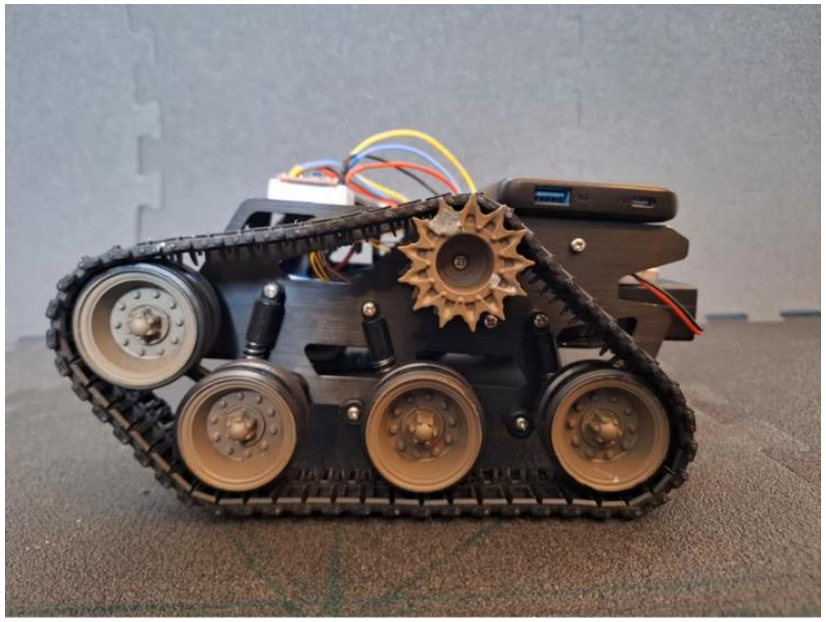
AGRI ROBOT MAPPING AND PATHING

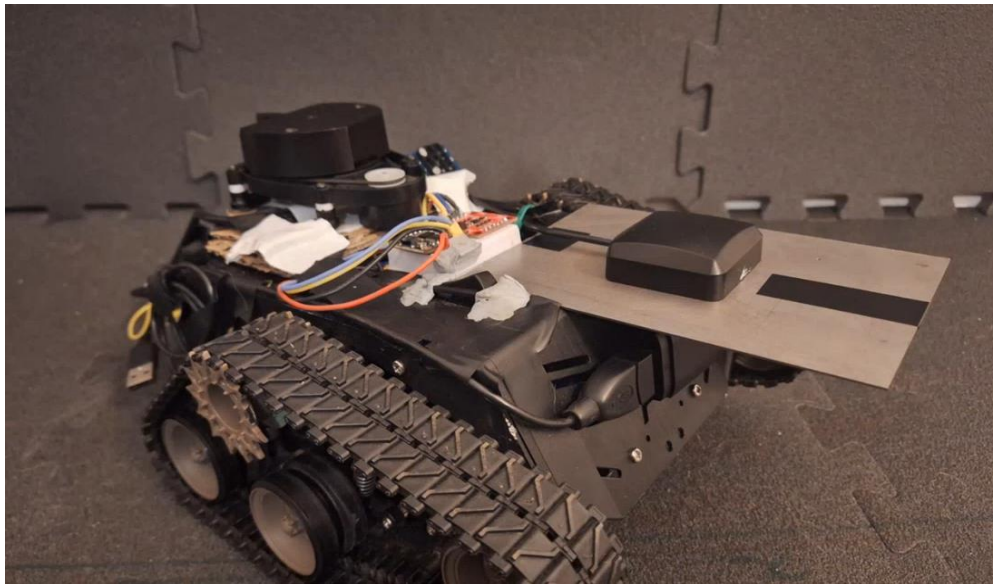
TOBY WILLIAM TOWLER

INTRODUCTION

- Agri Robot
  - Developed by previous masters' students at UEA
  - Autonomous lawn mower



- Repurpose Agri Robot for golf courses
  - Mapping
  - Route planning



AIMS

- Automate route planning
  - Map an area from an aerial image
  - Path planning with obstacle avoidance

MAPPING

- From drone image/orthophoto - (uniform scaled image)
- Neural network model
- Golf course components
  - Bunker
  - Green
  - Fairway
  - Rough
  - Water

THE MODEL

- MaskRCNN PyTorch
  - Mask Region-based Convolutional Neural Network
  - Designed for instance and semantic segmentation
- Components are classes
  - Background, bunker, green, fairway, rough, water
- Custom training data – Danish Golf Dataset
  - Custom annotations
  - Specialisation

