

2012 Technology Office Challenge

Project AUTOMATE

A Cooperative Team of Autonomous
Air and Ground Robots

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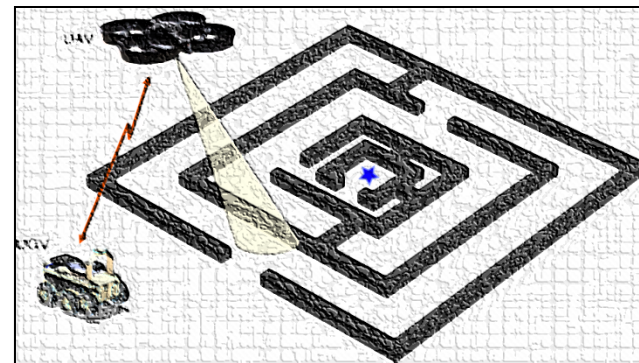


Challenge Overview

Challenge: Design, develop and deploy a UGV-UAV system that will traverse a maze-like course while avoiding obstacles and executing specific tasks

Technical Objectives:

- **Demonstrate cooperative UGV-UAV operation that will enable unmanned ground traversal through unknown terrain**
- **Explore cooperative behavior in semi-autonomous and autonomous systems toward the execution of a given task**



General Challenge Objectives:

- **Encourage open innovation to solve a technically challenging problem**
 - **Promote a culture of creative problem solving and innovative thinking**
 - **Support multidisciplinary, cross-division teams**

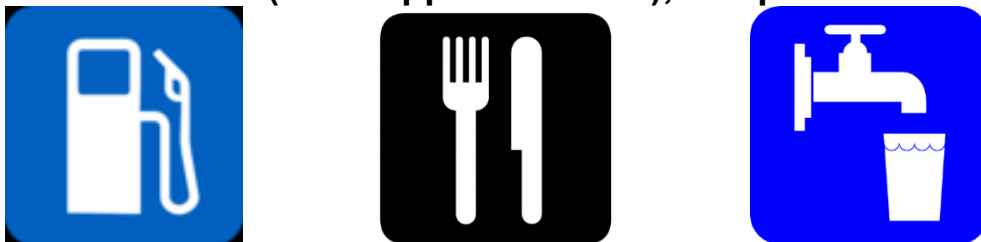


Challenge Rules

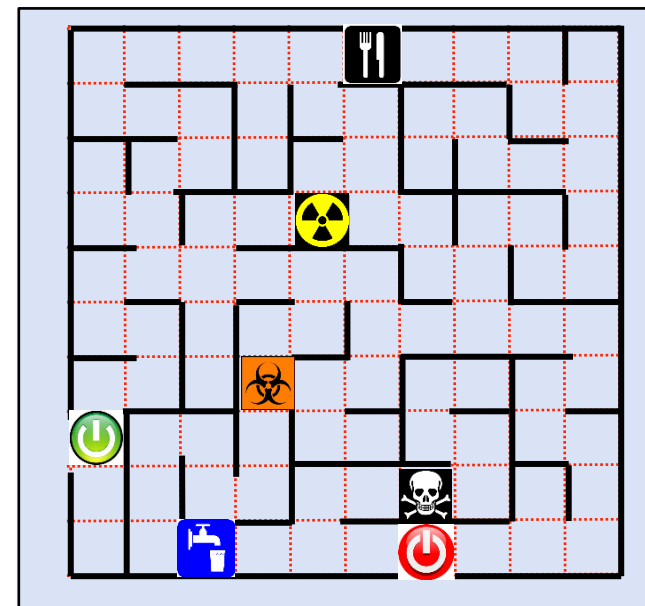
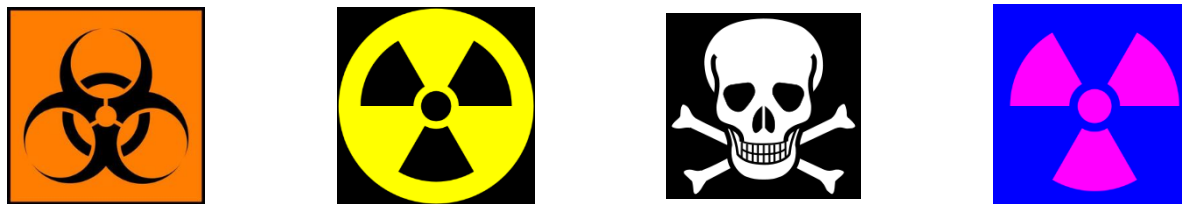
- Entrance/Exit Markers, 100 points



- Bonus Markers (2 will appear in maze), +20 points



- Hazard (3 will appear in maze), -25 points



- -1 point per cell traversed
- Two main rounds: UAV+human+UGV then UAV+UGV (i.e., no human)
- 60 – 90 minutes per round

