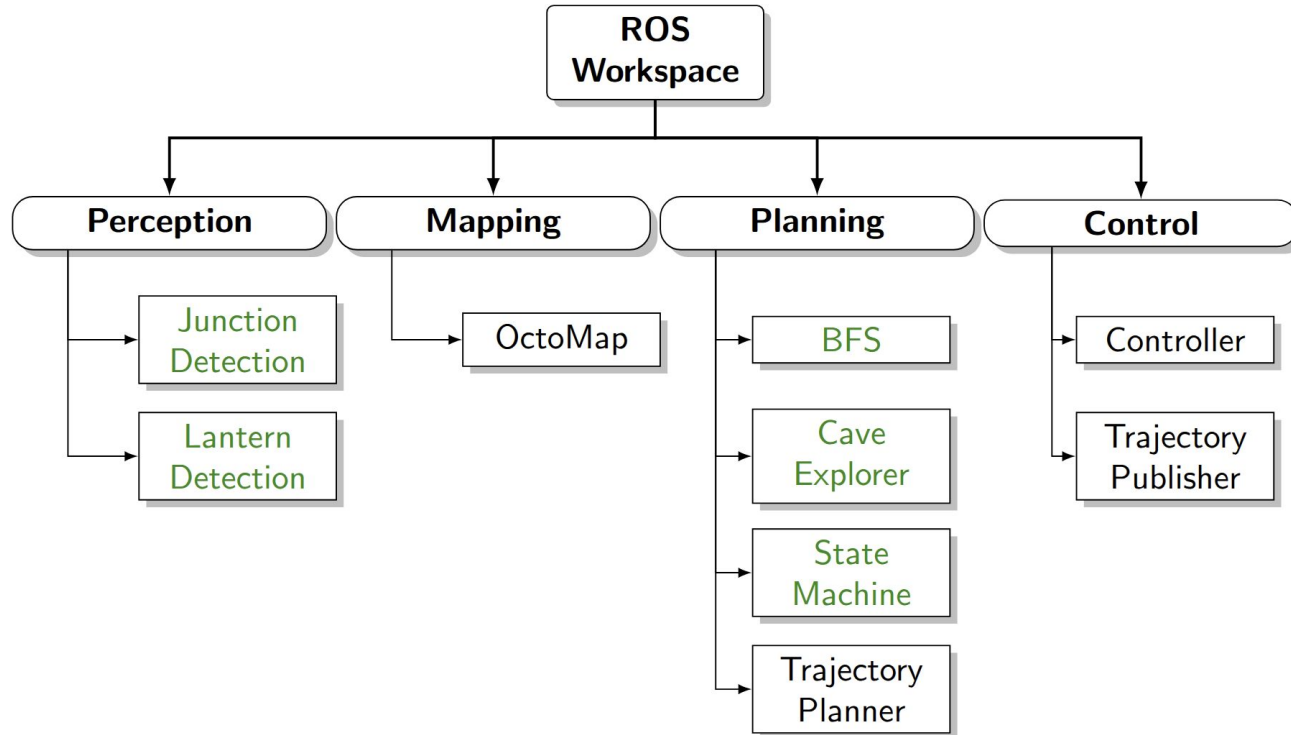


Autonomous Systems

Group 07

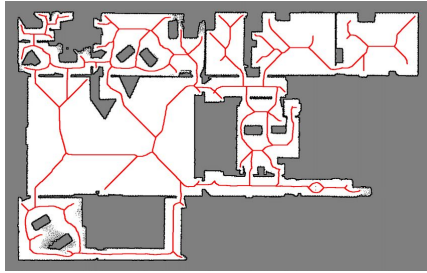
Sarper Gürbüz, Ali Karakullukcu, Valentin Merle, Mateus Salomao, Glenn Tungka

Workspace structure



Perception

Junction Detection - Old

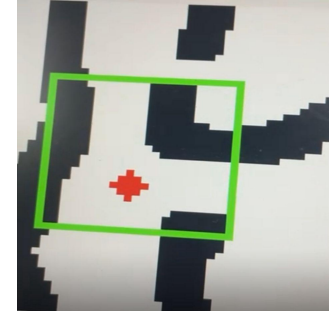


Skeletonize occupancy map



$$\begin{bmatrix} 1 & 1 & 1 \\ 1 & 10 & 1 \\ 1 & 1 & 1 \end{bmatrix} > 12$$

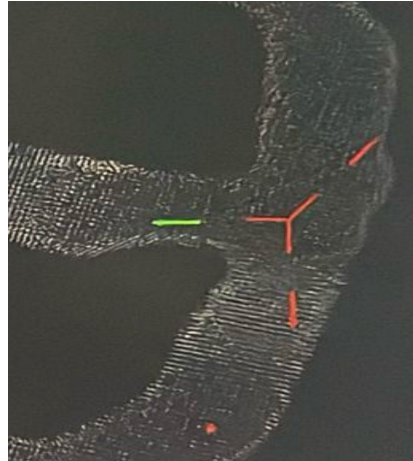
Apply kernel to skeleton to find junctions in 2D



If we observe it multiple timesteps

Limitations:

1. Many parameters to tune
2. Need additional dead-end detection



Get the skeleton directions, save them as outgoings and center as junction

Junction Detection

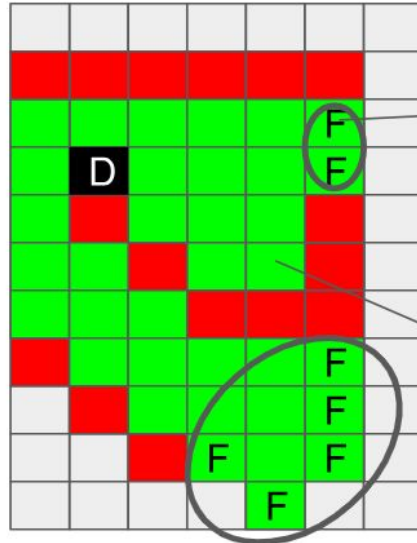
 unknown

 free

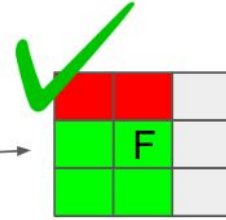
 occupied

 drone

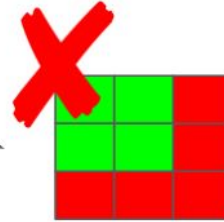
 cluster



 frontier



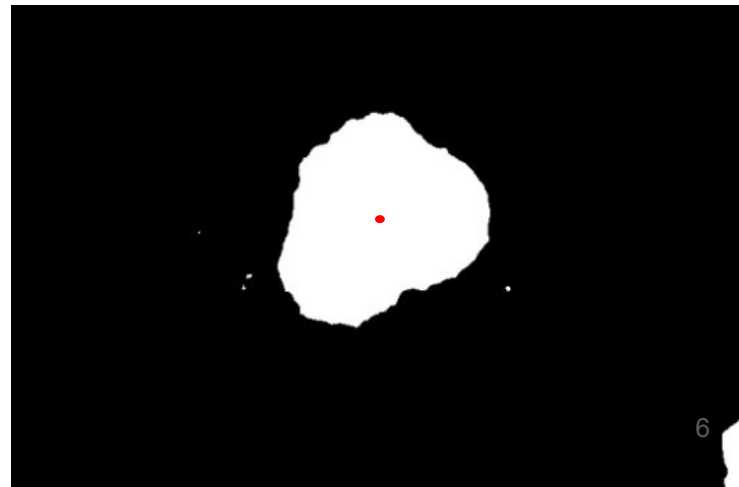
free cell adjacent to unknown cell



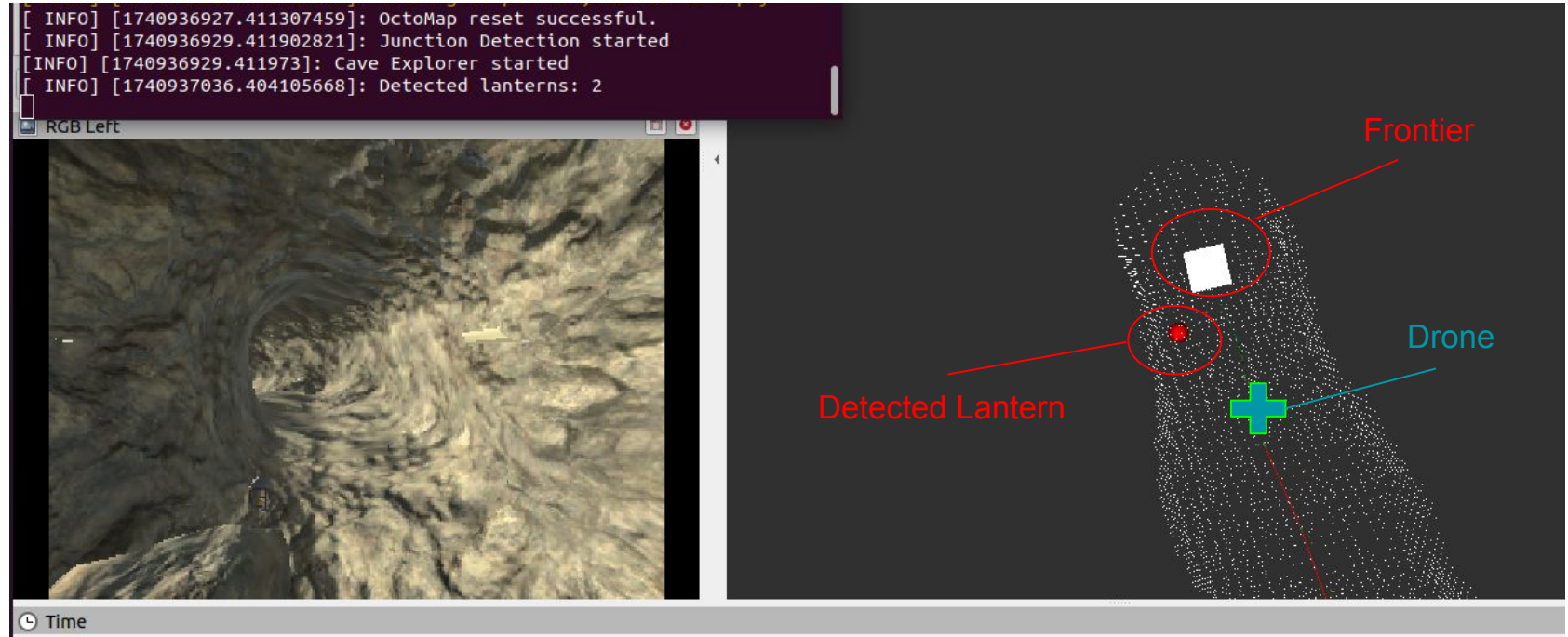
no unknown cell adjacent to free cell

Lantern detection

- **Data Fusion:** semantic camera data + depth camera information
- **Color Segmentation:** HSV conversion and thresholding for yellow hues, then masking
- **Contour Analysis:** Identifies the largest contour and computes its centroid
- **3D Mapping:** Maps 2D centroid to 3D space with depth data