COMPLETE COVERAGE PATH PLANNING

- Cover each point in an area at least once

- Performance metrics
  - Shortest route
  - Fewest of turns

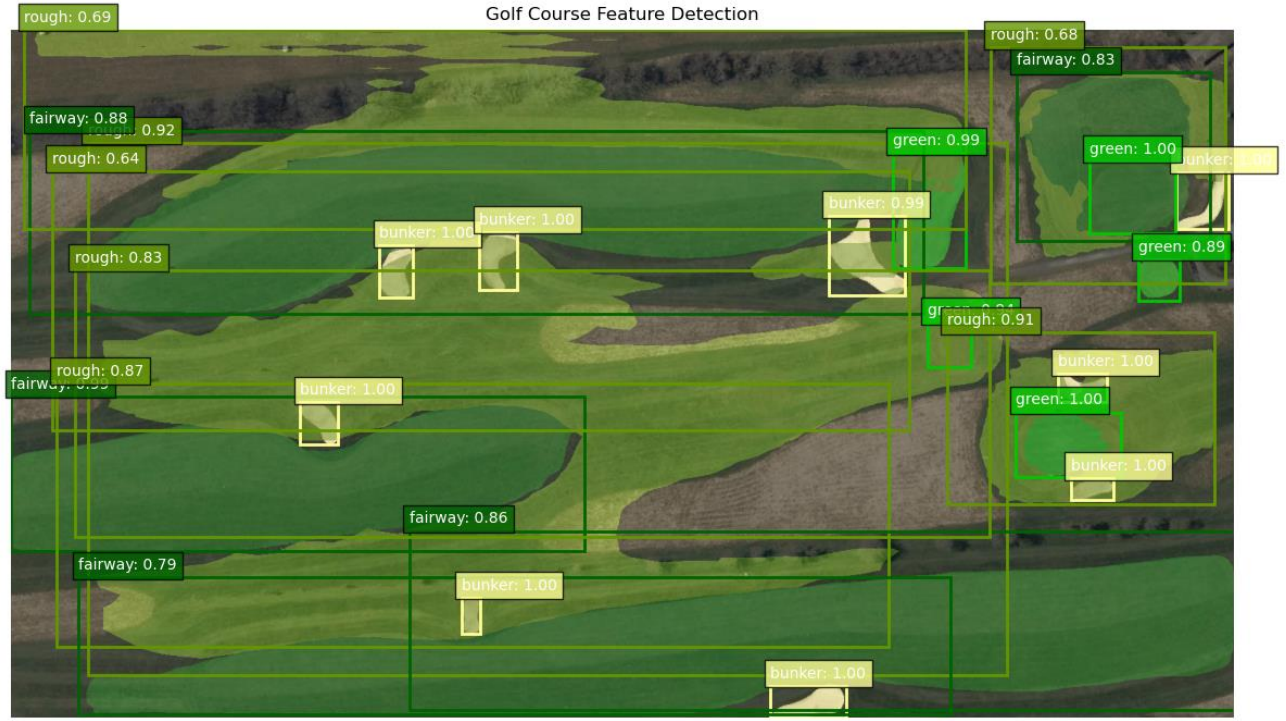
- Obstacle avoidance

COMPLETE COVERAGE PATH PLANNING

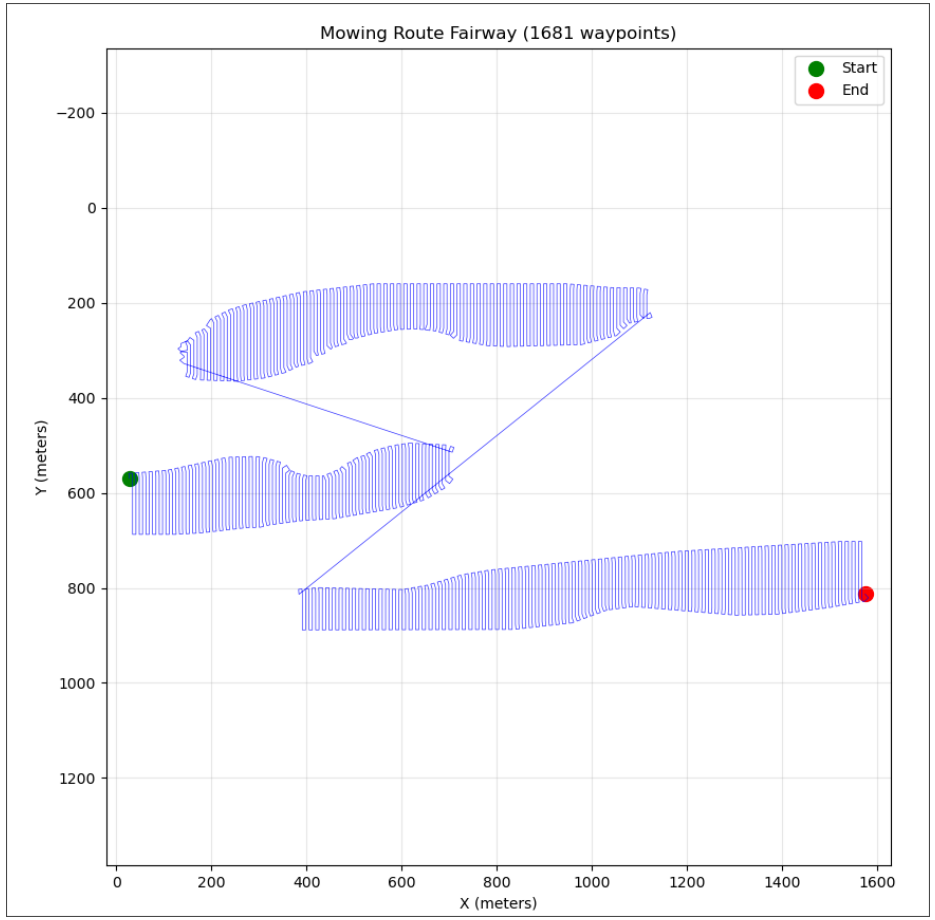
- 3 groups
  - Green/Tee
  - Fairway
  - Rough
- Levels – treat other as obstacles or not?

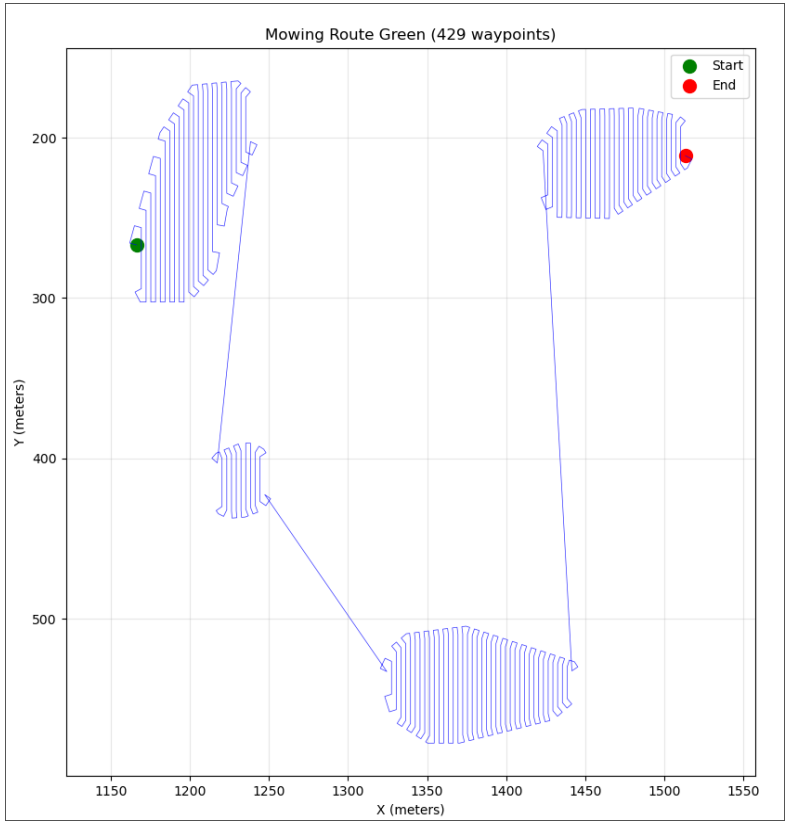
- Cutting height and style
  - Shorter/longer
  - striped/textured