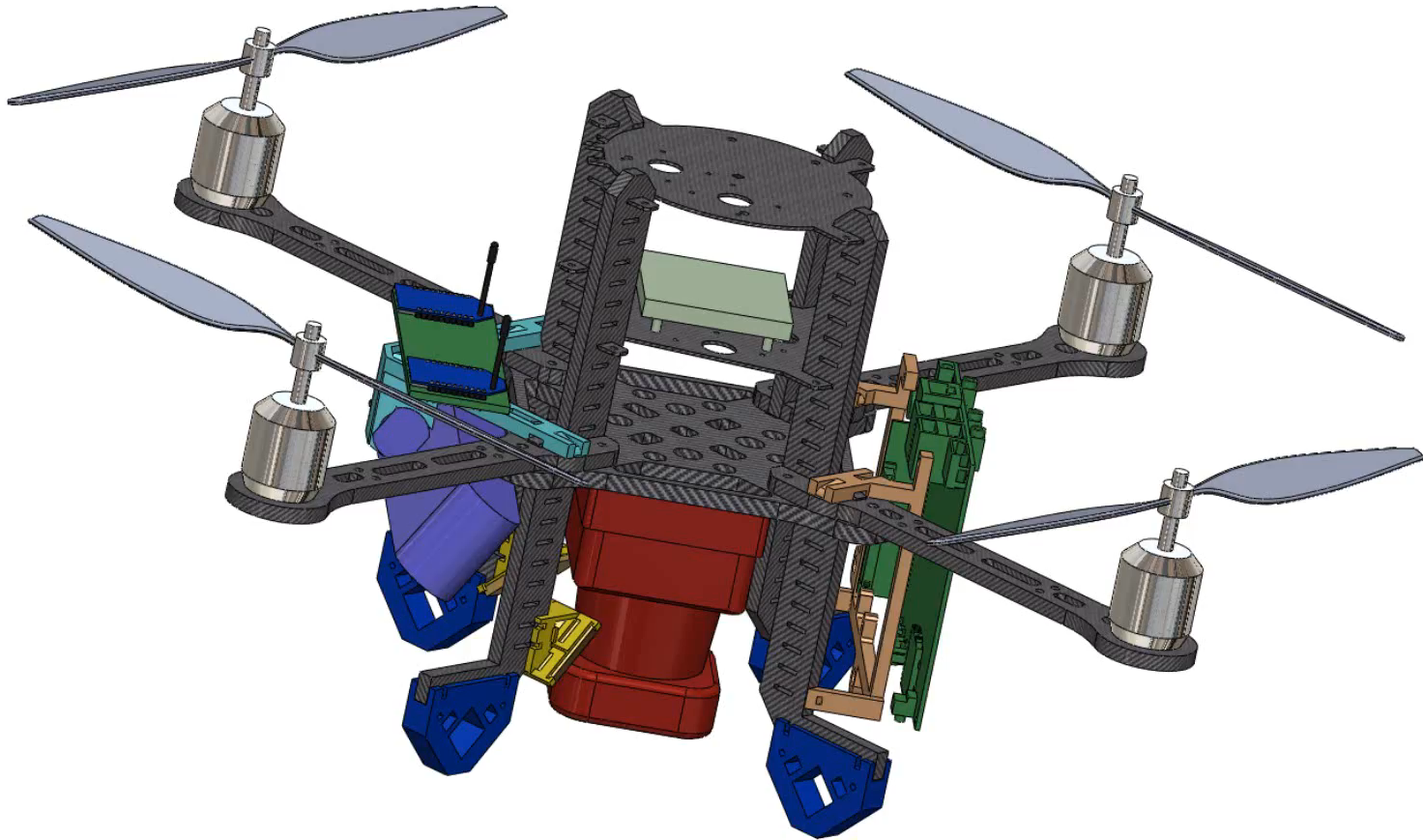


Key System Design Points

- **Modular and scalable**
 - Decentralized Robot Operating System architecture
- **Simple fail-safe behaviors**
 - Sequential state machines with predetermined timeouts
- **“Distributed” Gazebo simulations before hardware validation**
 - (Nearly) identical software, computational, and network architecture
- **Exploit a priori knowledge**
 - Pre-mapped challenge area, labeled marker training examples