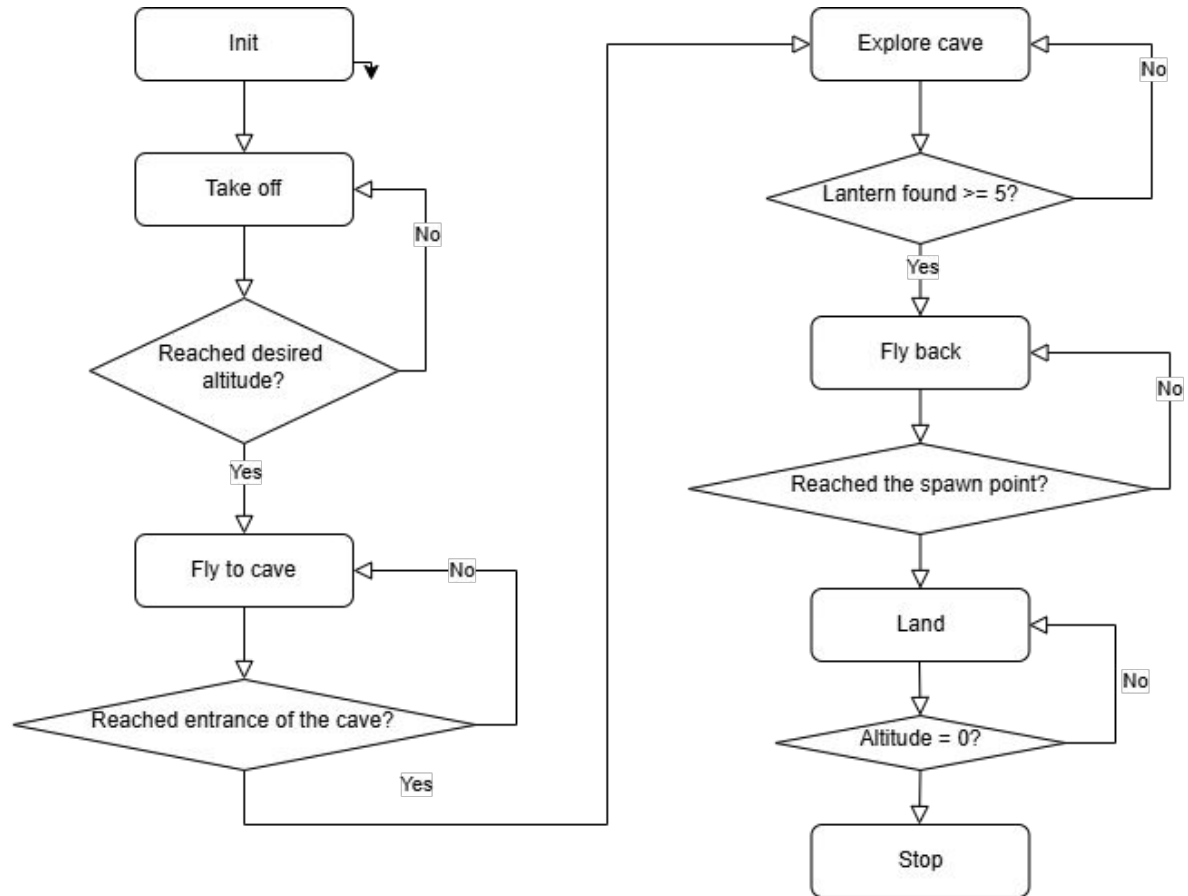


Lantern detection

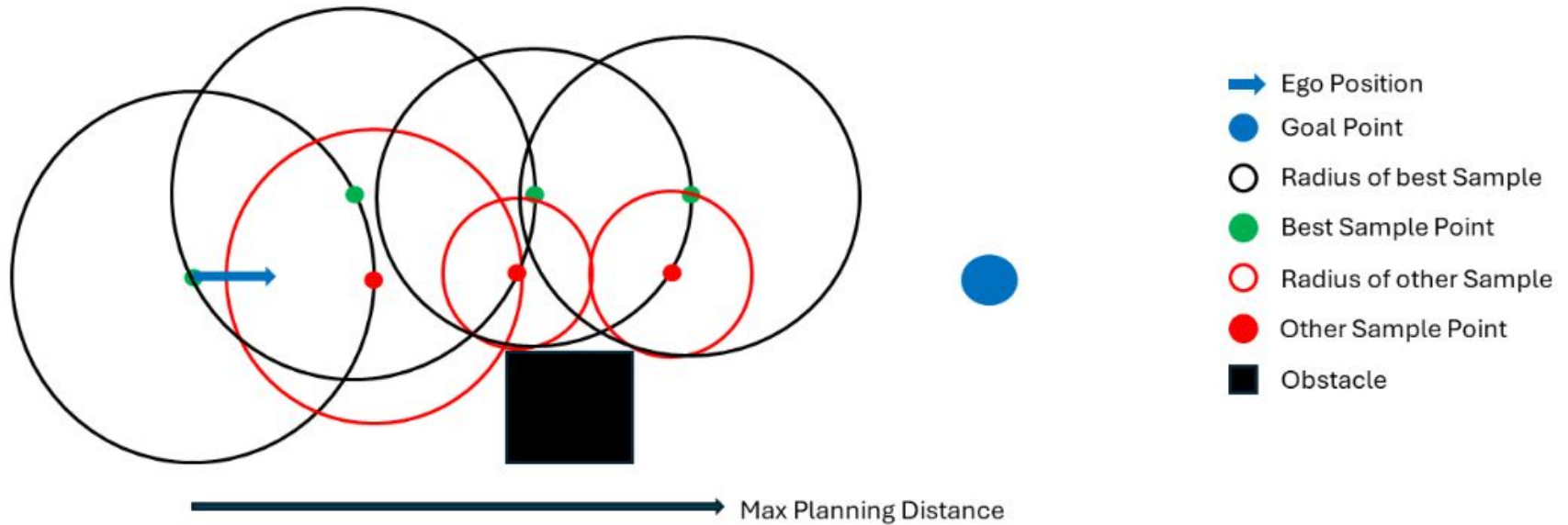


Planning

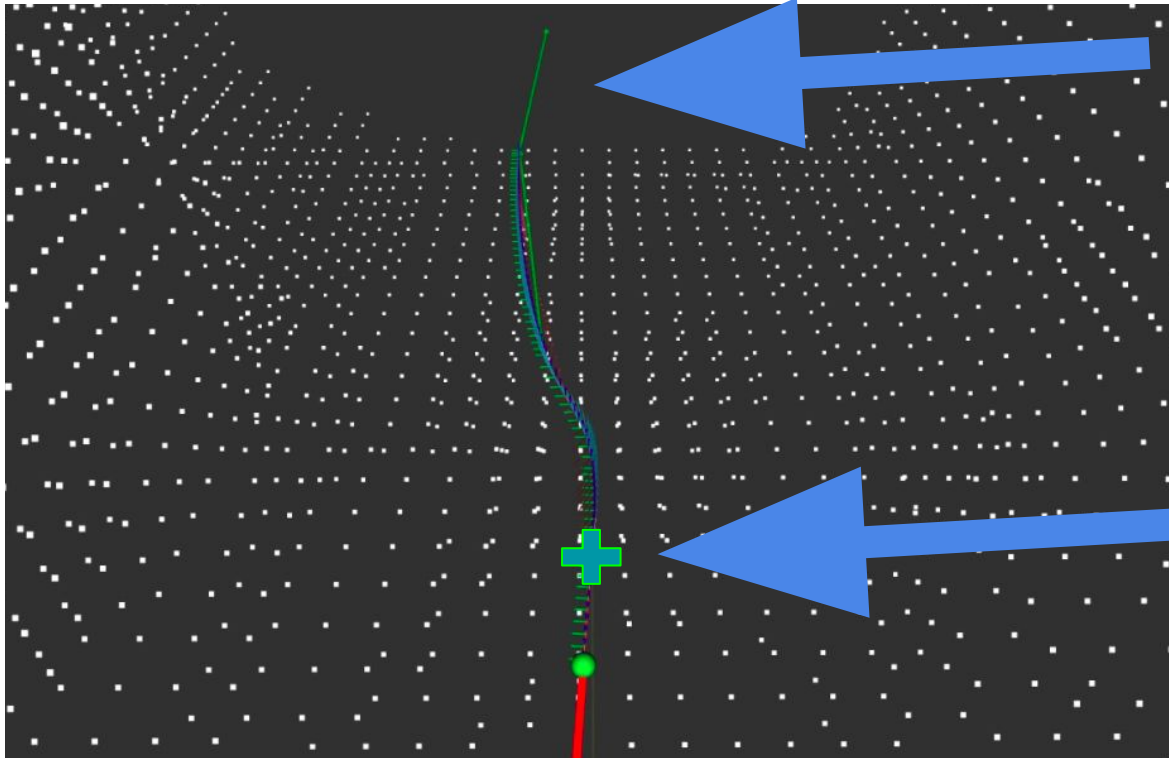
State machine