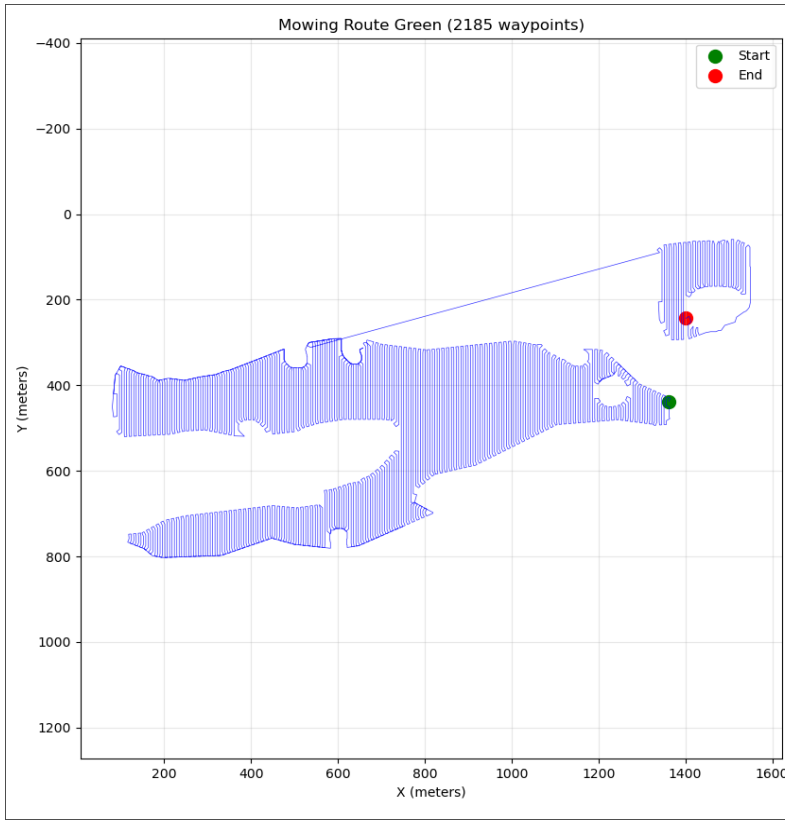
OUTPUTS - MODEL

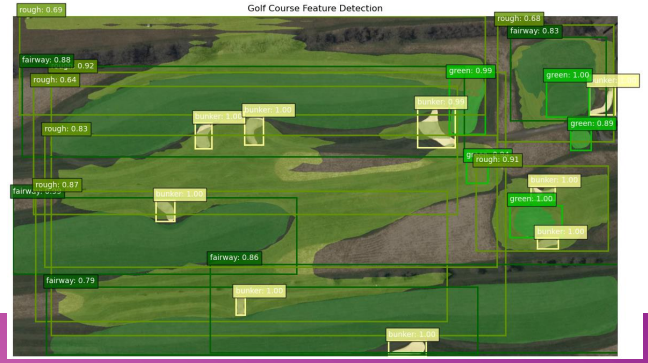


OUTPUTS - PATHS

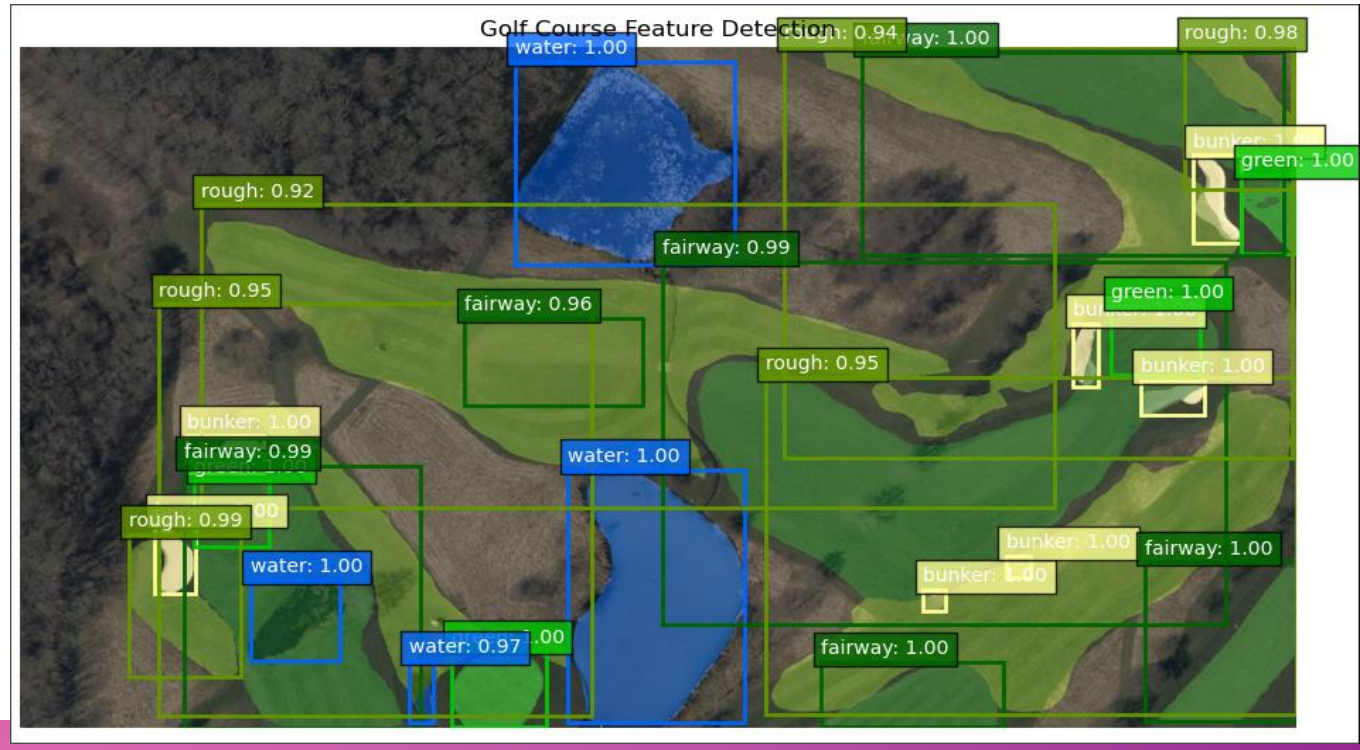