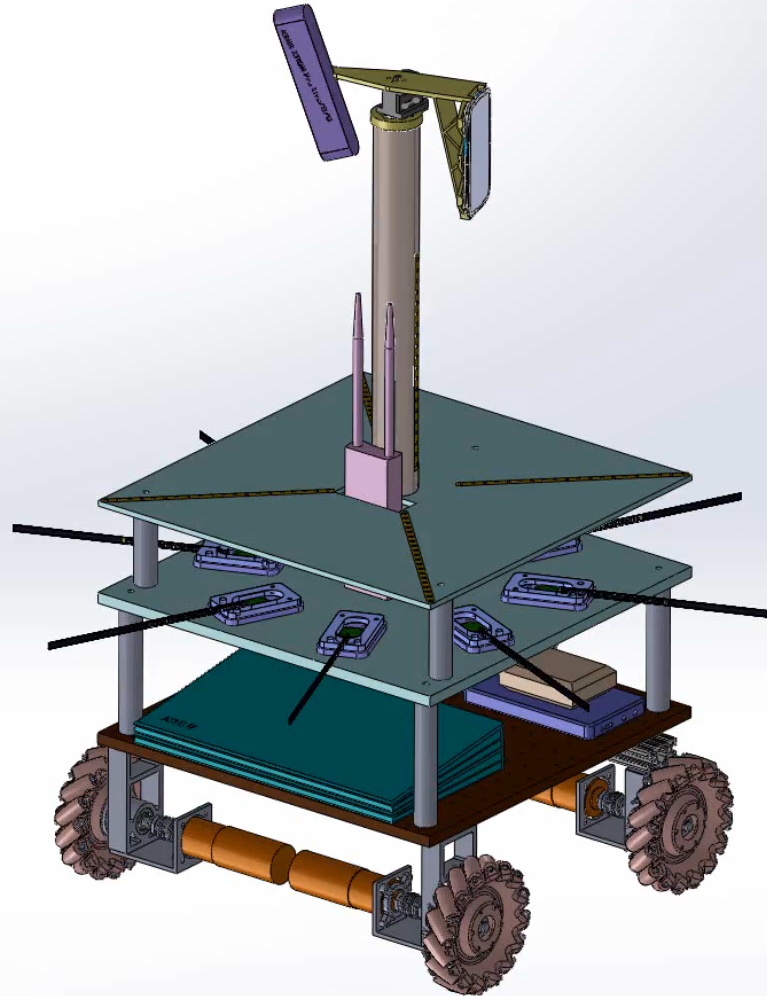


UAV Design



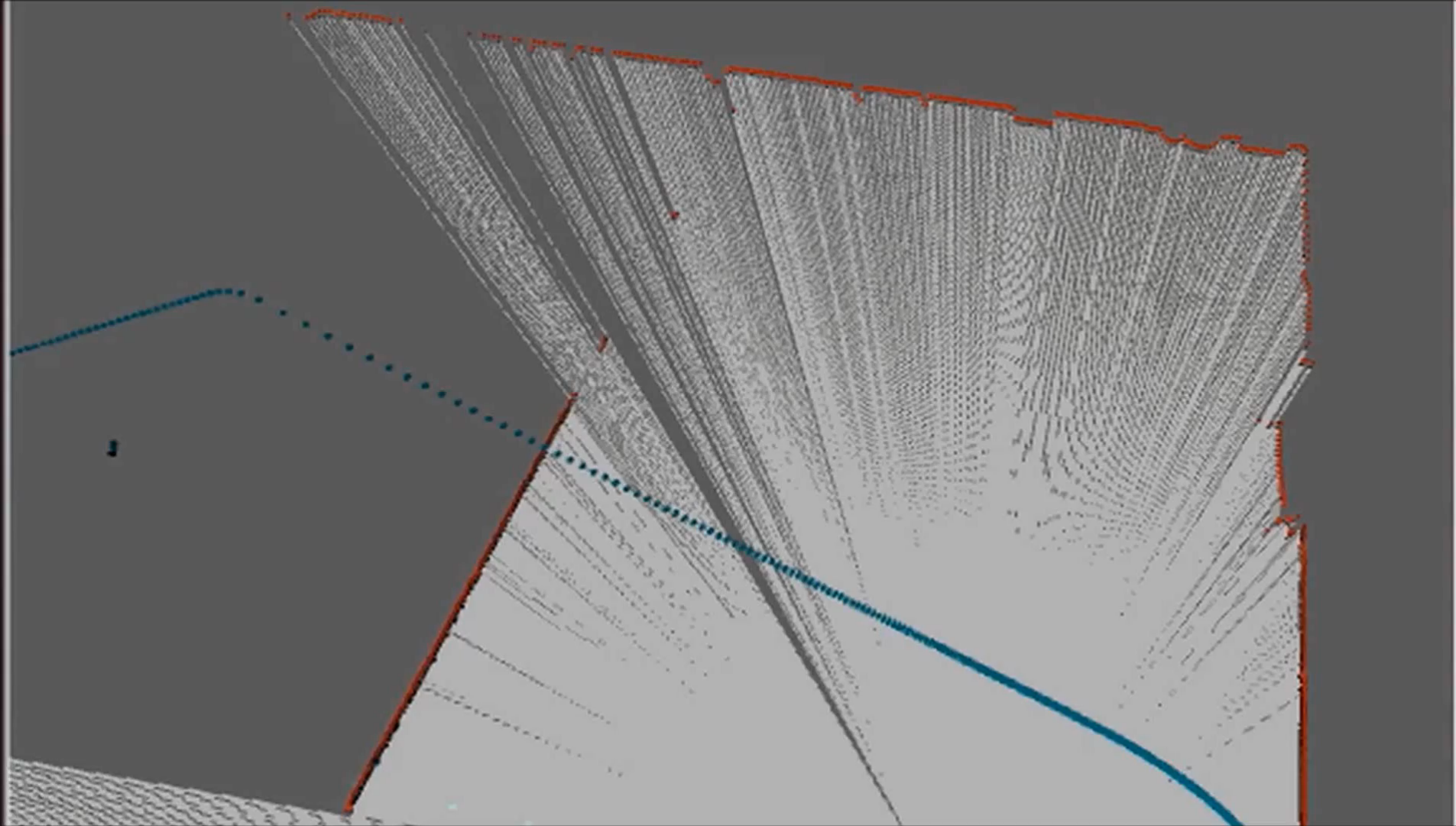


UGV Design



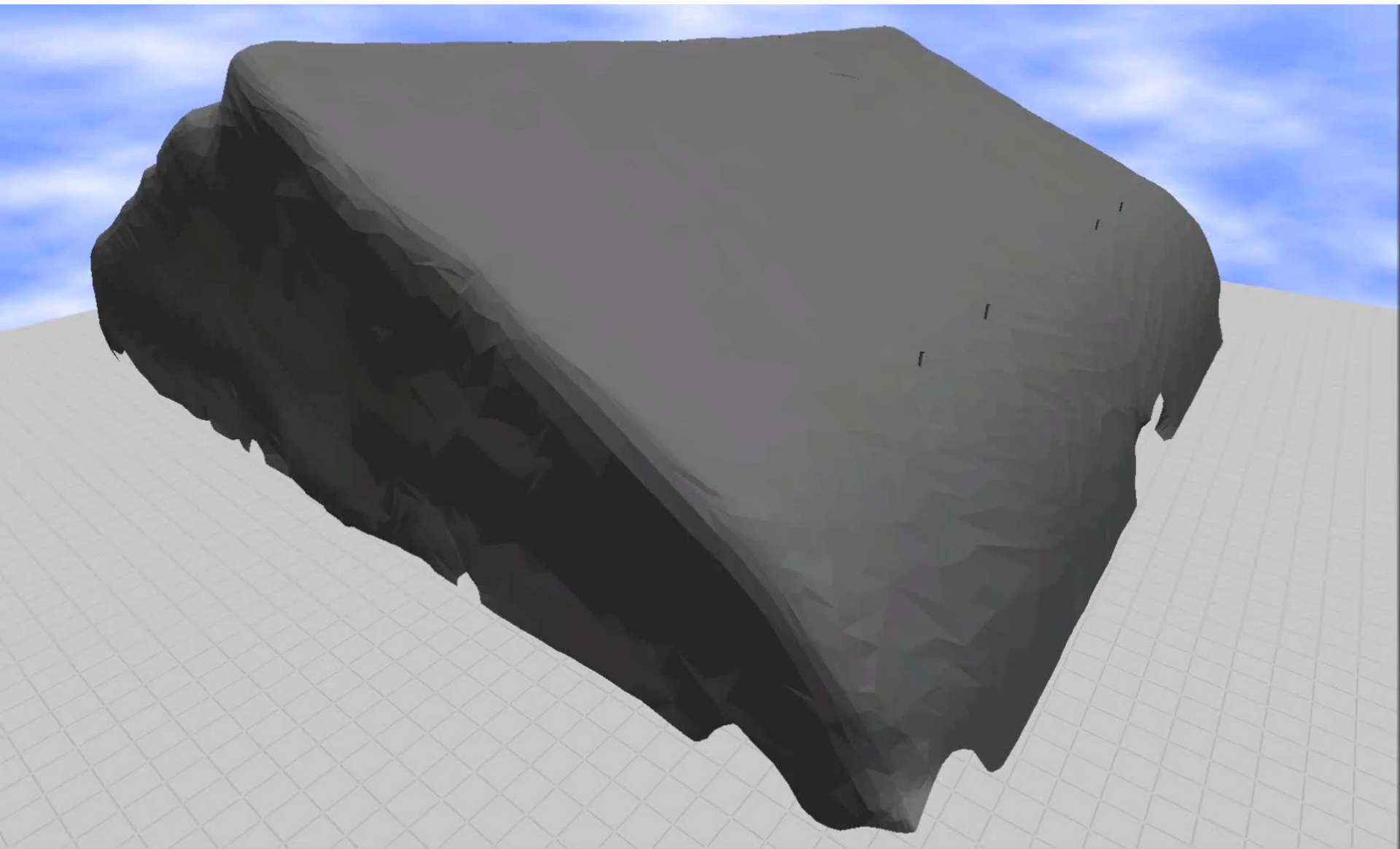


Challenge Area Reconnaissance



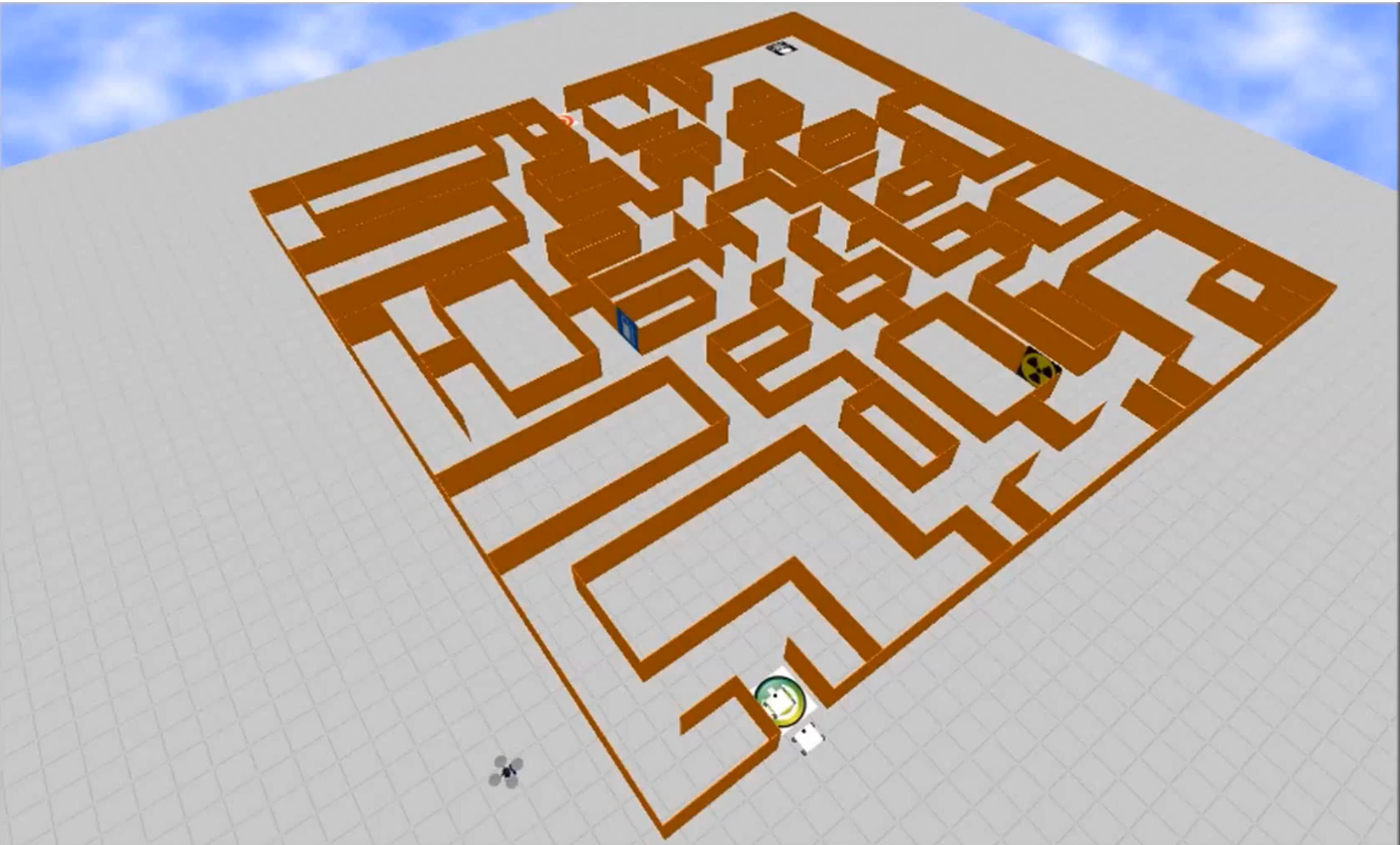