Cave explorer



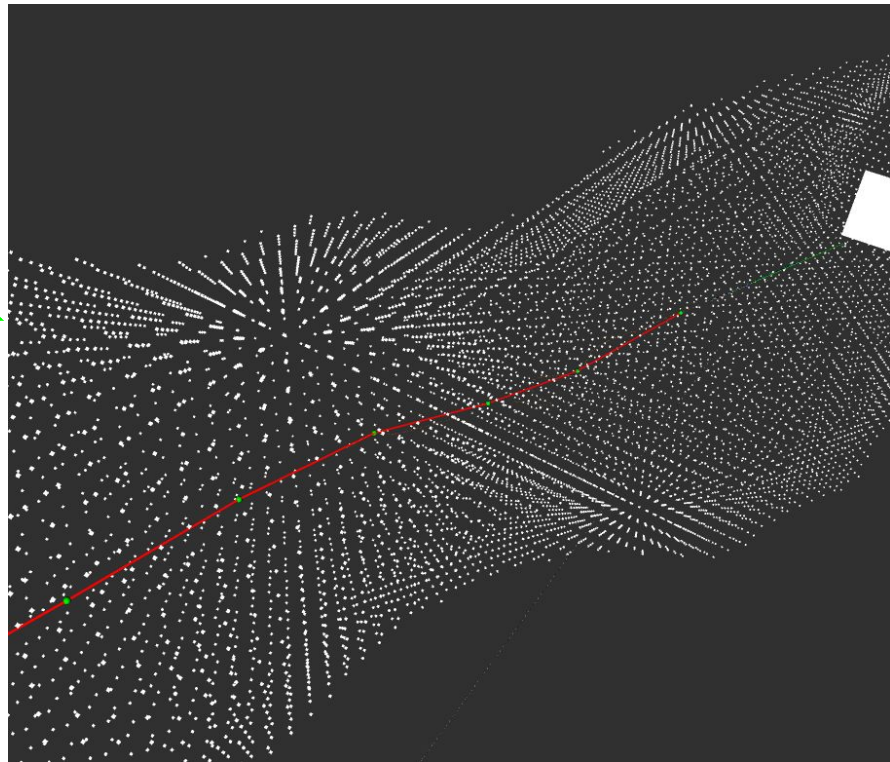
Cave explorer



Arrow from Sampled Point to
next Sampled Point in Path

Drone

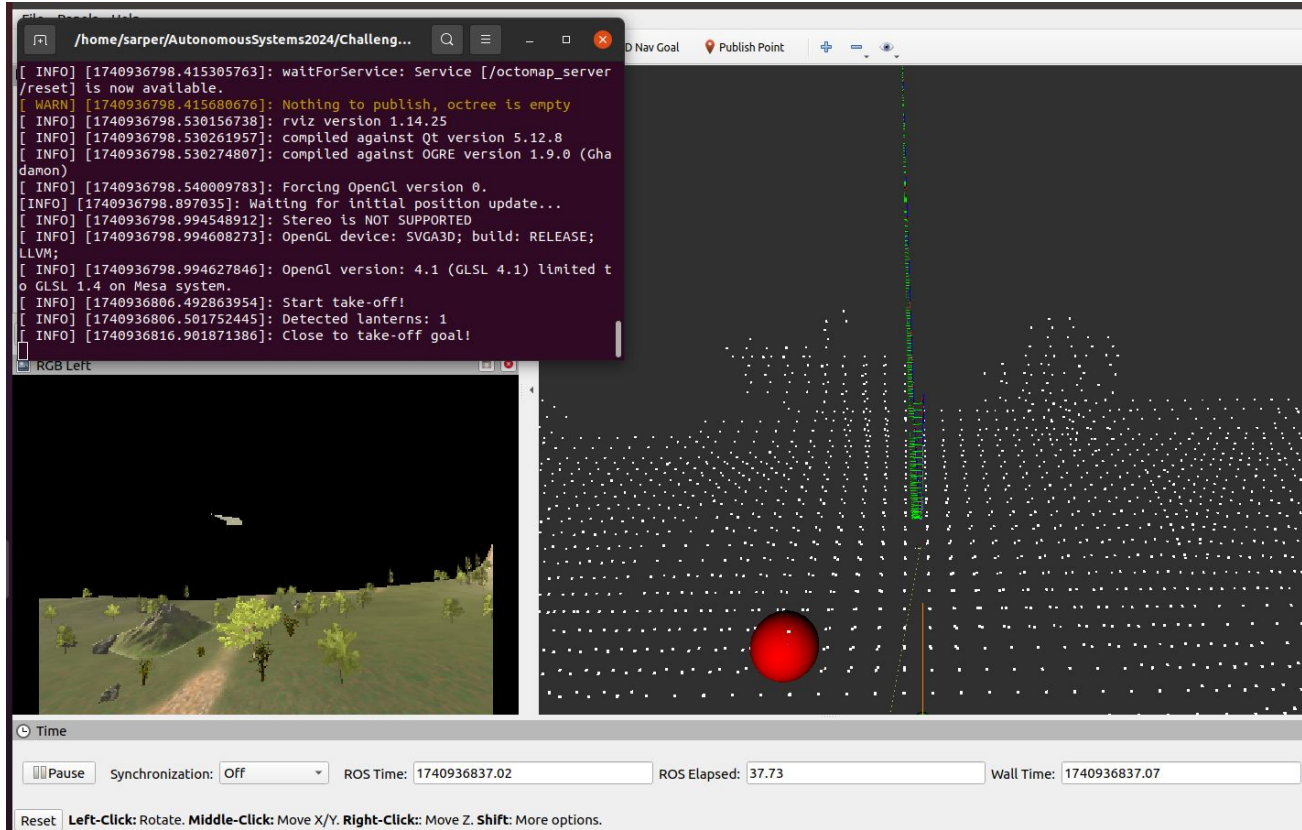
BFS



