Greatest challenge ahead is merging depth maps of path sections.

Device Networking & UI

- UI design and functionality completed
- Next steps are to establish communication between desktop app and drones.

TEXAS A&M UNIVERSITY
Engineering

Questions?