

An aerial photograph of a winding road through a desert landscape. The terrain is characterized by numerous red and orange rock formations, likely sandstone, with deep, weathered gullies and canyons. The road curves through the landscape, appearing as a thin, dark line against the lighter-colored earth. The overall scene is vast and rugged, with the colors of the rocks ranging from deep reds to bright oranges and yellows.

# Autonomous Path Planner for Aerial Photography

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# Project Outline



**Calculate UAV flight path for aerial photography**



**Reduce user interaction required to set up a flight mission**



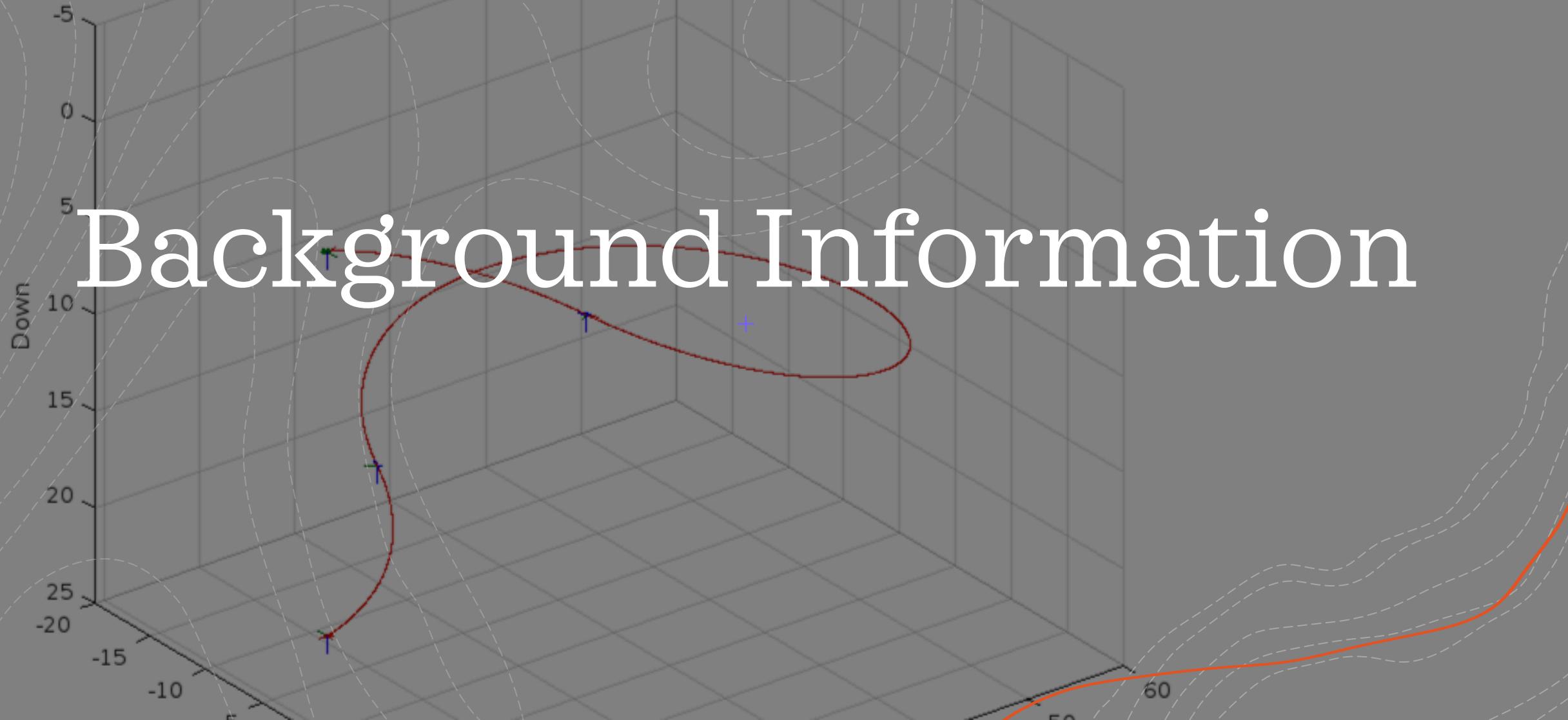