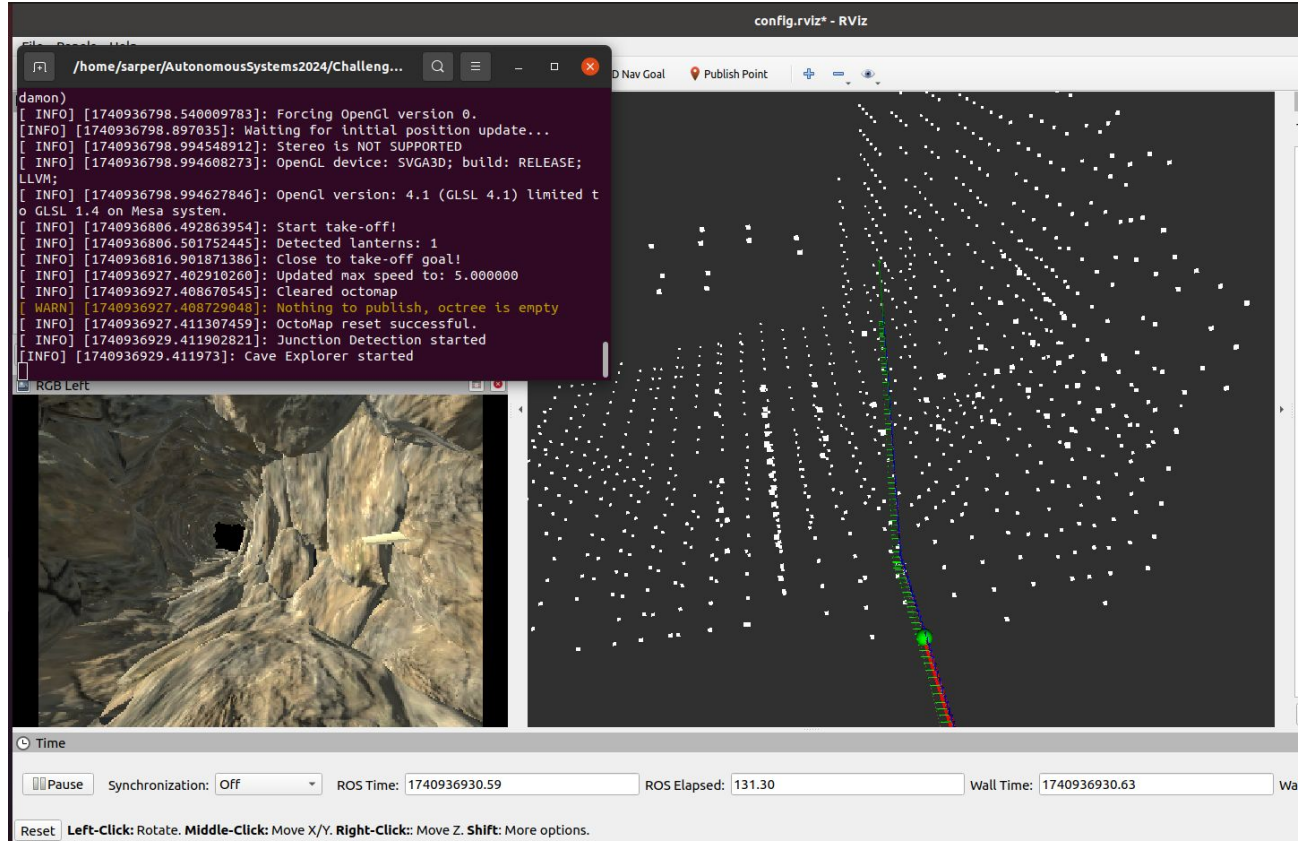
● Nodes
— Edges

Screenshots From the Simulation

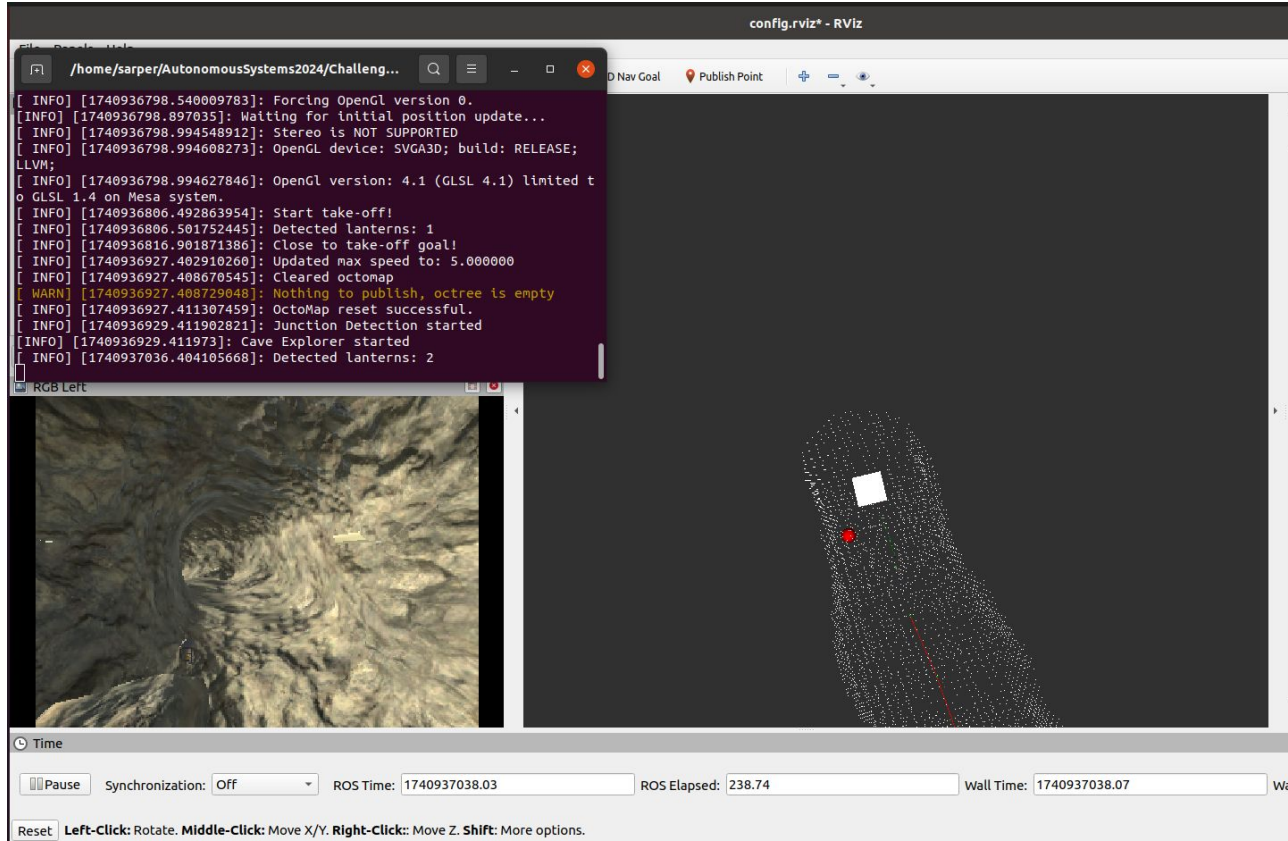
Step 1: Taking-Off



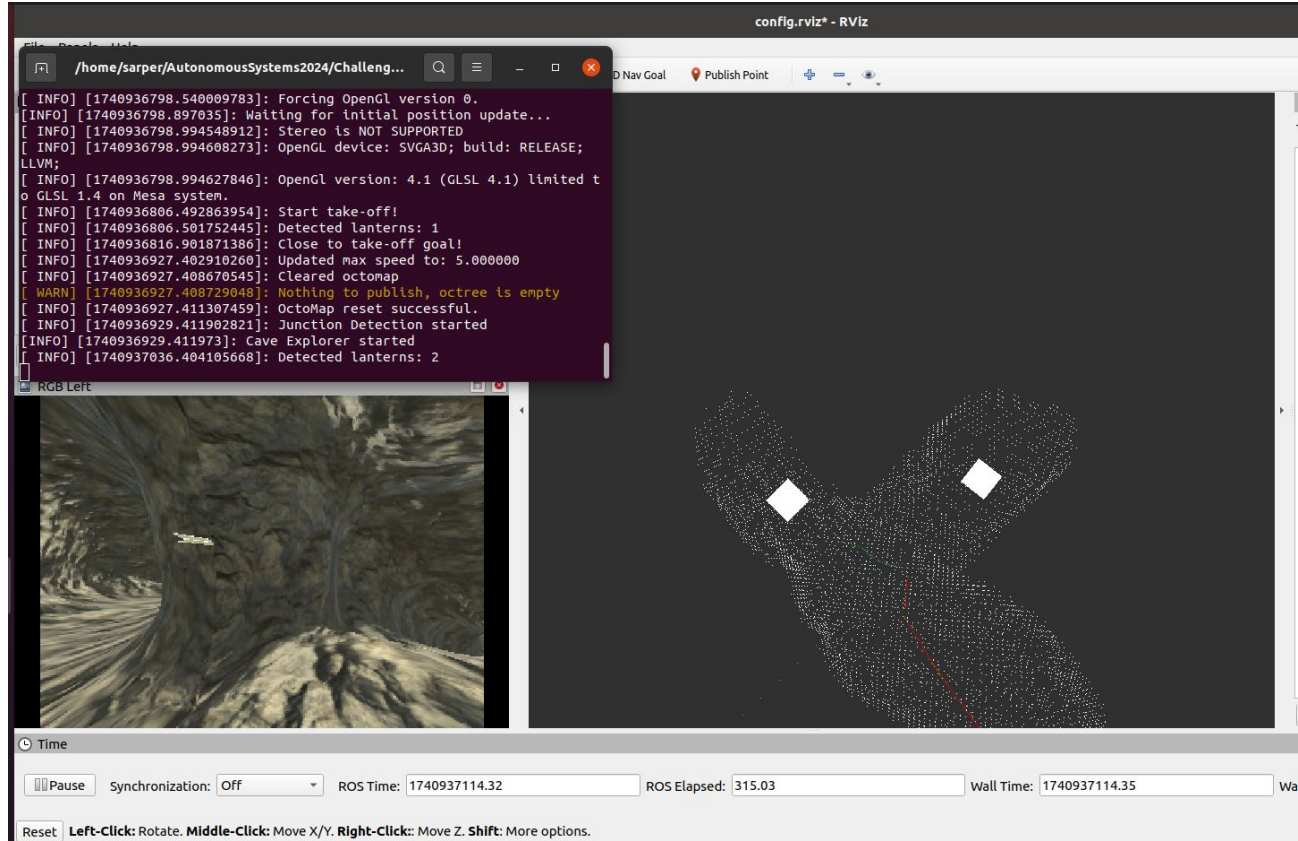