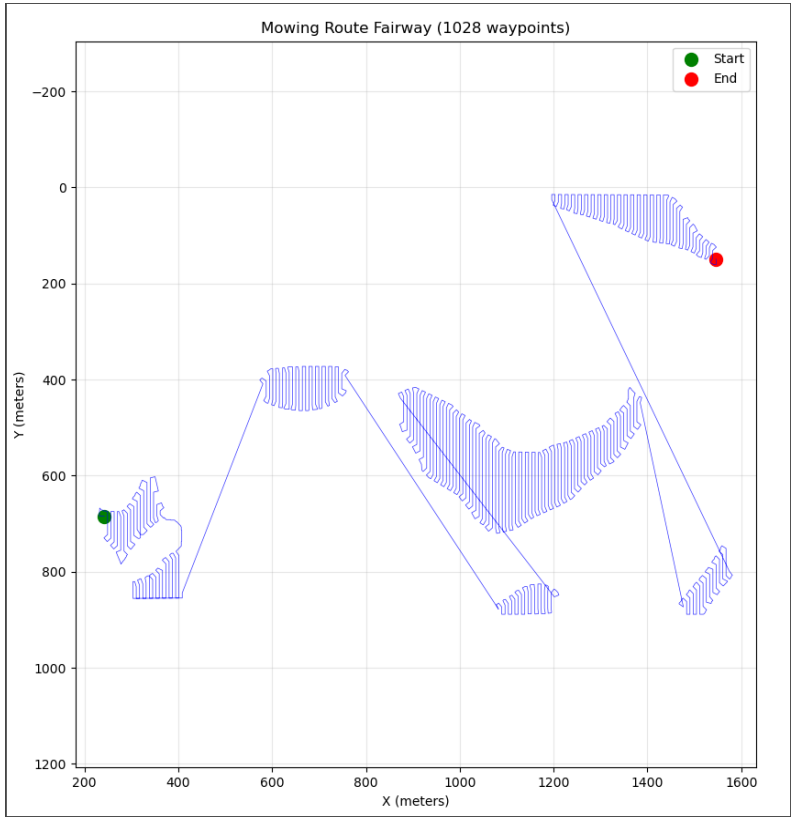


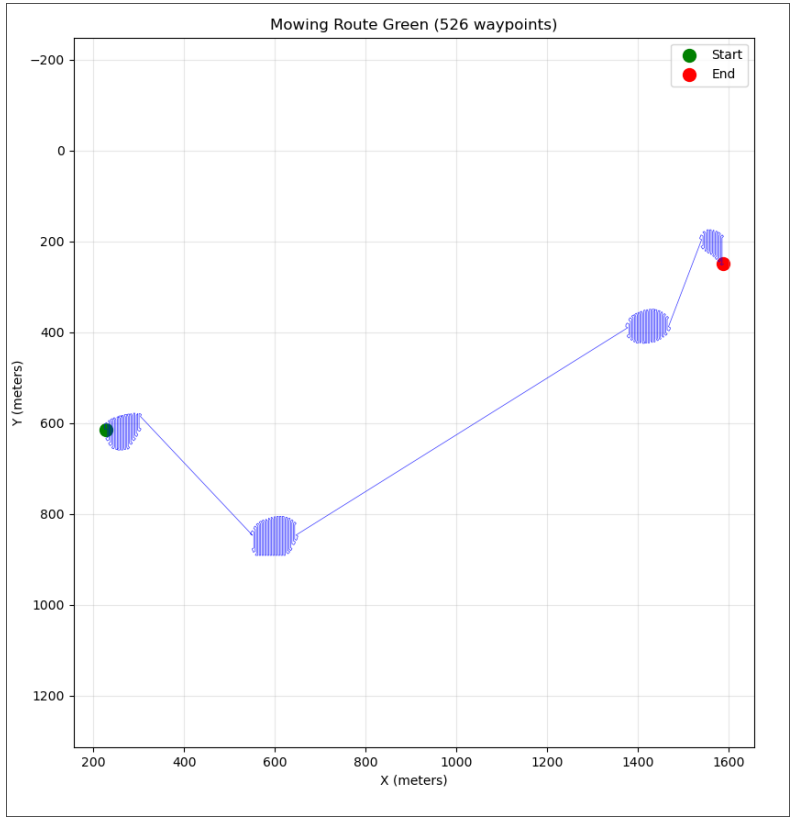


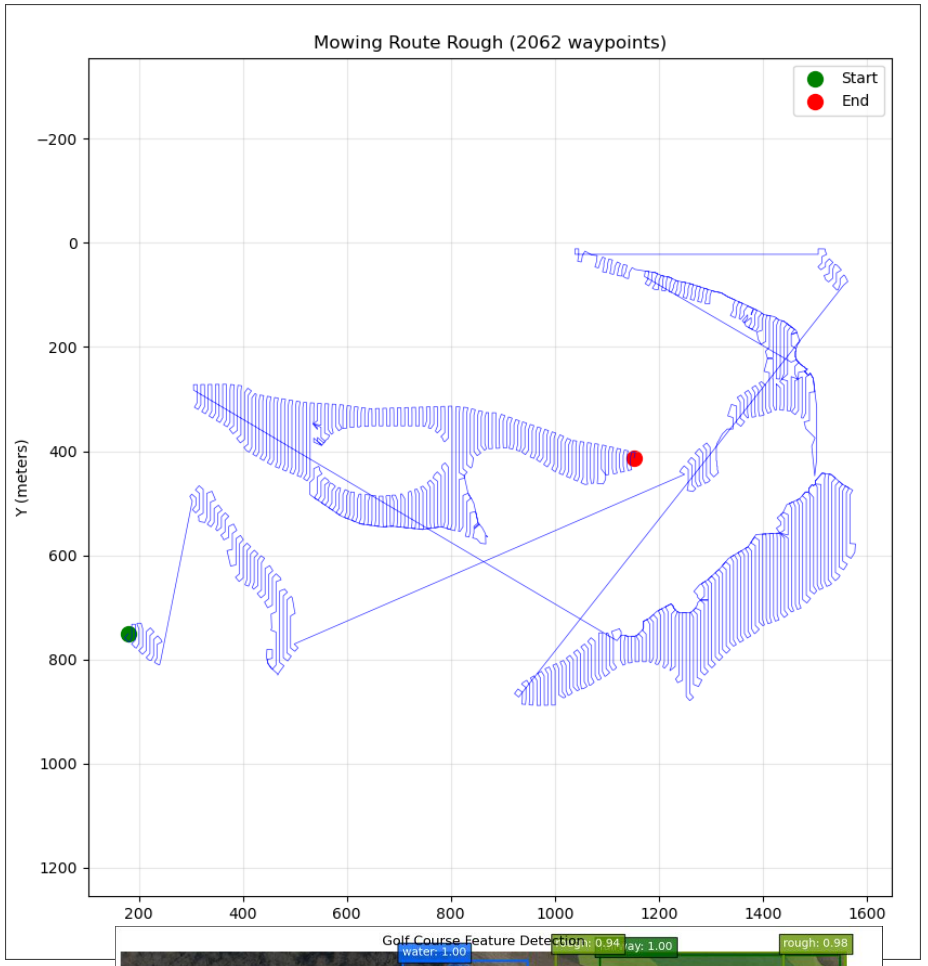