**Account for 3D (altitude changes)**



**Consider several environmental constraints**

- Path
- Transition Position
- Start Position
- Goal Position

# Background Information



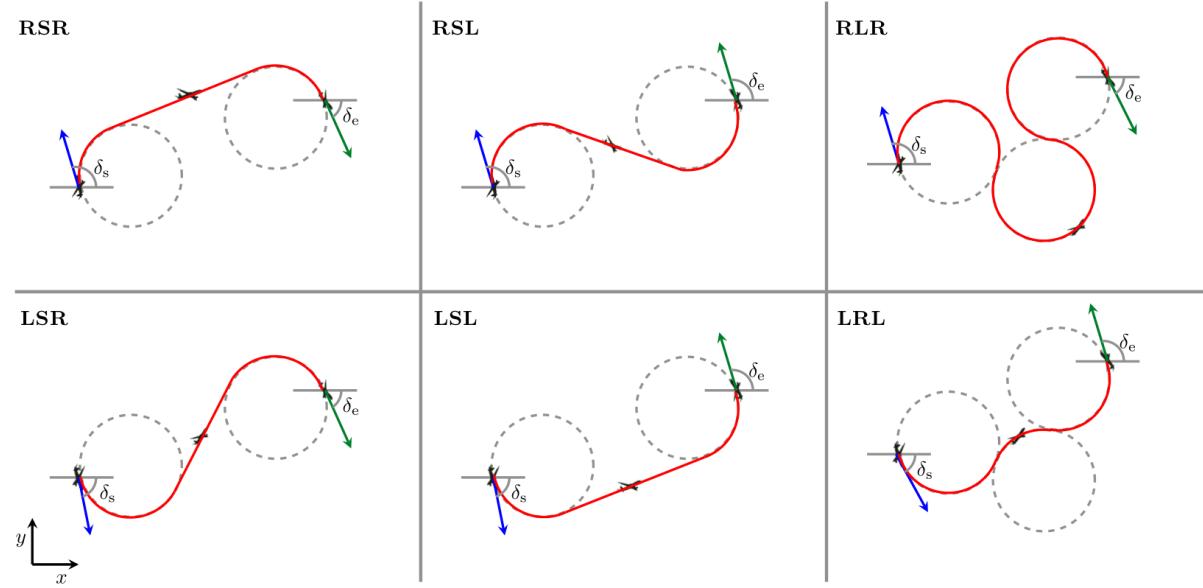
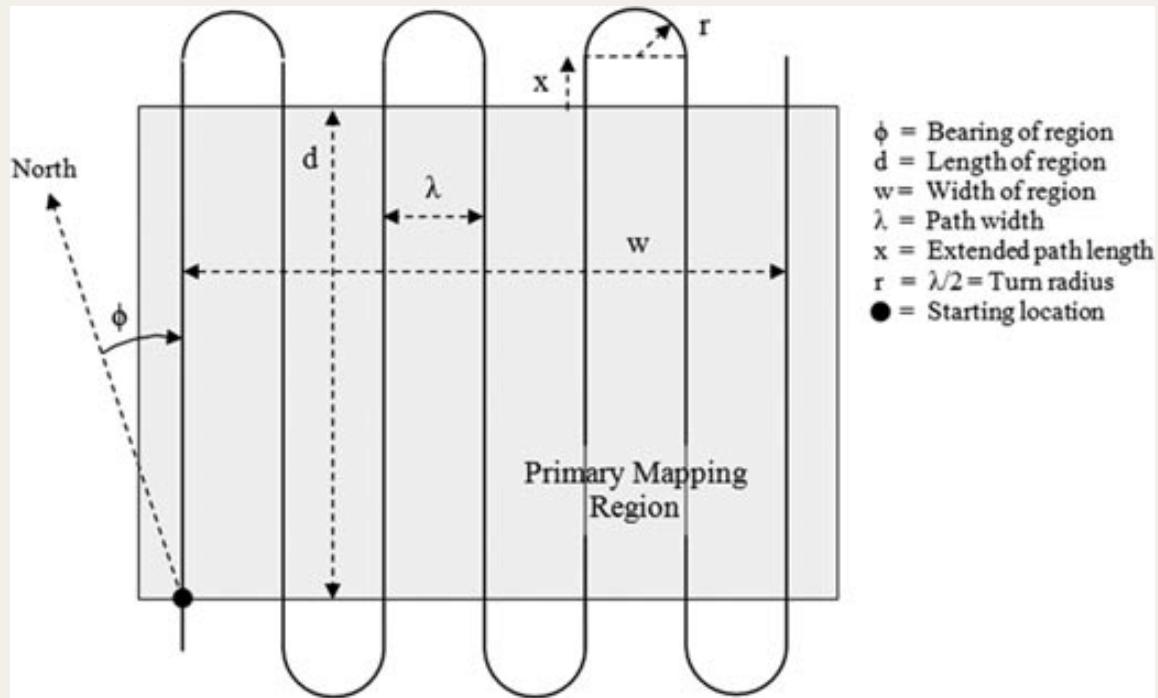
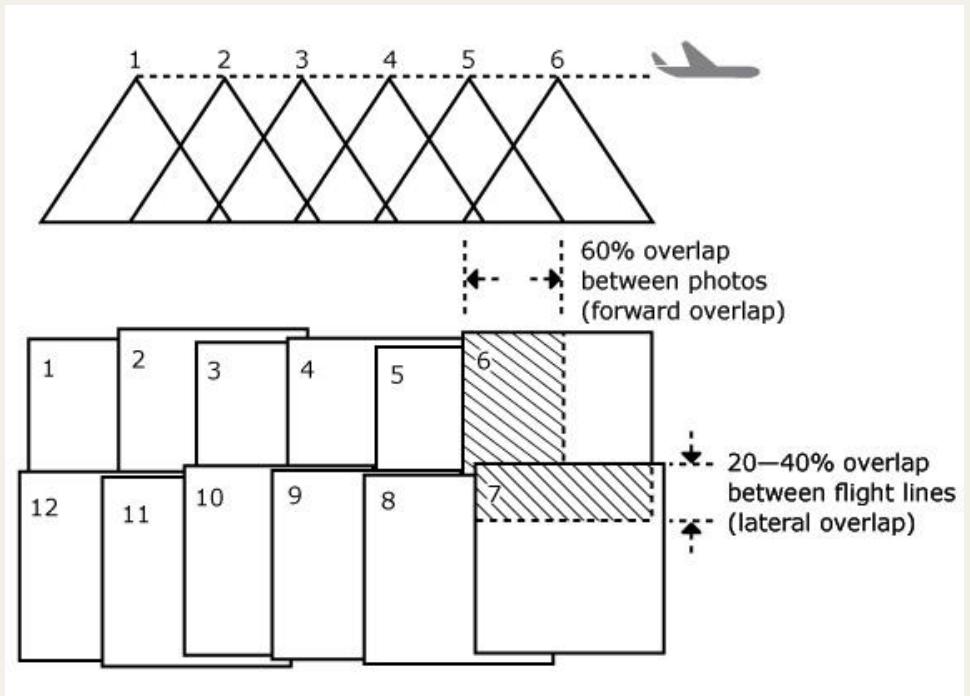
# Unmanned Aerial Vehicles (UAVs)

- + Small aircraft flown without onboard pilot, controlled remotely
- + Used in navigation, photo surveillance, combat, transportation etc.
- + Rotary-wing:
  - + Generate lift by forcing air downwards by rotating the wings
  - + Navigate tight environments
  - + Remain stationary mid flight
- + Fixed-wing:
  - + Generate lift via large wingspan & small propellor
  - + Can carry large payloads e.g. cameras for surveillance
  - + Longer battery life