Step 2: Entering the Cave



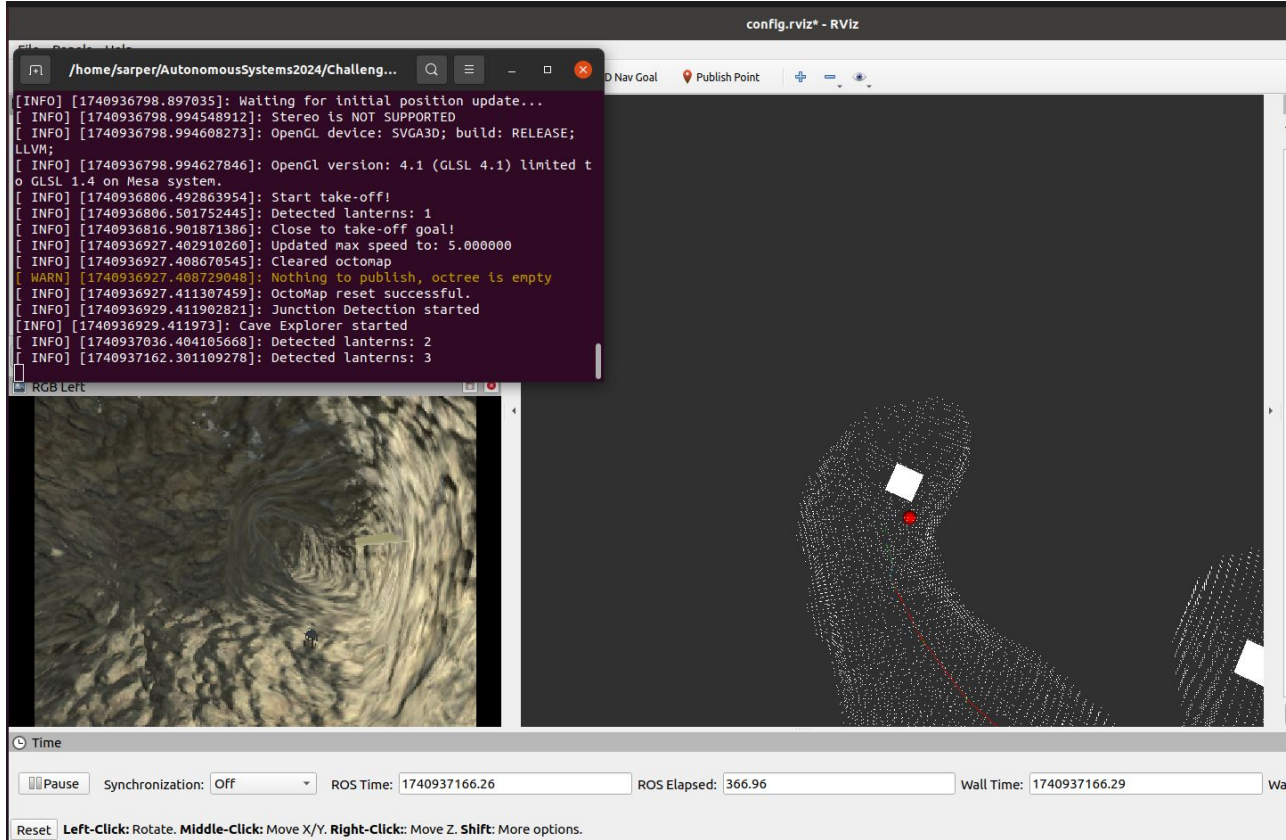
Step 3: Lantern Detection 1



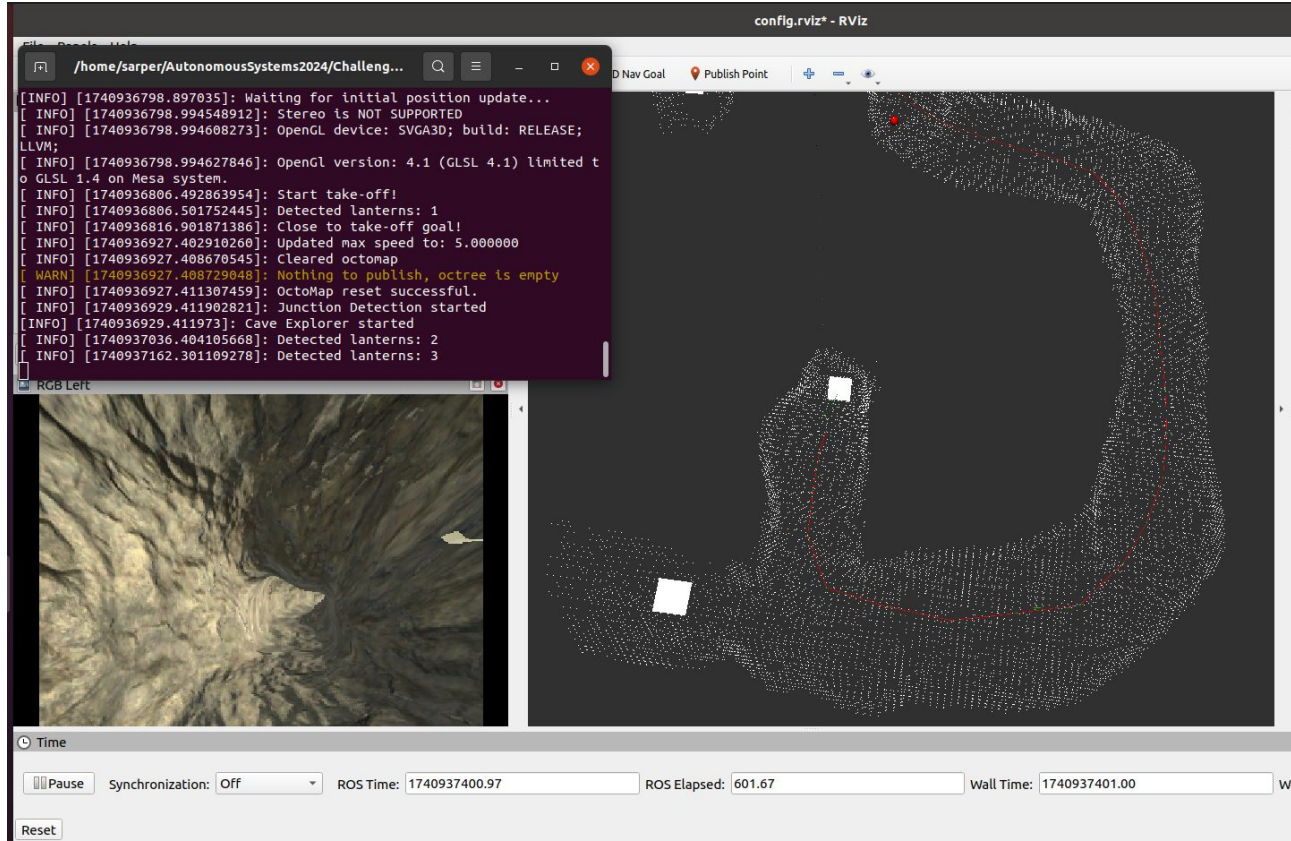
Step 4: First Junction Detection