Gazebo Reconstruction



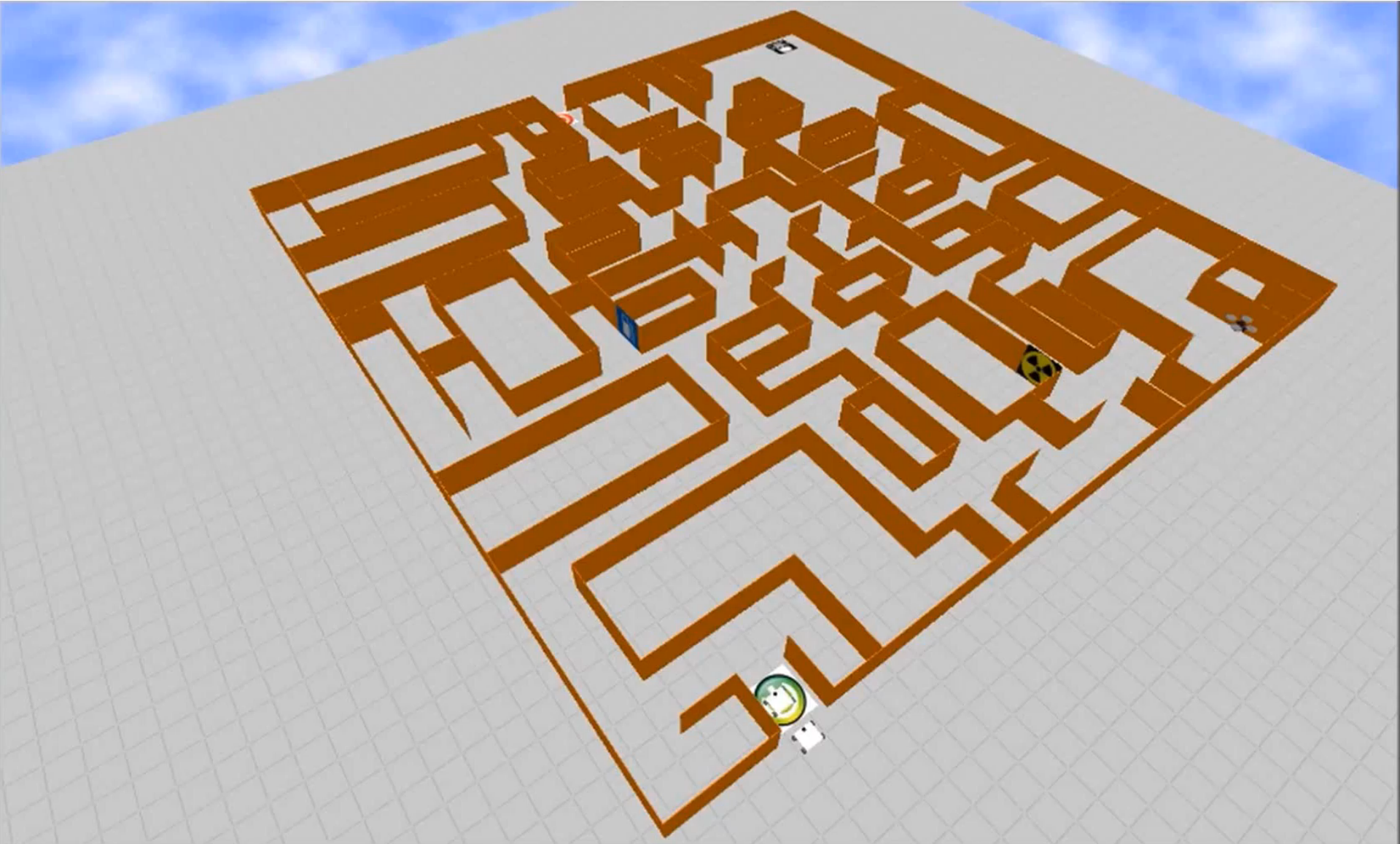


Baseline CONOPs



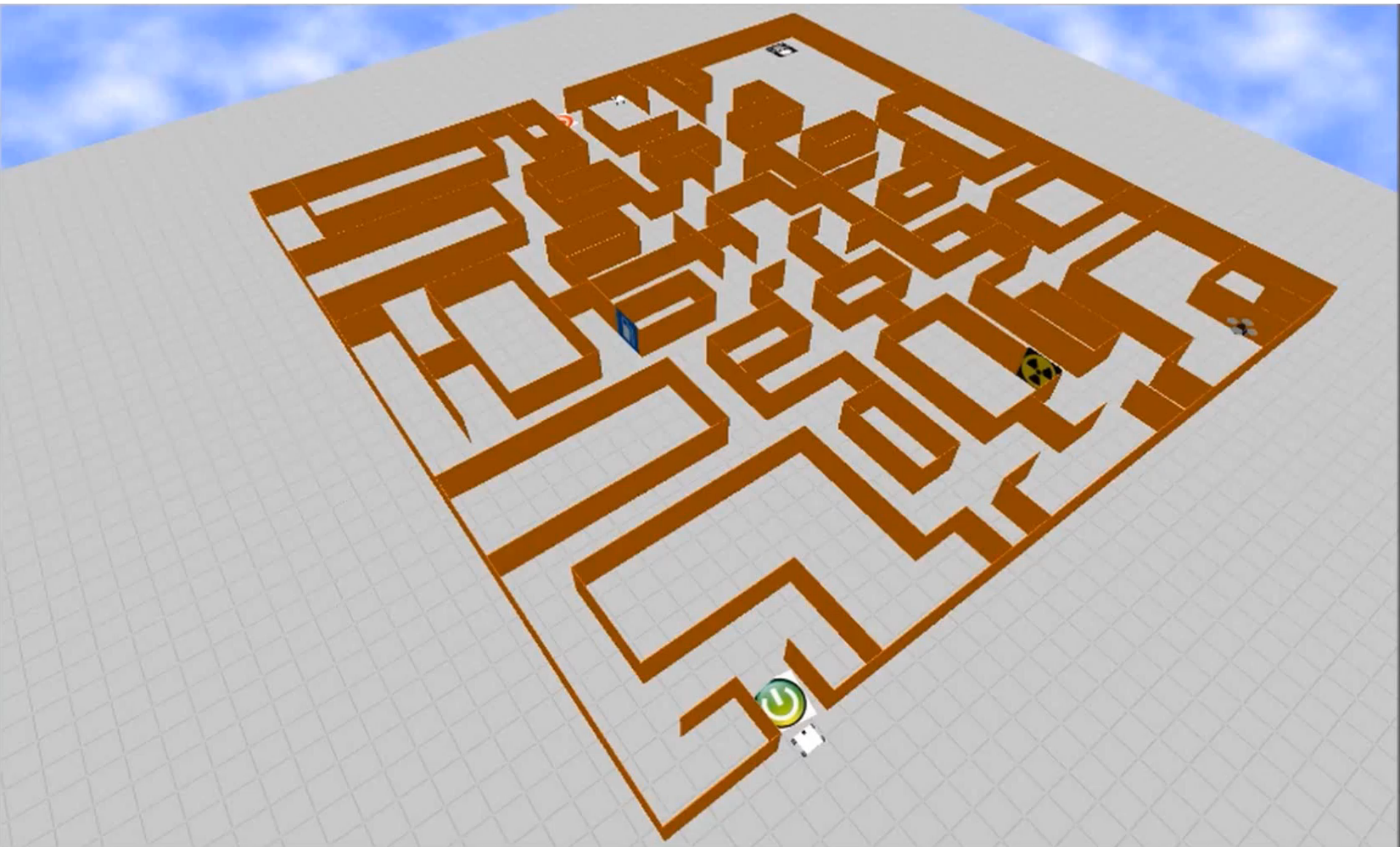


Baseline CONOPs



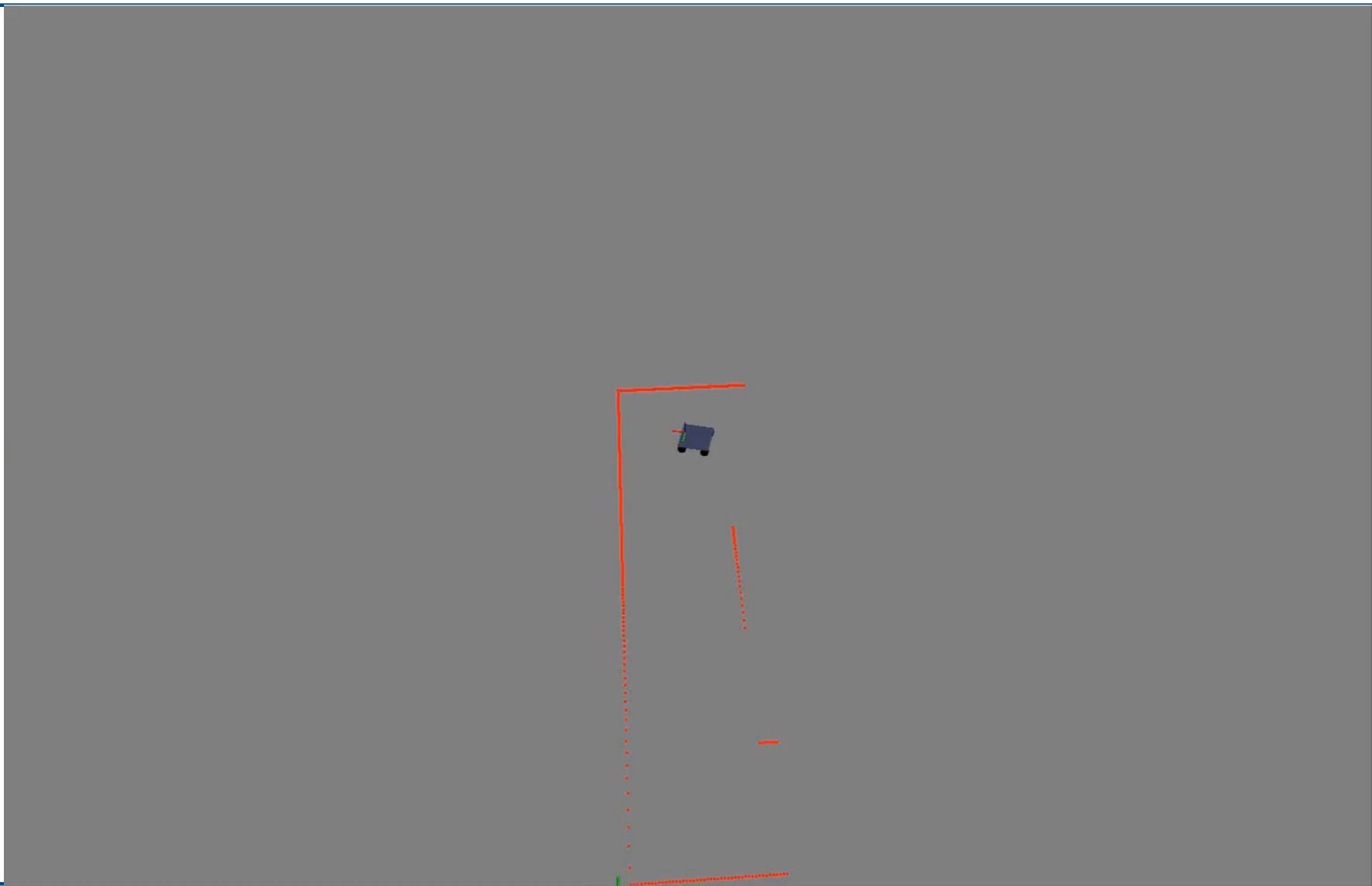


Baseline CONOPs





UGV Exploration