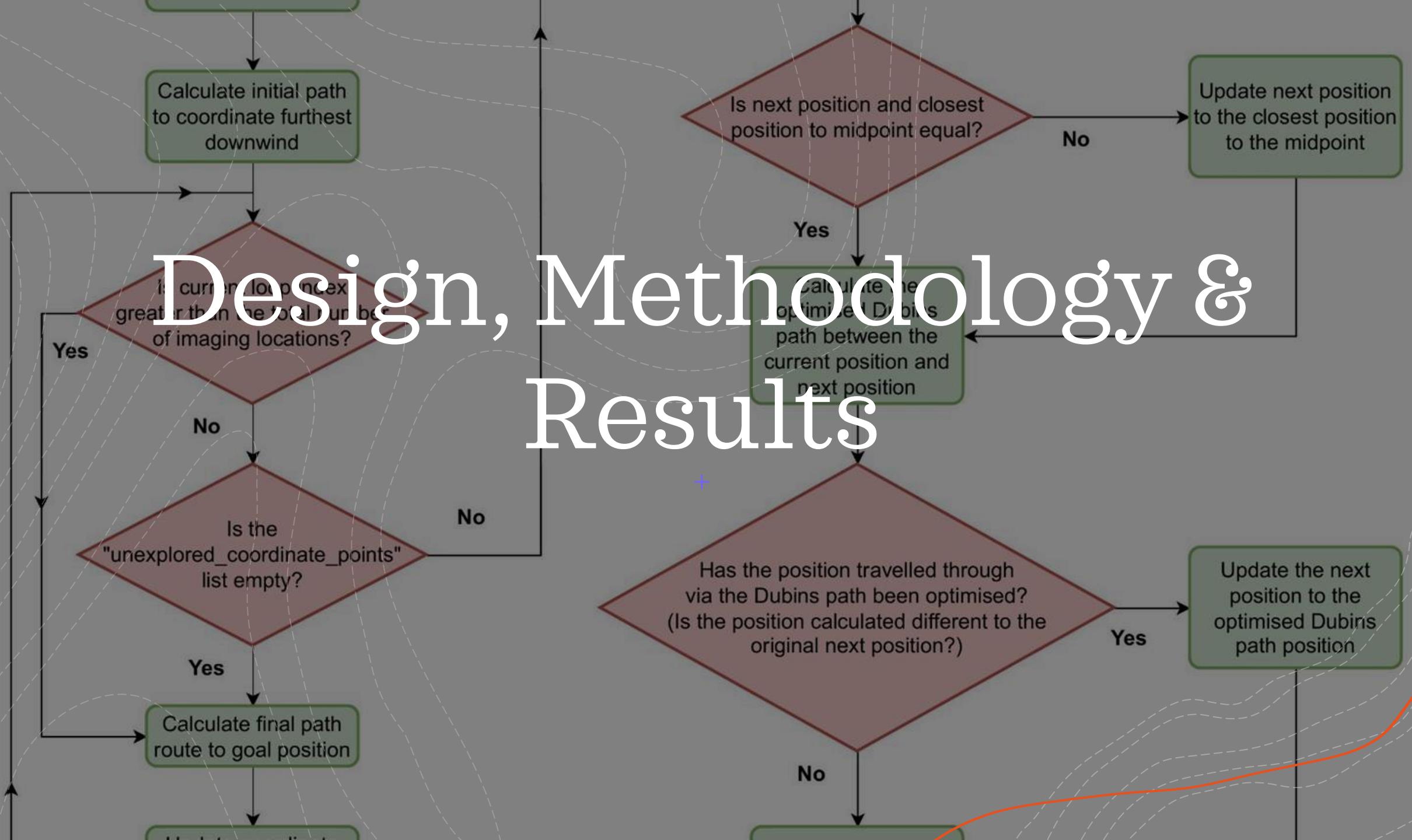


# UAV Path Planning

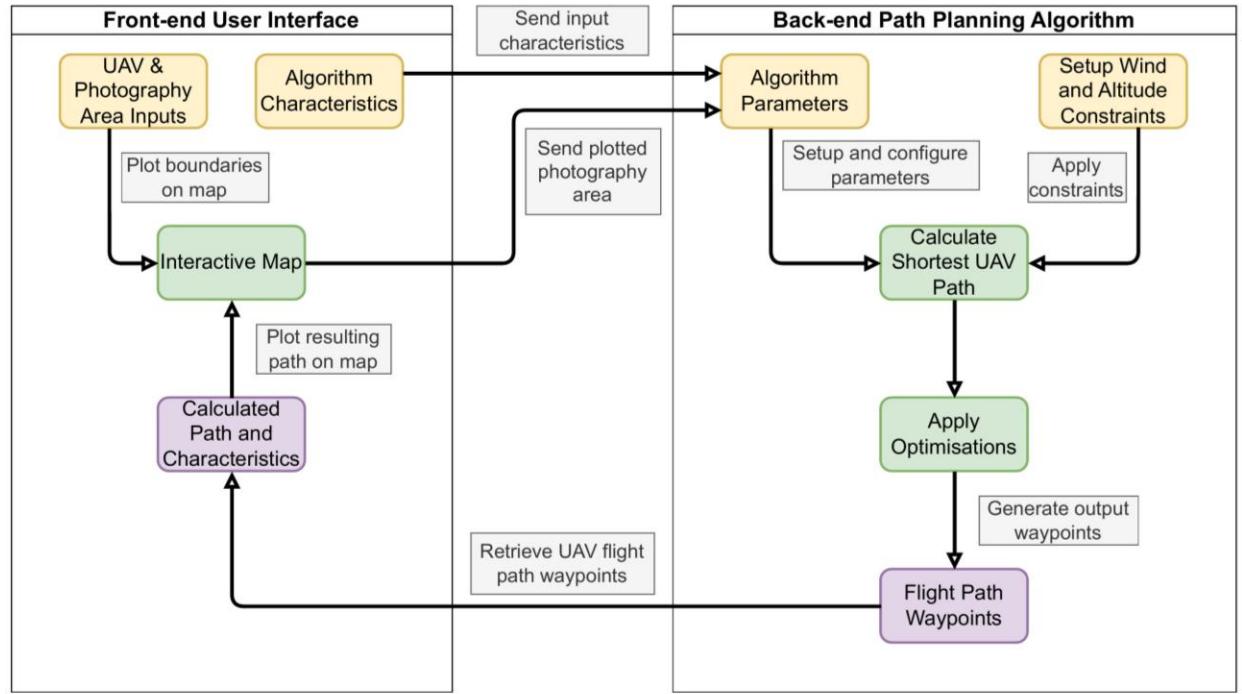
- + Lawnmower path shape
- + Dubins path turns
- + Image overlap requirements
- + UAV height AGL