OUTPUTS - MODEL

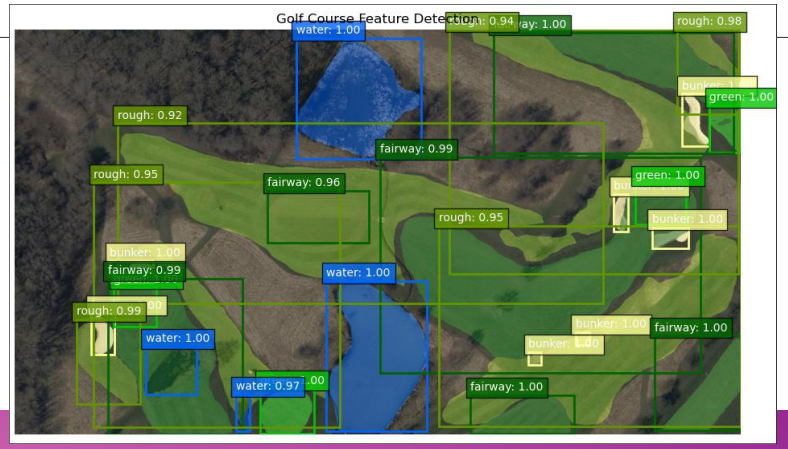


OUTPUTS - PATHS 2



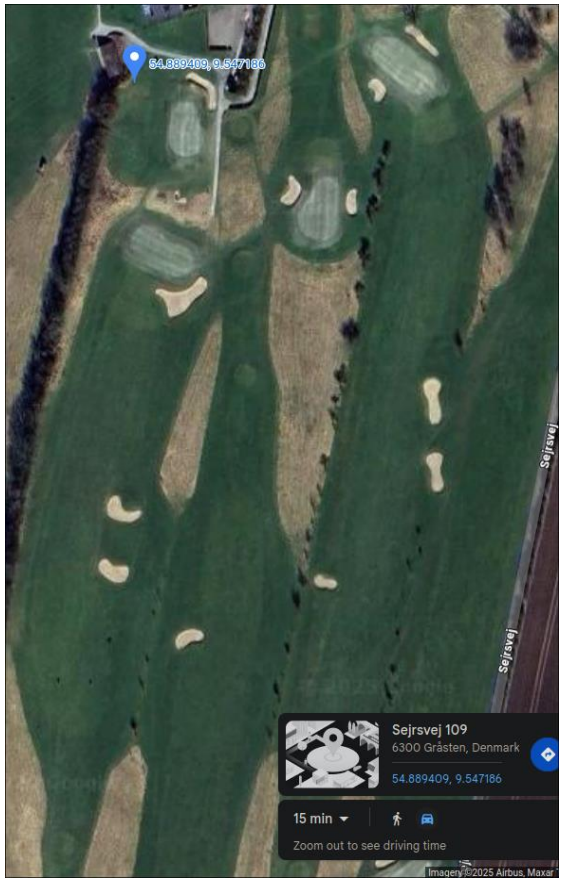




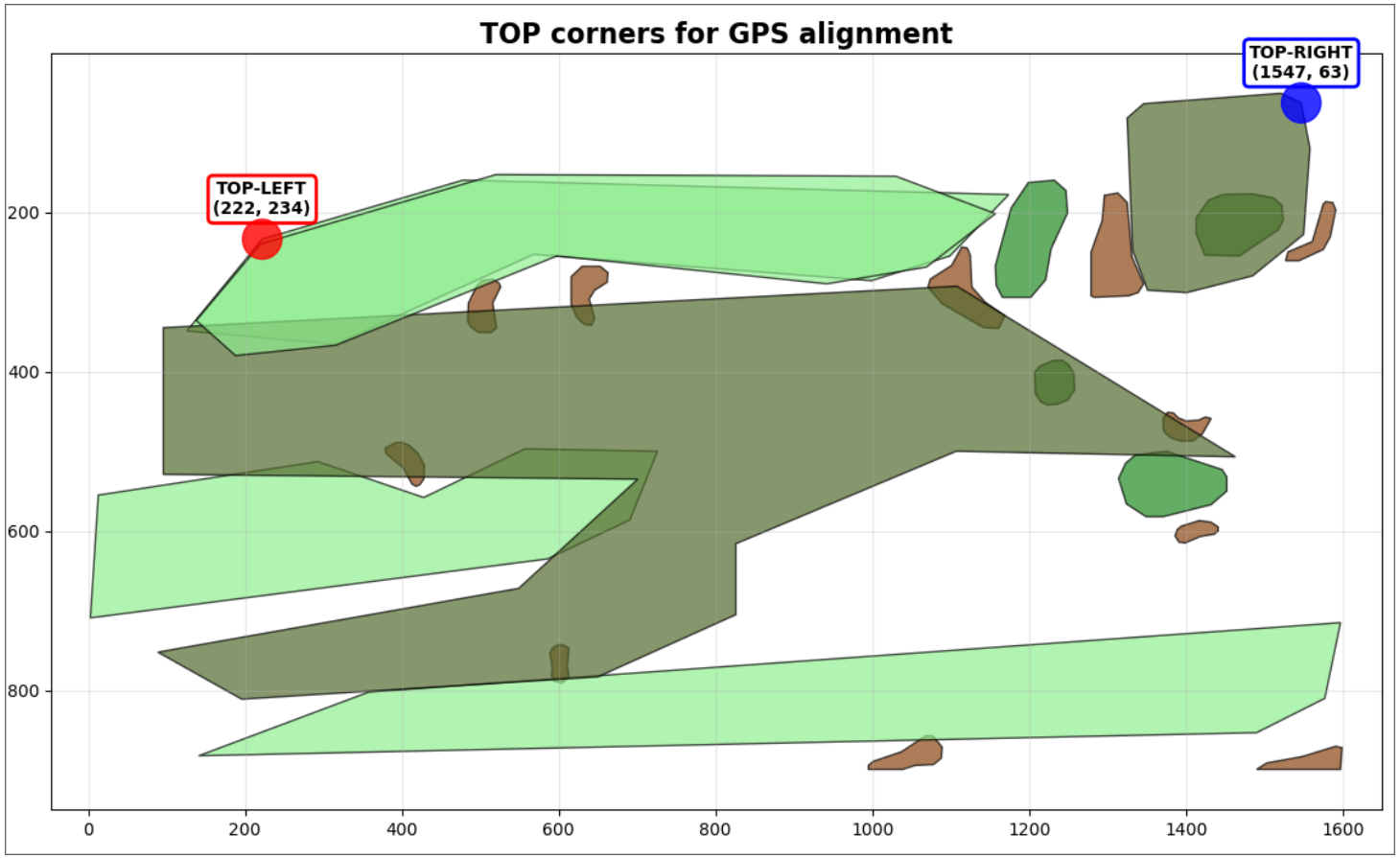