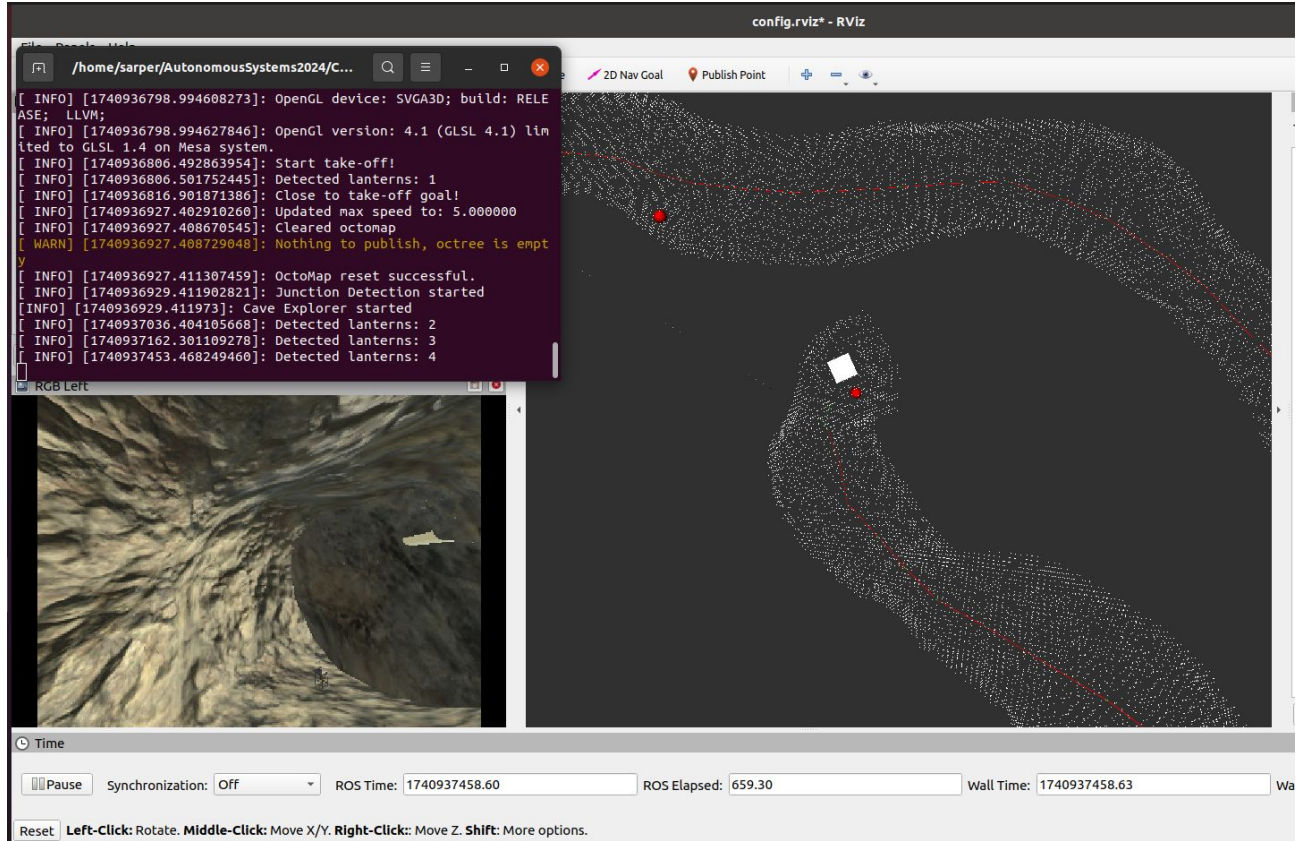
Step 5: Lantern Detection 2



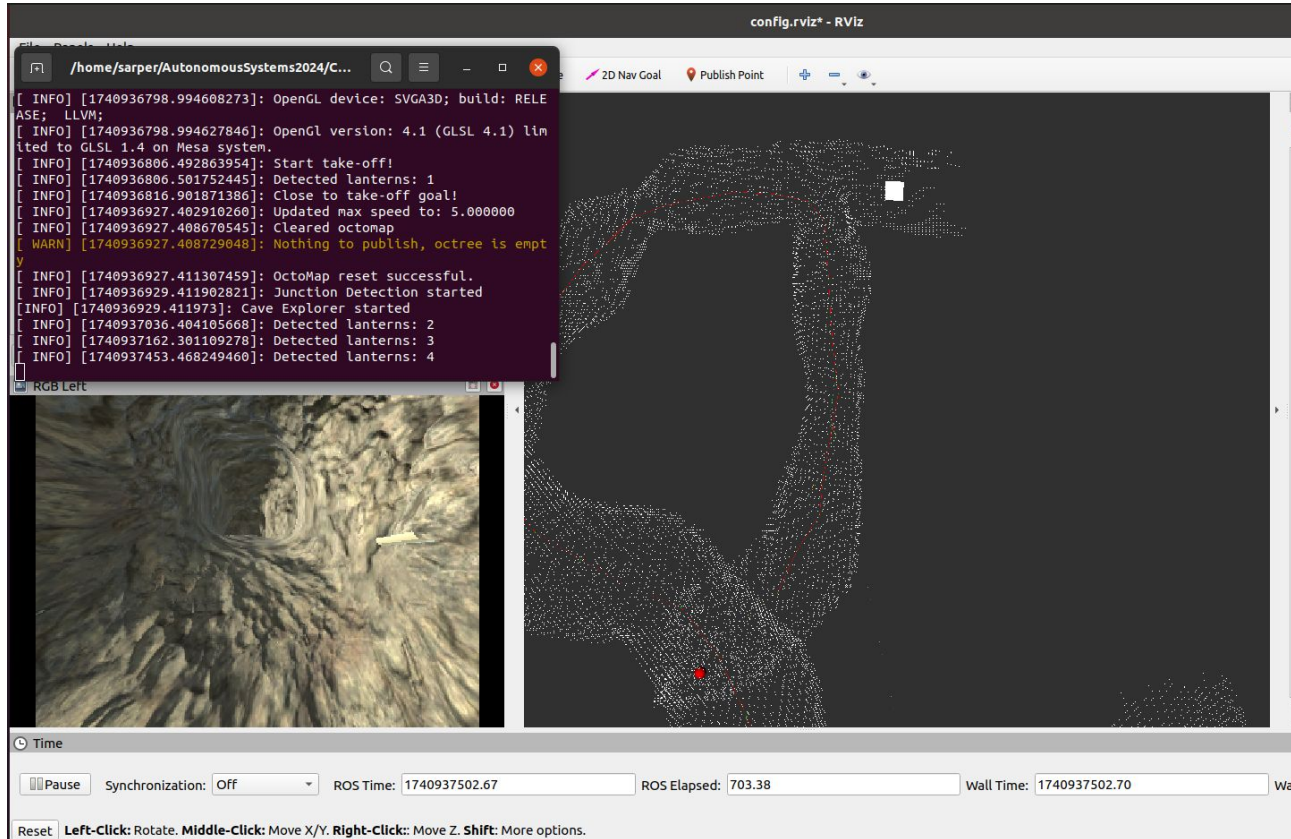
Step 6: Second Junction Detection and Dead-end