# Design, Methodology & Results

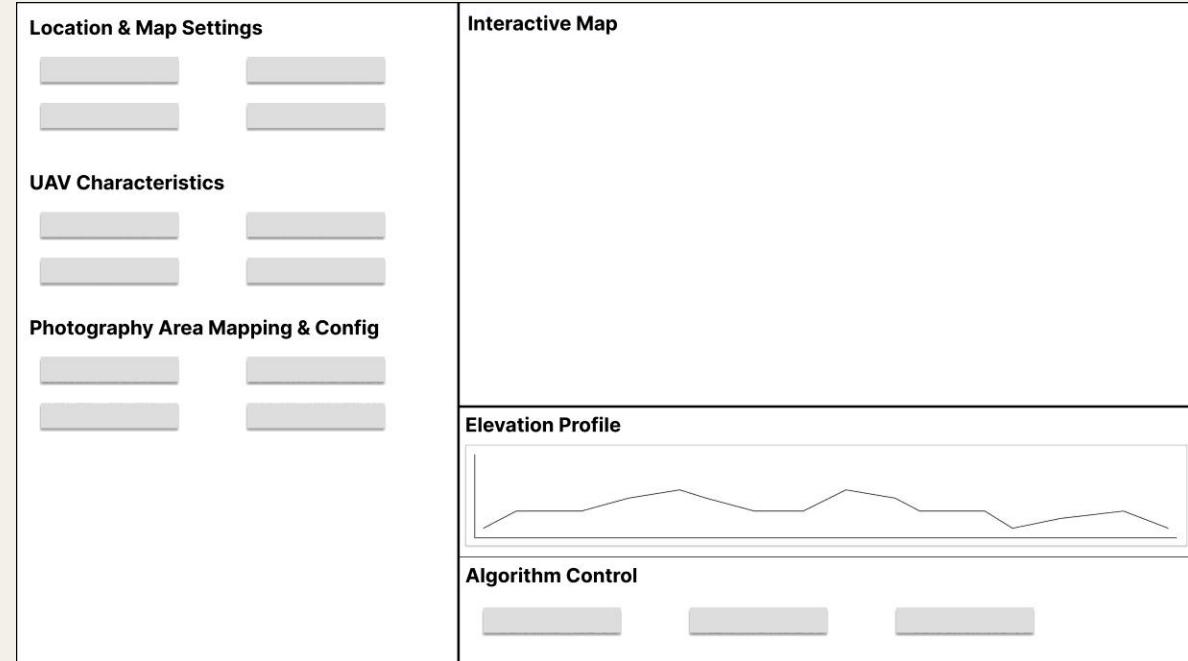


# Design Overview



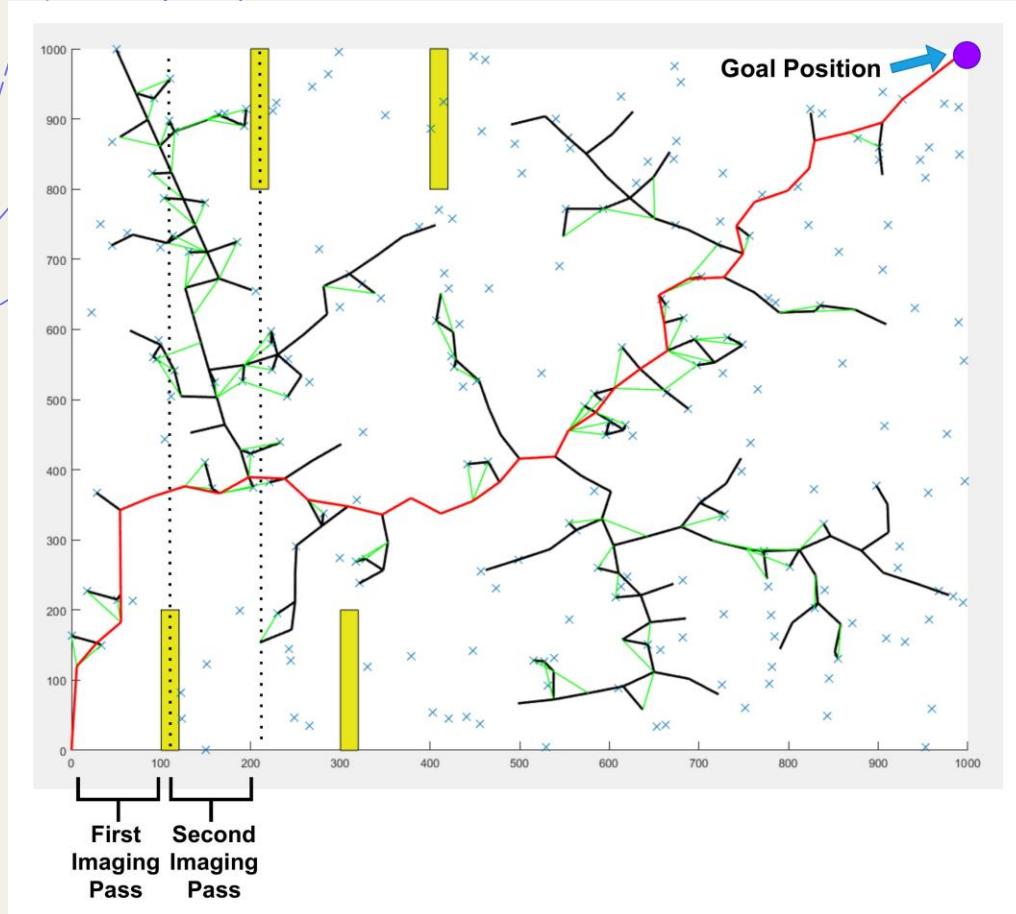
Key
Input
Output
Process

+ System Architecture

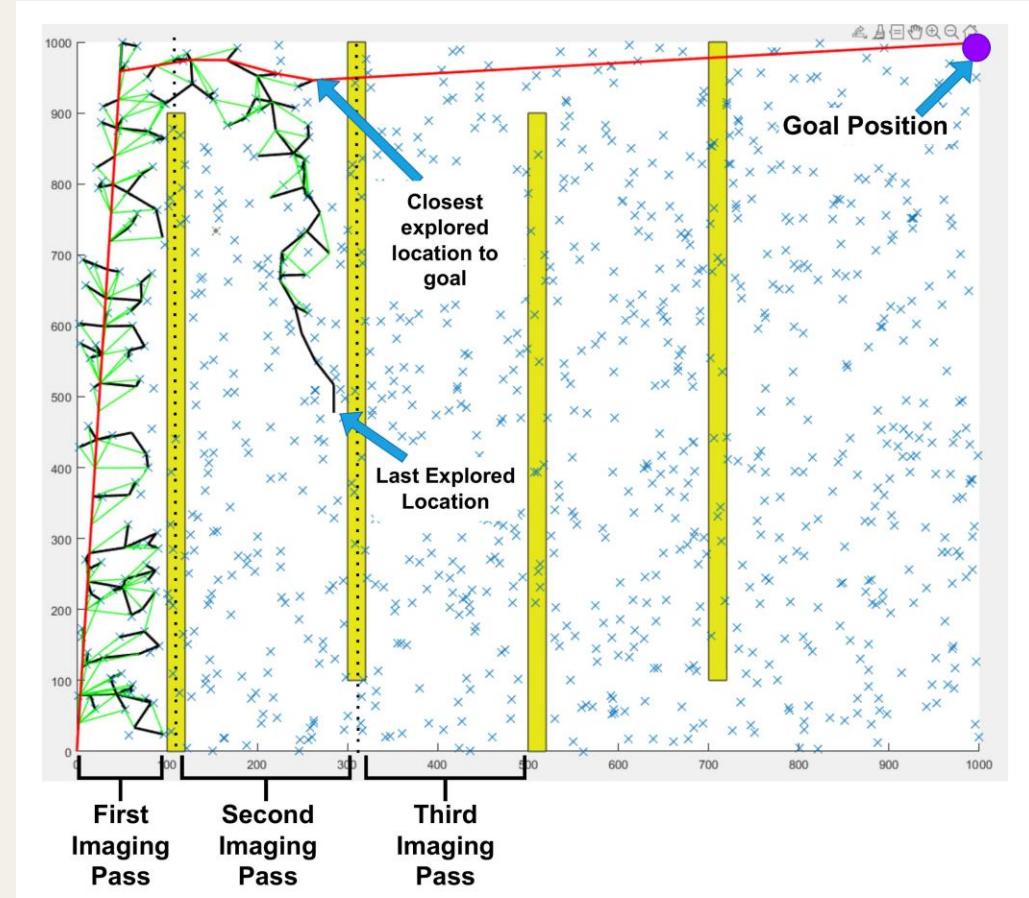


+ GUI Mockup

# Rapidly Exploring Random Tree (RRT)

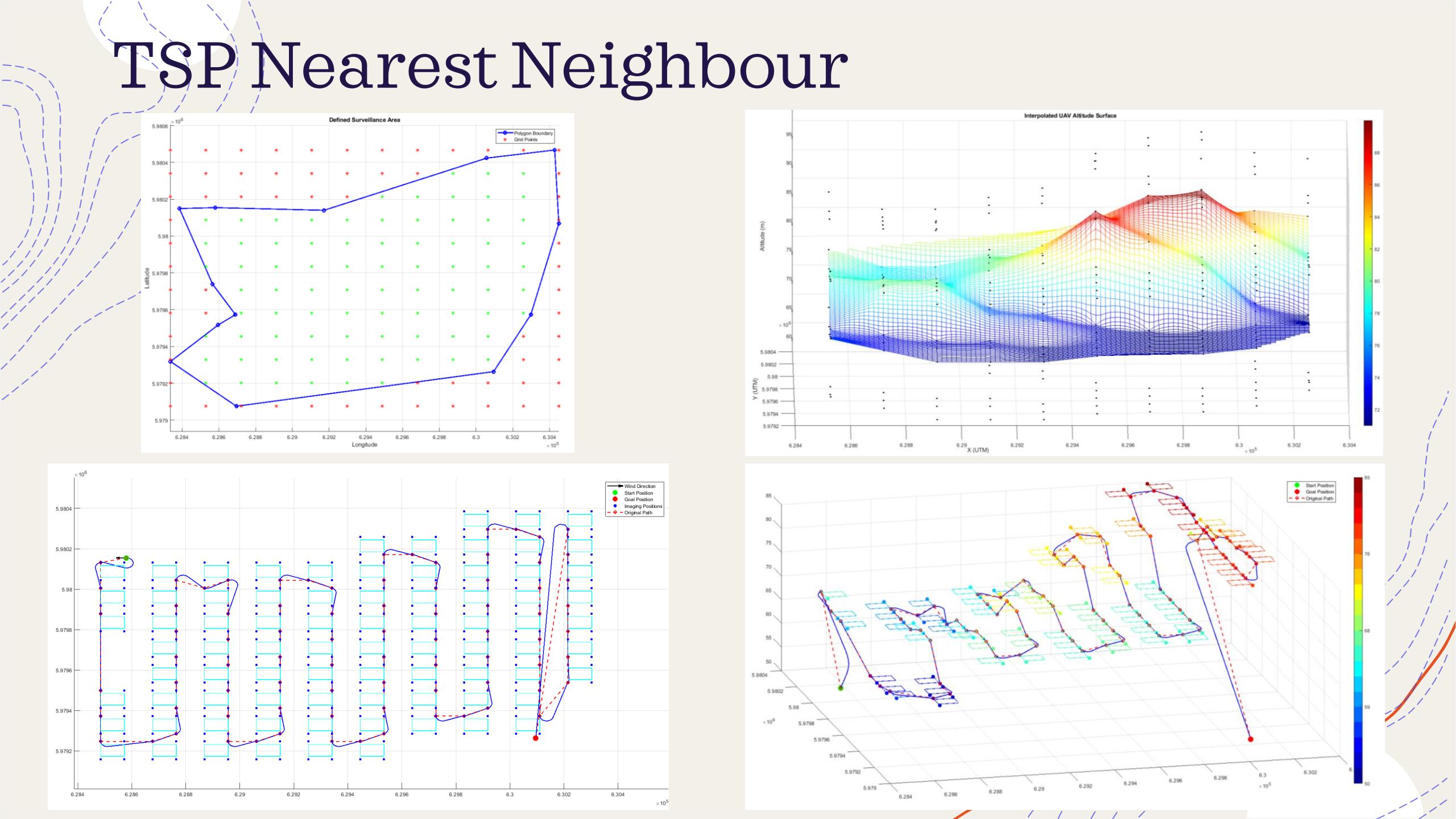


- + Short obstacles don't provide enough "guidance"



- + Long obstacles prevent algorithm from pathfinding

# TSP Nearest Neighbour



# User Interface & Mapping

Path Planner Application

**Location Search**

Search

**Map Tile Options**

Select Tile Layer:

OSM   Google   Satellite   Terrain

**Flight Parameters**

Select Wind Direction:

W

UAV Altitude Limits (Metres):

Min Limit: 20   Max Limit: 40

Set altitude limits

UAV Properties:

UAV Airspeed (m/s): 20   UAV Turning Radius (m): 70

Set UAV properties

**Drawing Modes**

Current Mode = none

No Mode   Draw Line   Draw Polygon

Clear

Save Polygon

0: (53.947460369143144, -1.0422321130927514)  
1: (53.95026378338647, -1.0316749384101342)  
2: (53.953256409544366, -1.0300226976569604)  
3: (53.953925617234646, -1.0262246896918725)  
4: (53.95463269293662, -1.022641258447976)  
5: (53.953710966881296, -1.0212250520881128)  
6: (53.95330691615983, -1.0200663377936792)  
7: (53.953774099452865, -1.0178776552375260)  
8: (53.95302912901773, -1.0171695520575952)  
9: (53.95076888303455, -1.0145731737311792)  
10: (53.94989758231619, -1.0145731737311792)  
11: (53.94887472781014, -1.0154100229438257)  
12: (53.9486059539213535, -1.016439912055444)  
13: (53.94825595179507, -1.0189934541877221)  
14: (53.94759928149338, -1.0188003351386499)  
15: (53.947068886394185, -1.0208388139899682)  
16: (53.94600807596094, -1.0239501764472436)  
17: (53.9449219018517, -1.026739673822732)  
18: (53.94455573221028, -1.030258732050271)  
19: (53.94474517121948, -1.0334344675239038)  
20: (53.94453047361072, -1.037425594538064)  
21: (53.94456361504324, -1.0409231950934839)  
22: (53.945351370267396, -1.041566925257058)  
23: (53.94638693992713, -1.044592457025857)  
24: (53.94713834327907, -1.0436054041083764)

**Map View**

Start Position   Goal Position

Marker 1   Marker 2   Marker 3   Marker 4   Marker 5   Marker 6   Marker 7   Marker 8   Marker 9   Marker 10   Marker 11   Marker 12   Marker 13   Marker 14   Marker 15   Marker 16   Marker 17   Marker 18   Marker 19   Marker 20   Marker 21   Marker 22   Marker 23   Marker 24   Marker 25

**Elevation Profile**

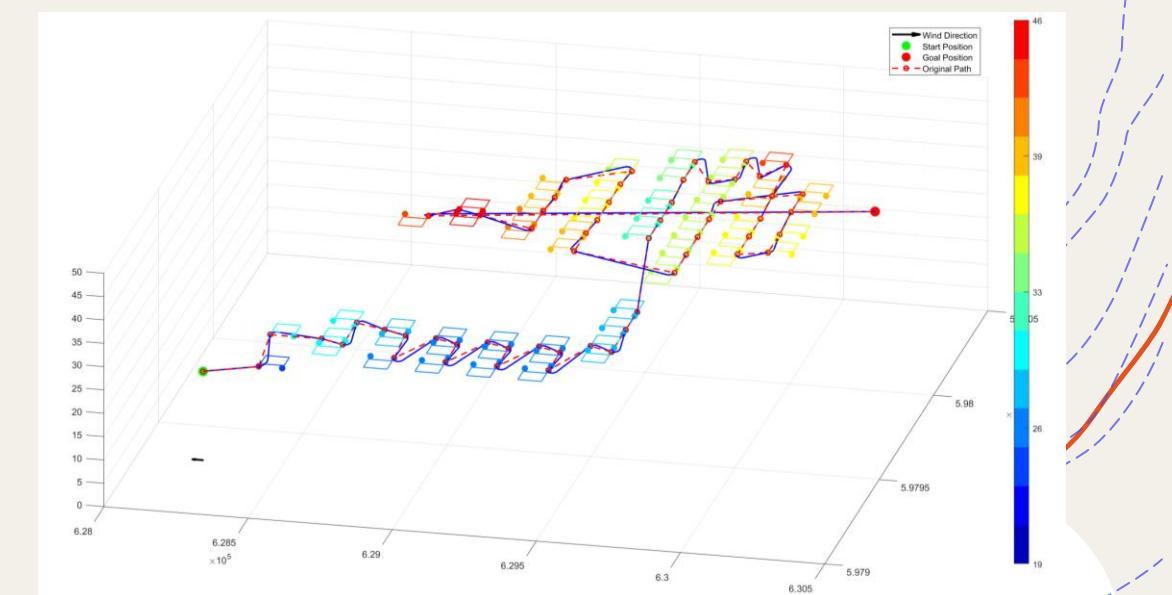
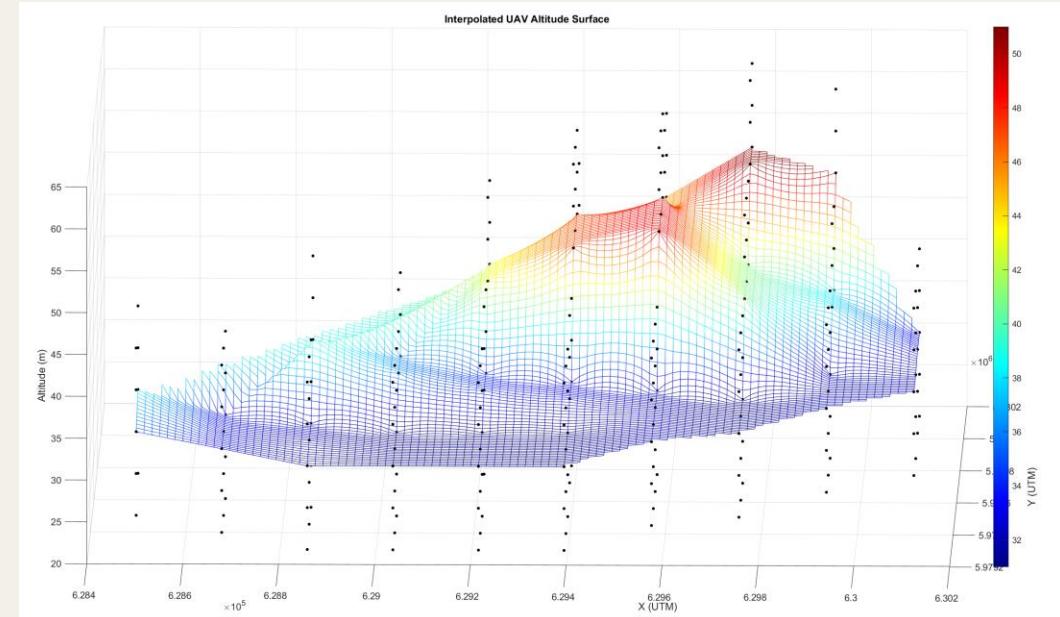
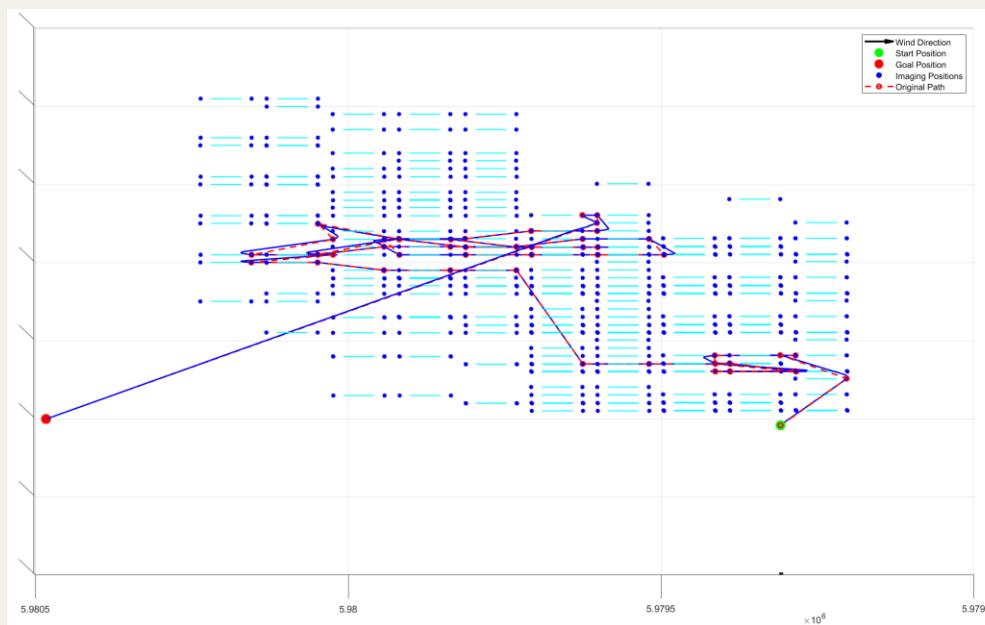
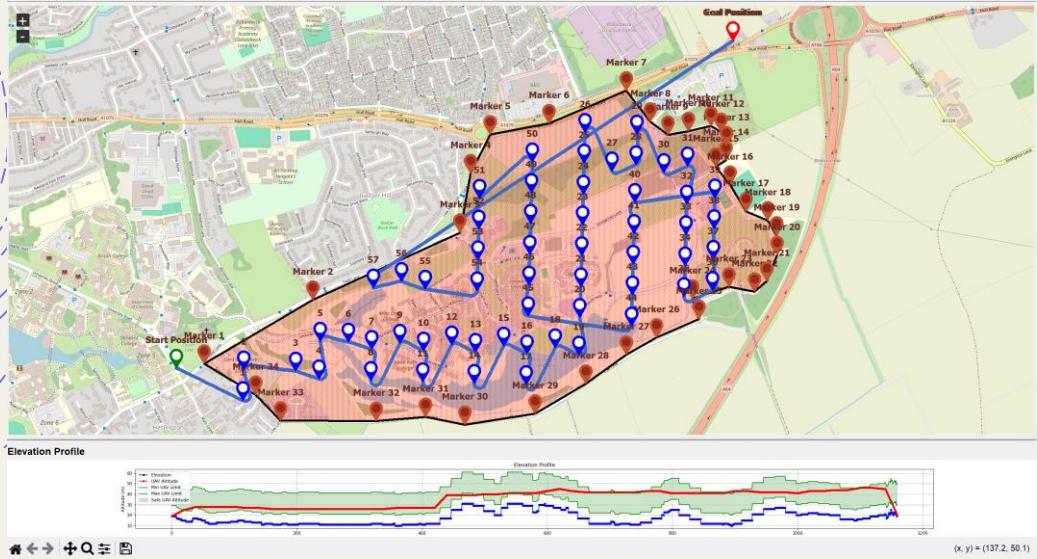
Altitude (m)