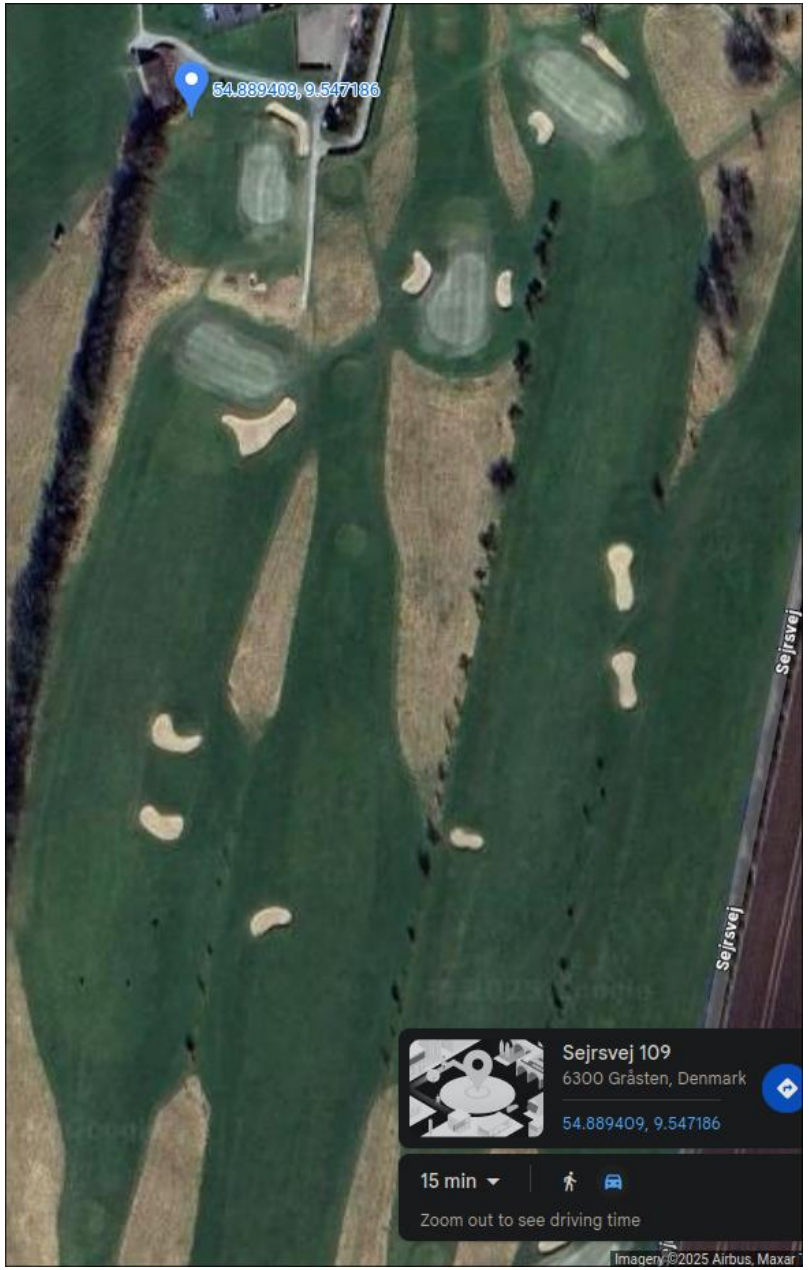
REAL WORLD TRANSFORMATION

- GPS coordinates
  - Bearing
  - Size



GPS