Marker Identification

original



Original image

Color segmentation

Edge detection

Clustering

Convex hull

Match color histogram

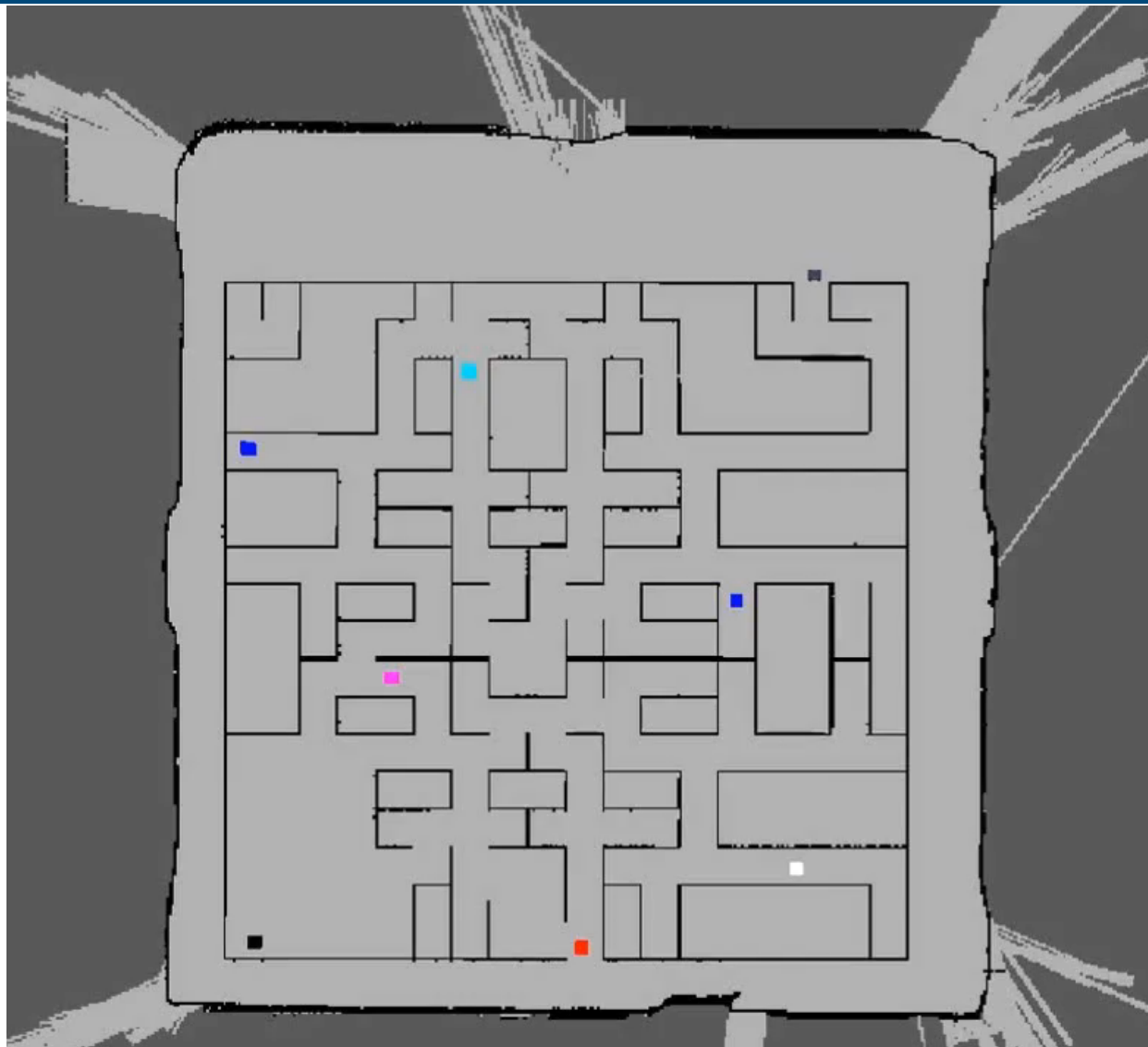


Marker Identification