Elevation   UAV Altitude   Min UAV Limit   Max UAV Limit   Safe UAV Altitude

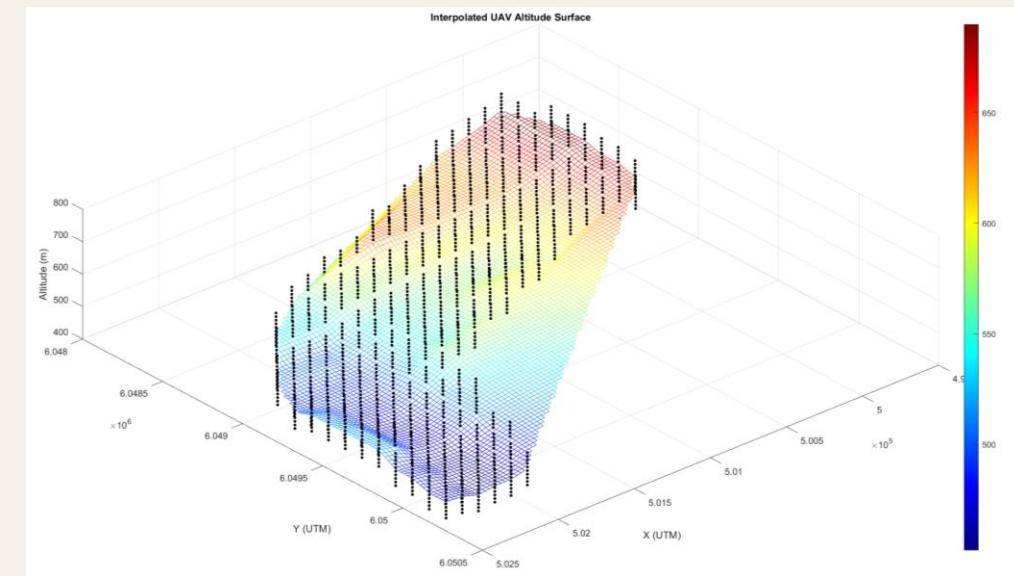
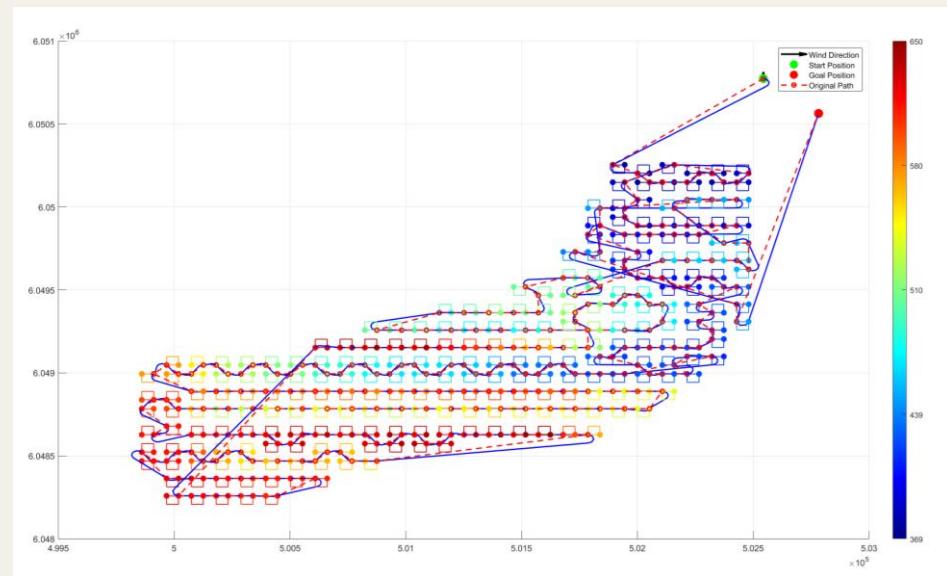
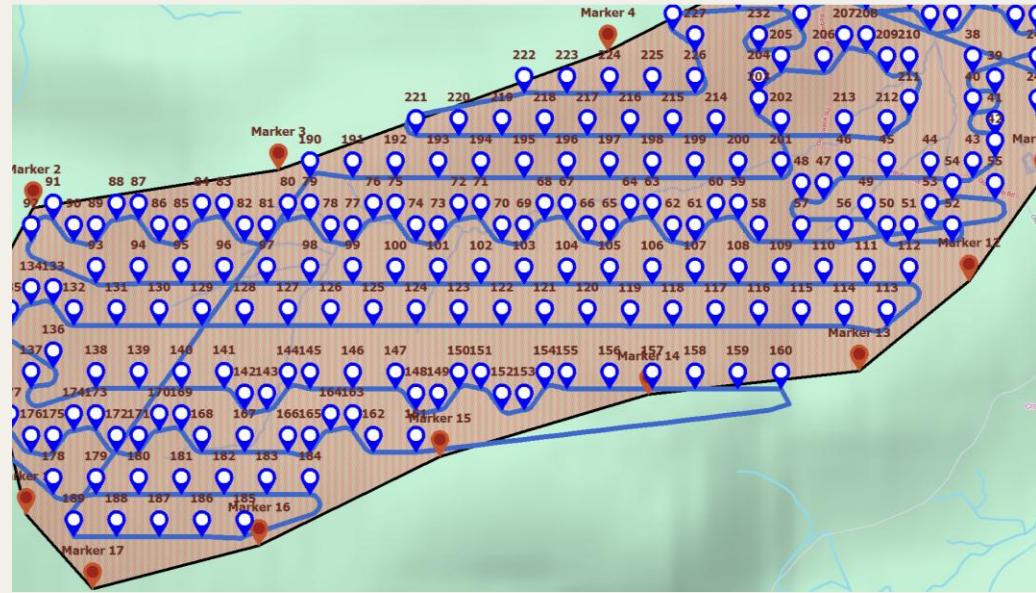
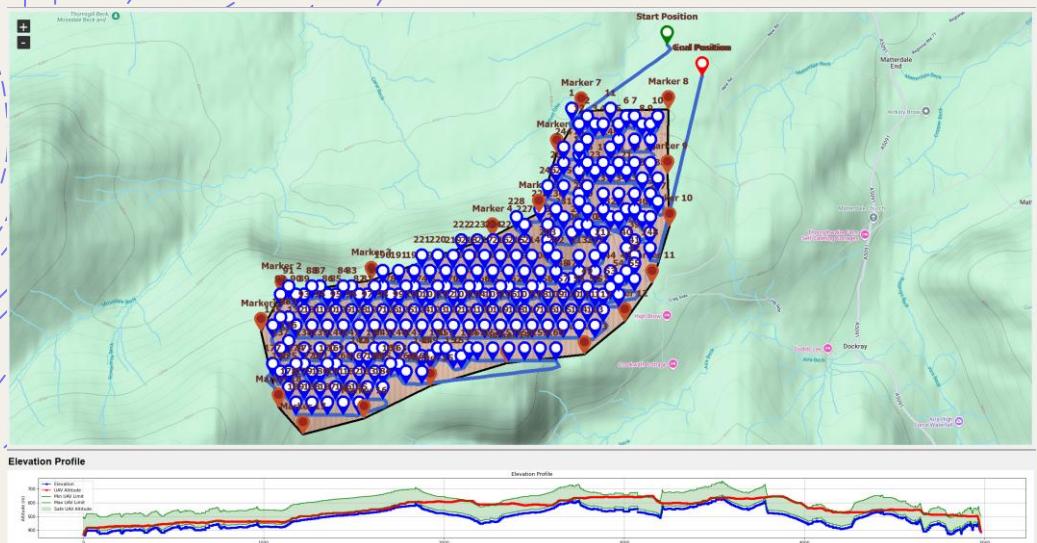
**Algorithm Parameters**

Calculate shortest path 2D  
Calculate shortest path 3D  
Import existing waypoints  
Plot waypoints

# Campus East Results - Flatter Terrain



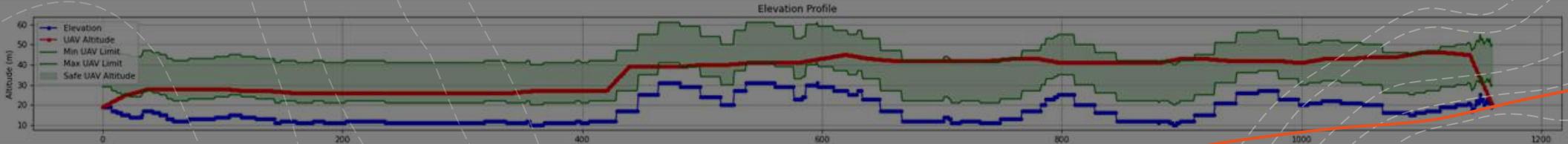
# Groove Beck Results – Hilly Terrain



# Conclusions & Further Work



Profile



(x, y) = (137.2, 50.1)

# Conclusions

## Successful Outcomes

- + Achieved core objectives.
  - + 3D flight path with constant height AGL
  - + Intuitive UI
  - + Environmental constraints implemented
- + Robust proof-of-concept for autonomous 3D path planning for aerial photography.
- + Successfully reduces user interaction required to fly a UAV.

## Problems & Drawbacks

- + Calculates flight path using one iteration, so does not calculate *the* most efficient path
- + No battery cycle management and landing predictions

# Further Work

- + Improve TSP heuristics – look ahead more than 2 points
- + Battery life estimation – notify user when battery is expected to run out and land to swap battery and continue flight.



# Thank You

Any Questions? 