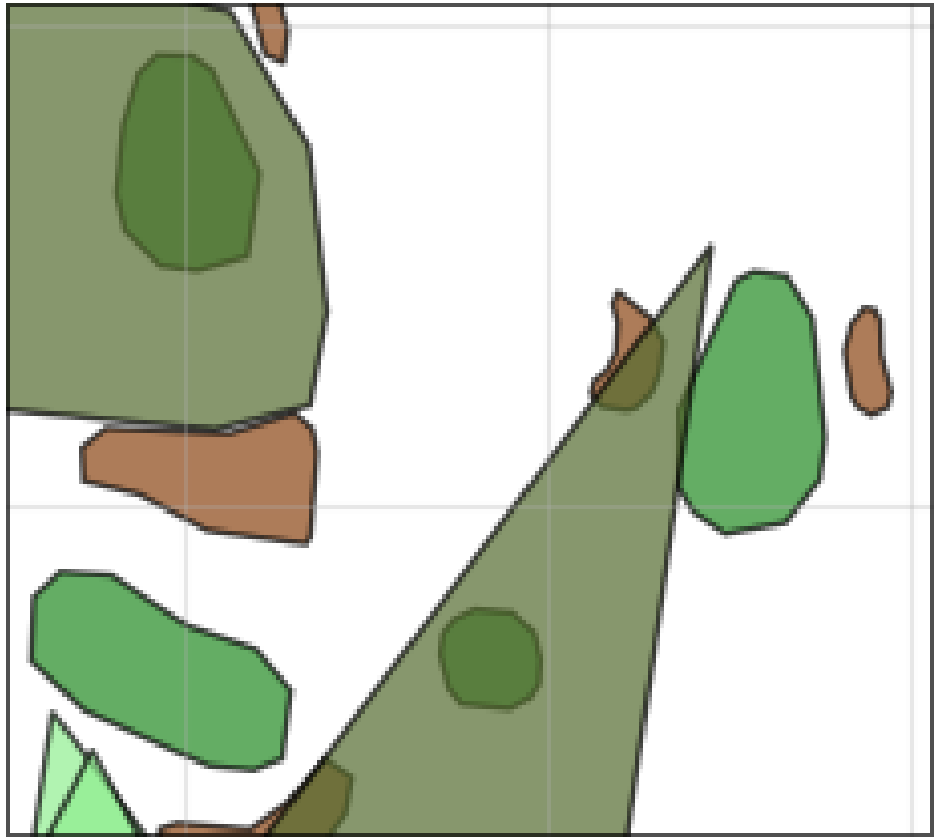

TOP corners for GPS alignment
TOP-RIGHT
(1547, 63)
TOP-LEFT
(222, 234)
200
400
600
800
0
200
400
600
800
1000
1200
1400
1600