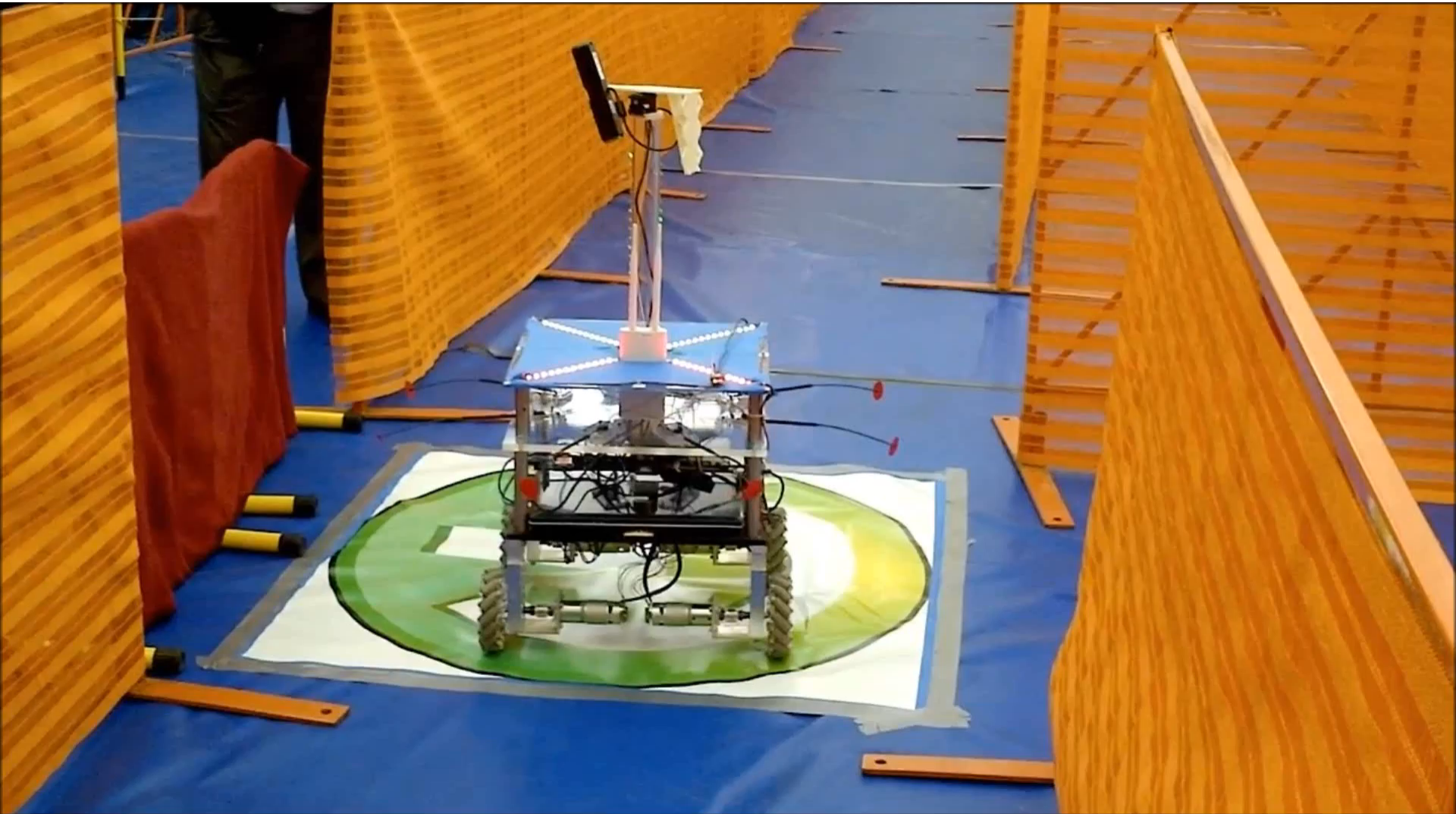


UGV Exploitation



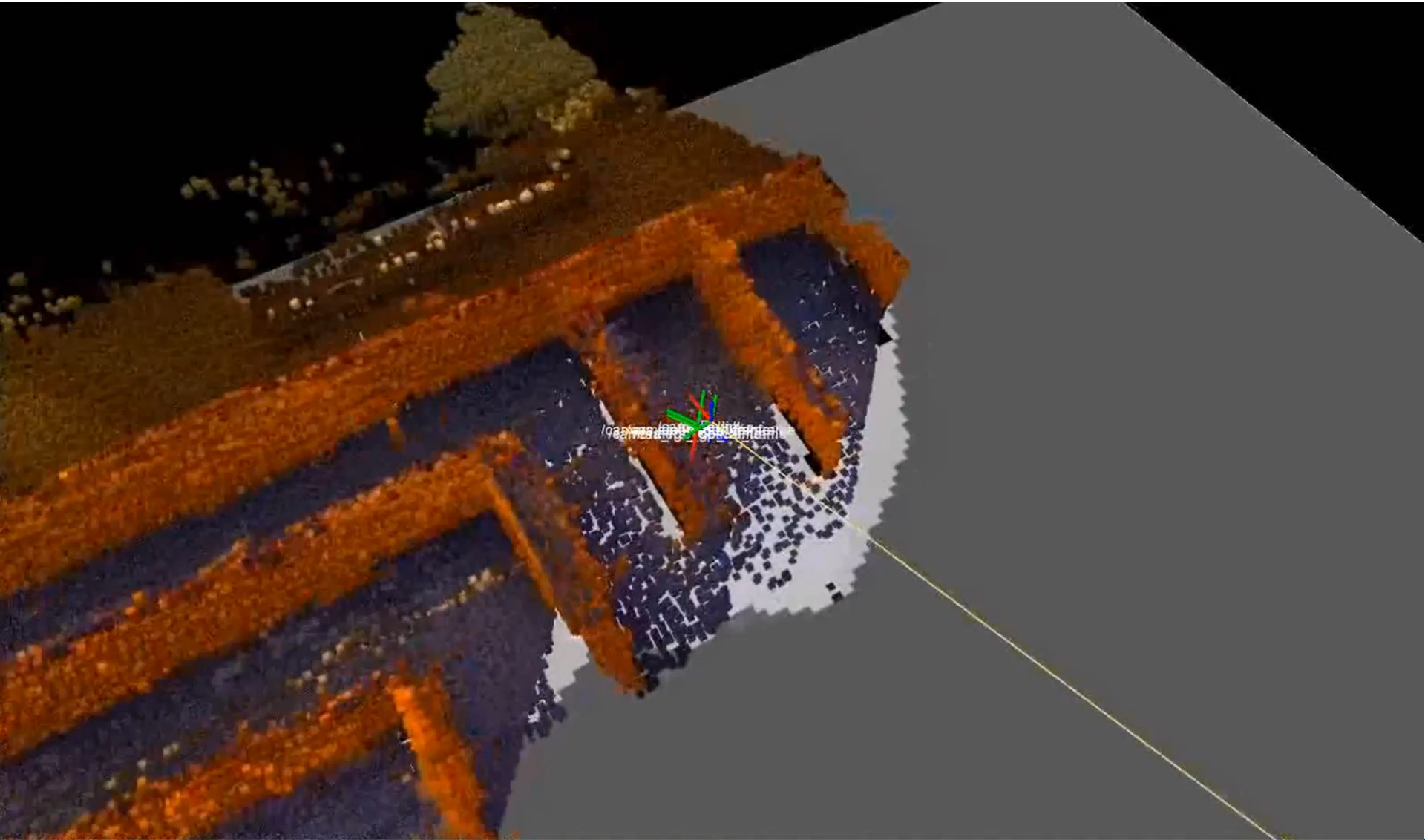


Game Day Practice Run





Round 1 - UAV Reconnaissance





Round 1 – UGV Exploitation



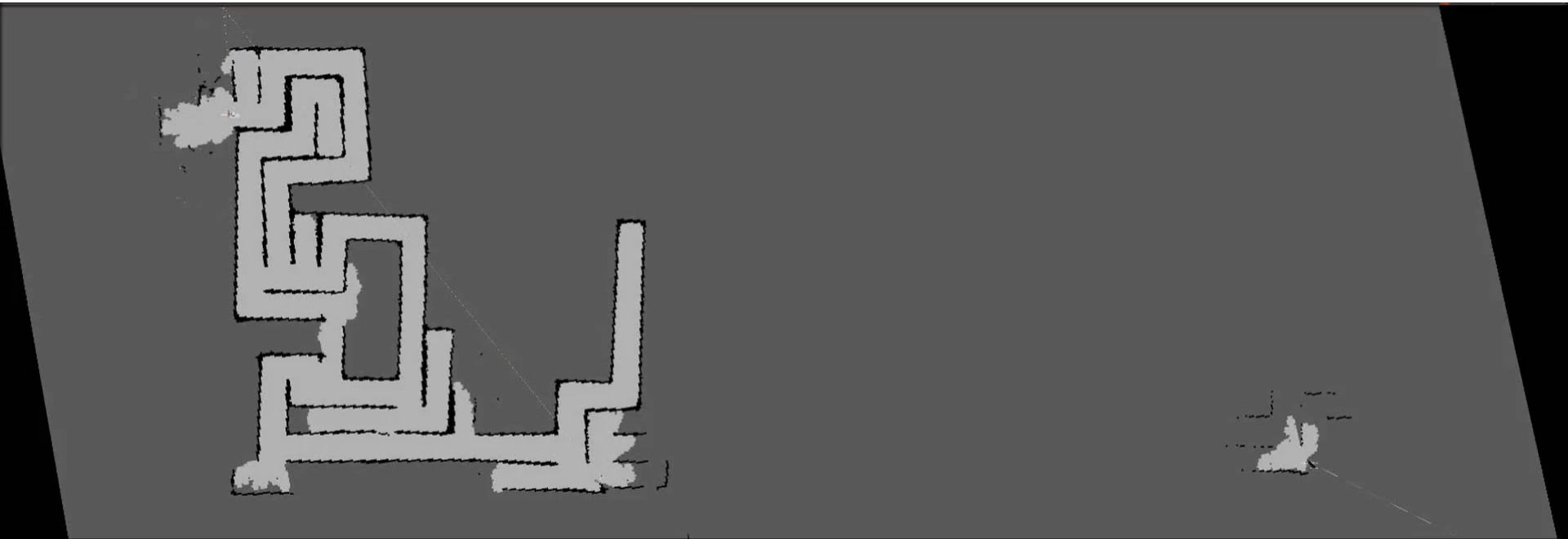
Round 2 – UAV Mapping



Round 2 – UGV Exploration

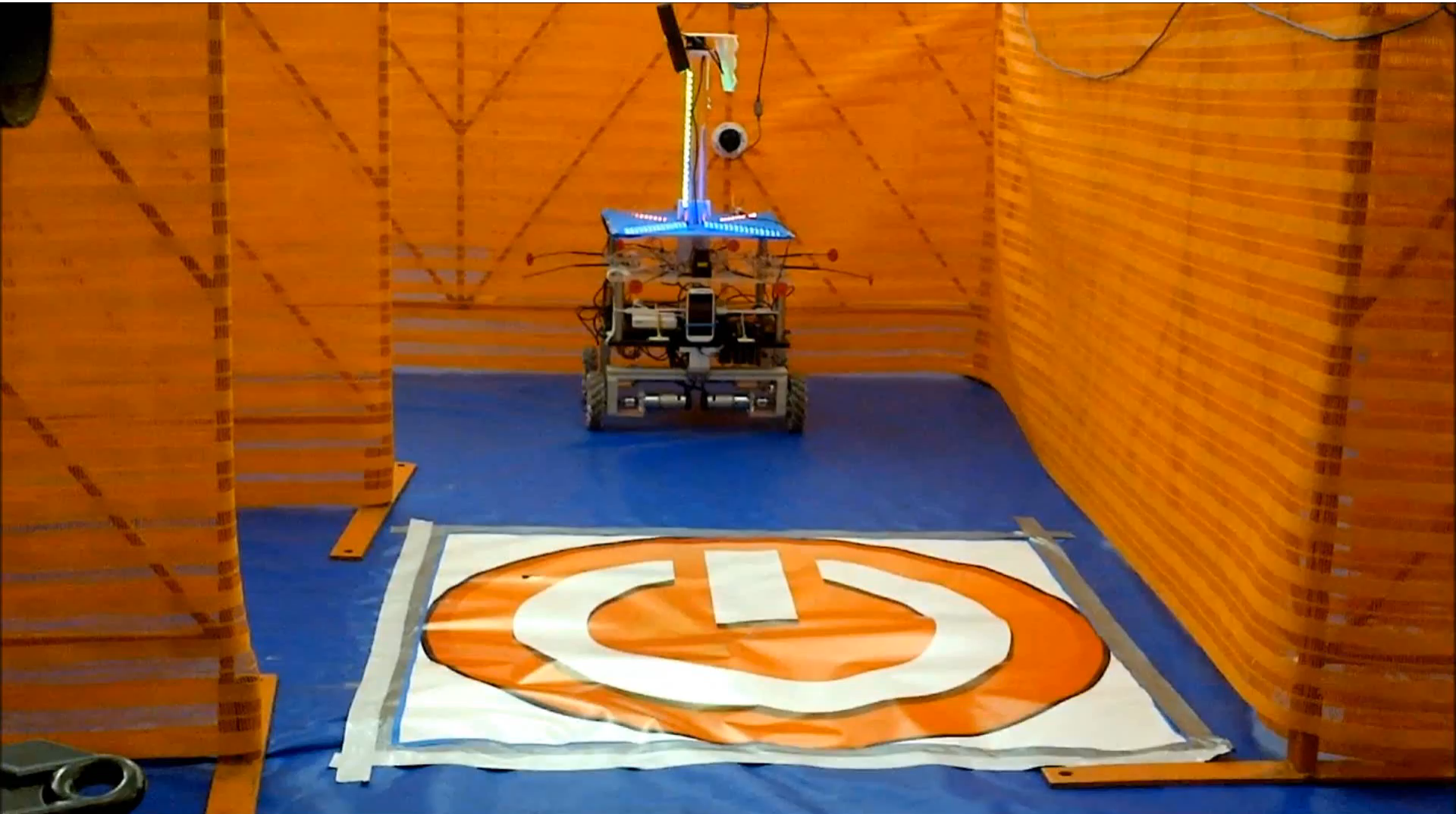


Round 2 – Map Merging



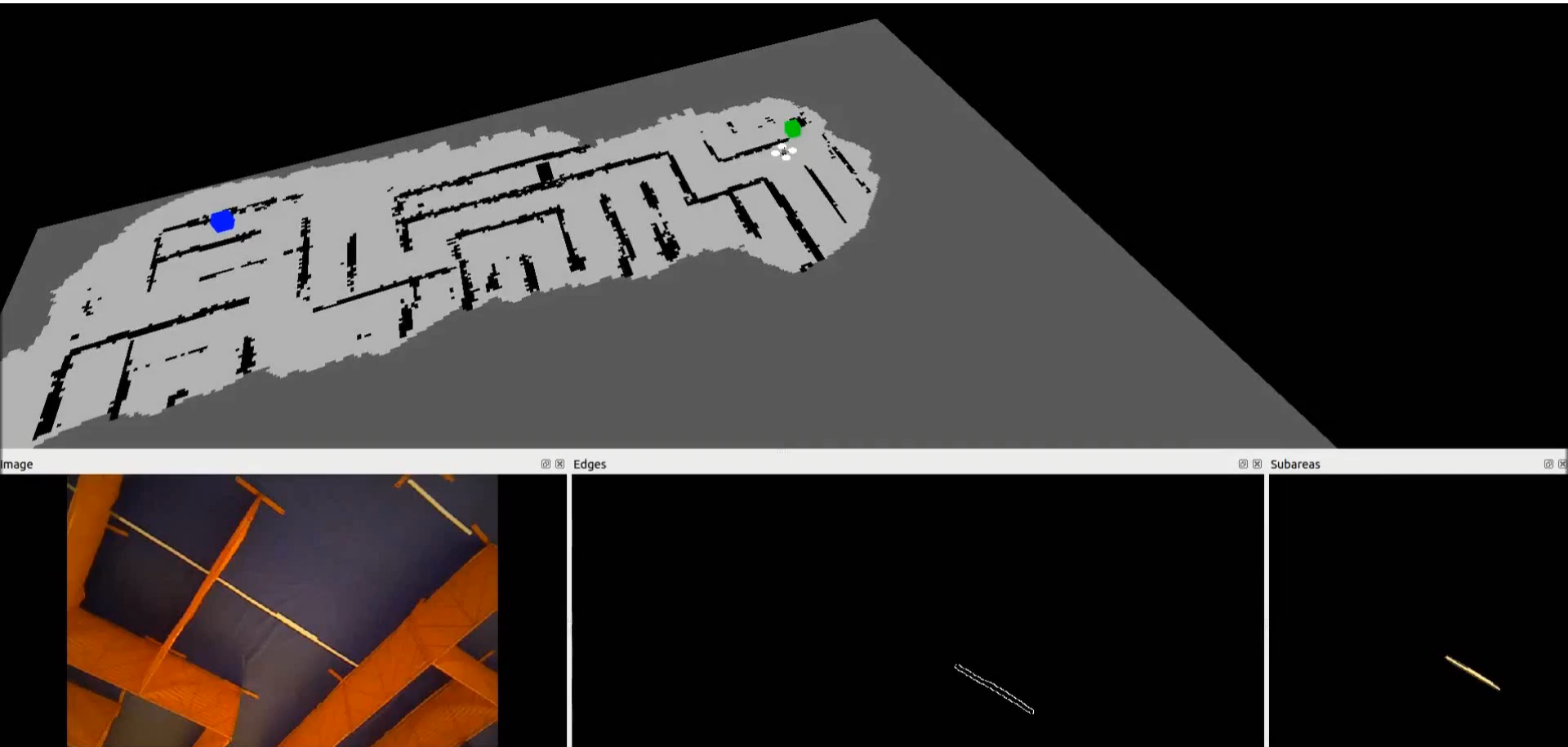


Round 2 – Victory!





Ongoing Development at MITLL





Team



- Ethan Philips
- Kenta Hood
- Frank Bieberly
- Ken Cole
- Nick Armstrong-Crews
- Brian Julian
- Michael Carroll
- Anil Mankame
- Emily Anesta



(Reiterate) Key System Design Points

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