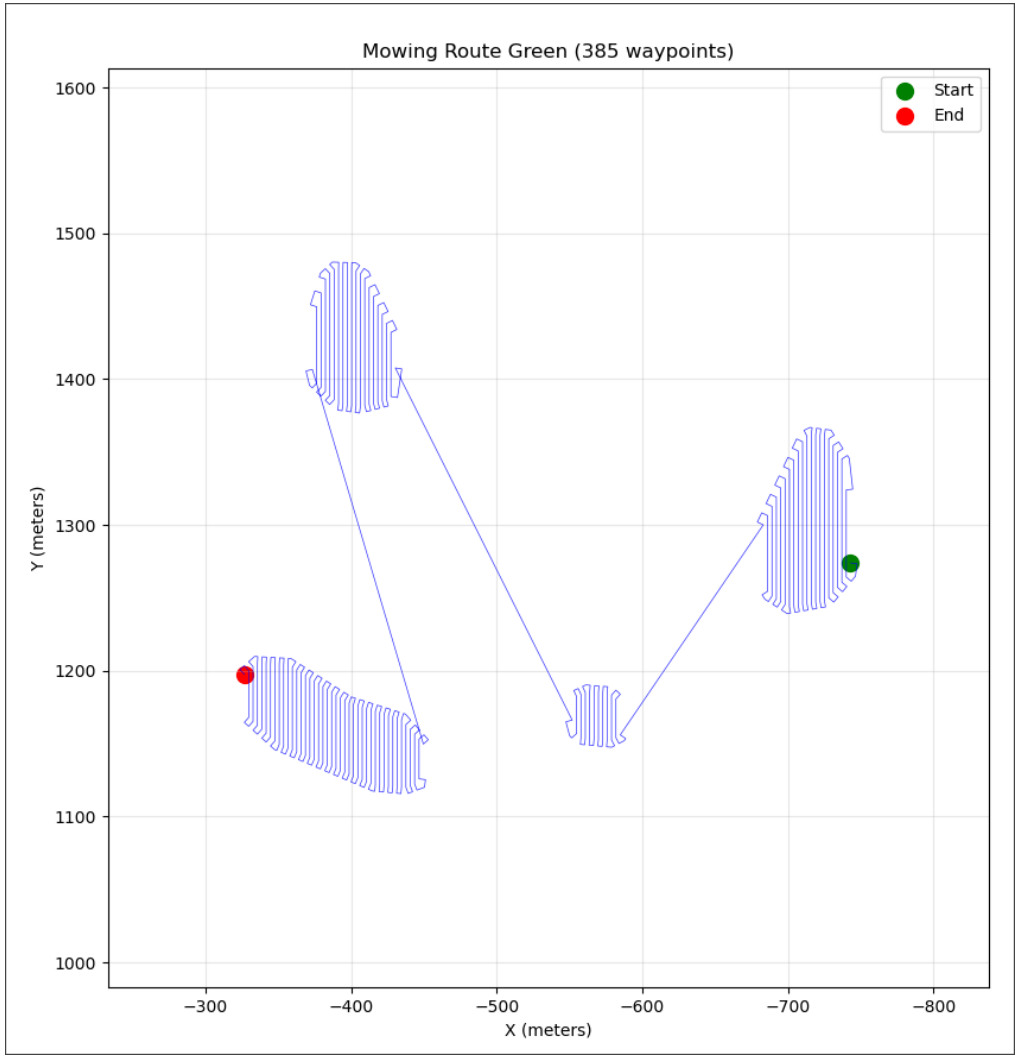

54.889409, 9.547186
Sejrsvej
Sejrsvej
Sejrsvej 109
6300 Gråsten, Denmark
54.889409, 9.547186
15 min
Zoom out to see driving time
Imagery ©2025 Airbus, Maxar

GPS

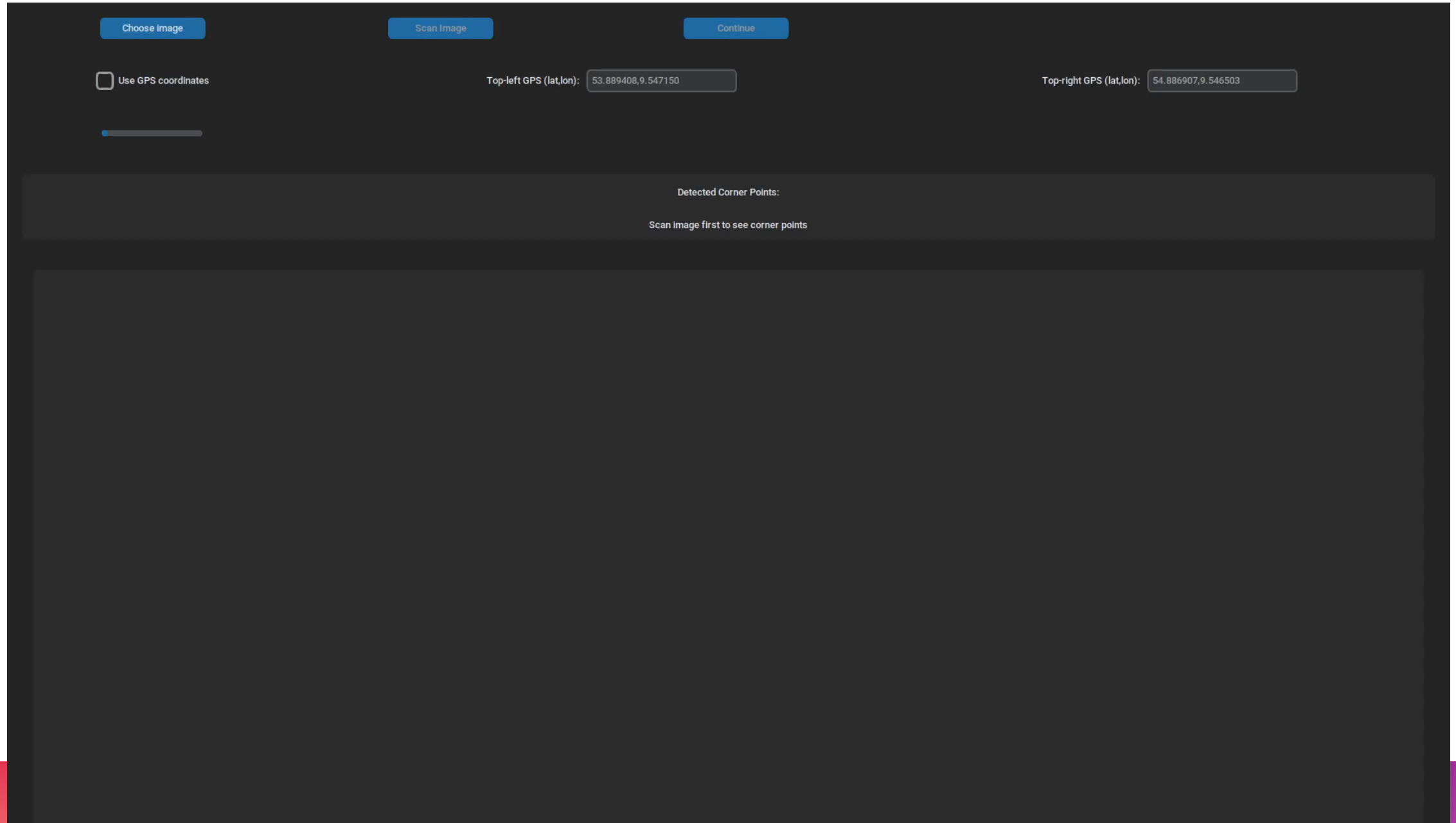

BEFORE: Pixel Coordinates
REF 1
(222, 234)
REF 2
(1547, 63)
Pixel X
AFTER: Rotated/Scaled Coordinates
REF 2
Original: (1547, 63)
Transformed: (-261.5, 1526.0)
REF 1
Original: (222, 234)
Transformed: (-260.6, 190.1)
Transformed Y
Transformed X

GPS PATHS




Mowing Route Green (385 waypoints)
Start
End
1600
1500
1400
1300
1200
1100
1000
Y (meters)
−300
−400
−500
−600
−700
−800
X (meters)

DEMO


Choose image
Scan Image
Continue
Use GPS coordinates
Top-left GPS (lat,lon):
53.889408,9.547150
Top-right GPS (lat,lon):
54.886907,9.546503
Detected Corner Points:
Scan image first to see corner points