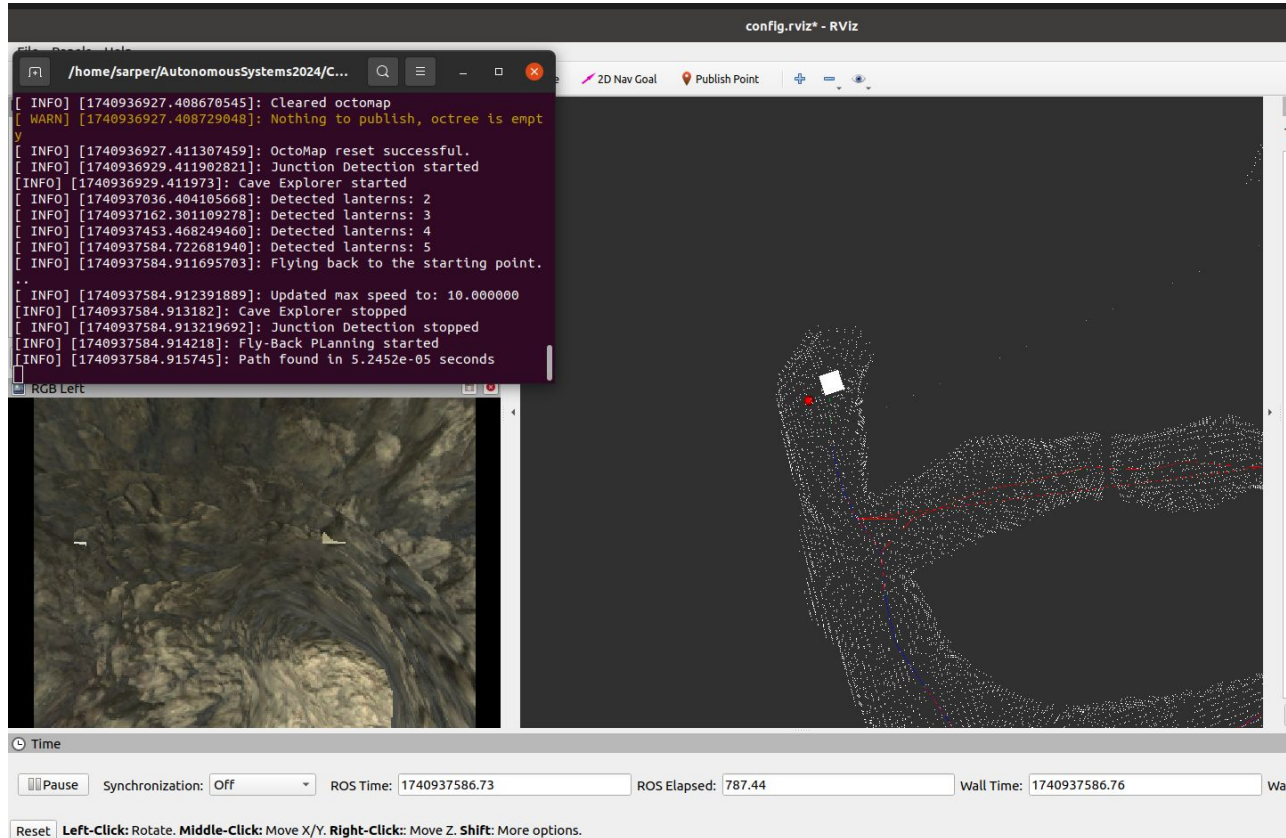
Step 7: Lantern Detection 3



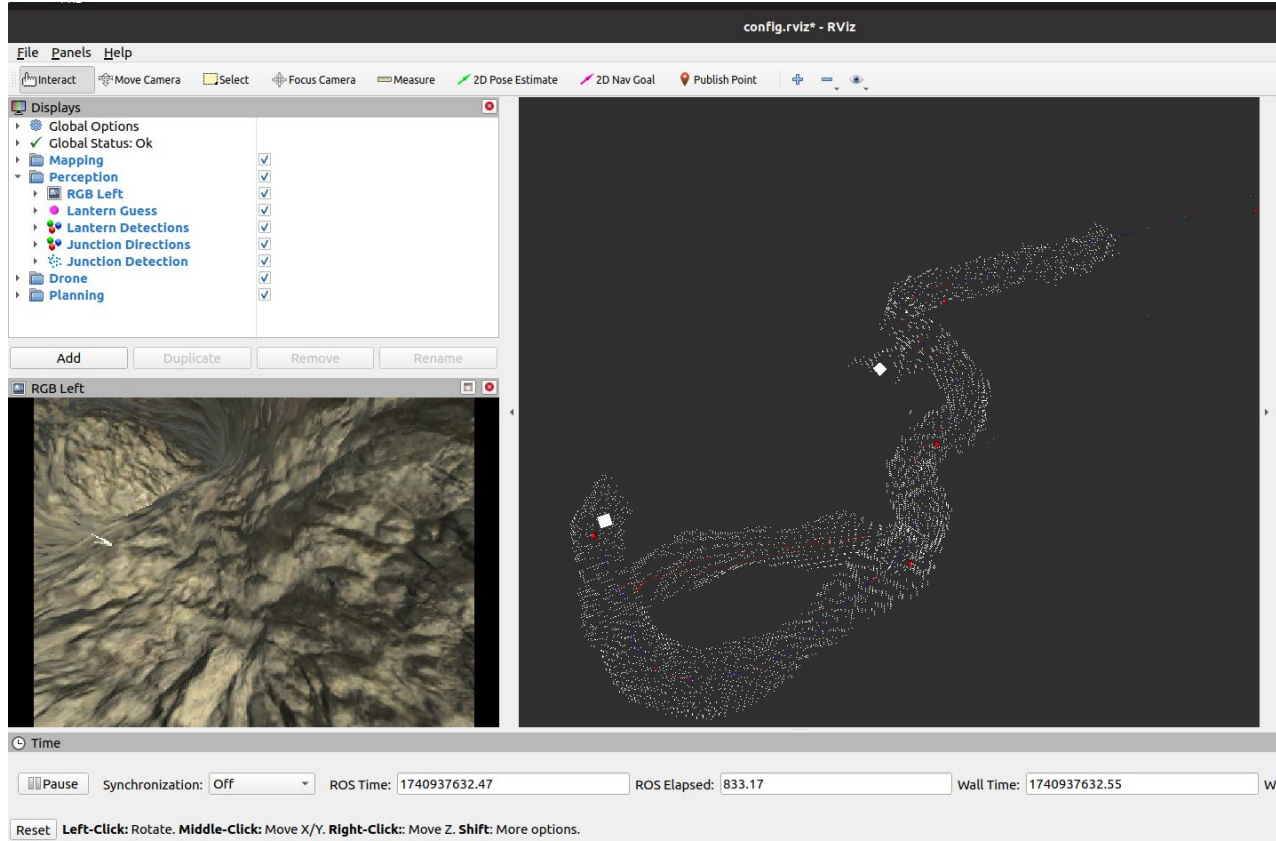
Step 8: Exiting From Dead-End



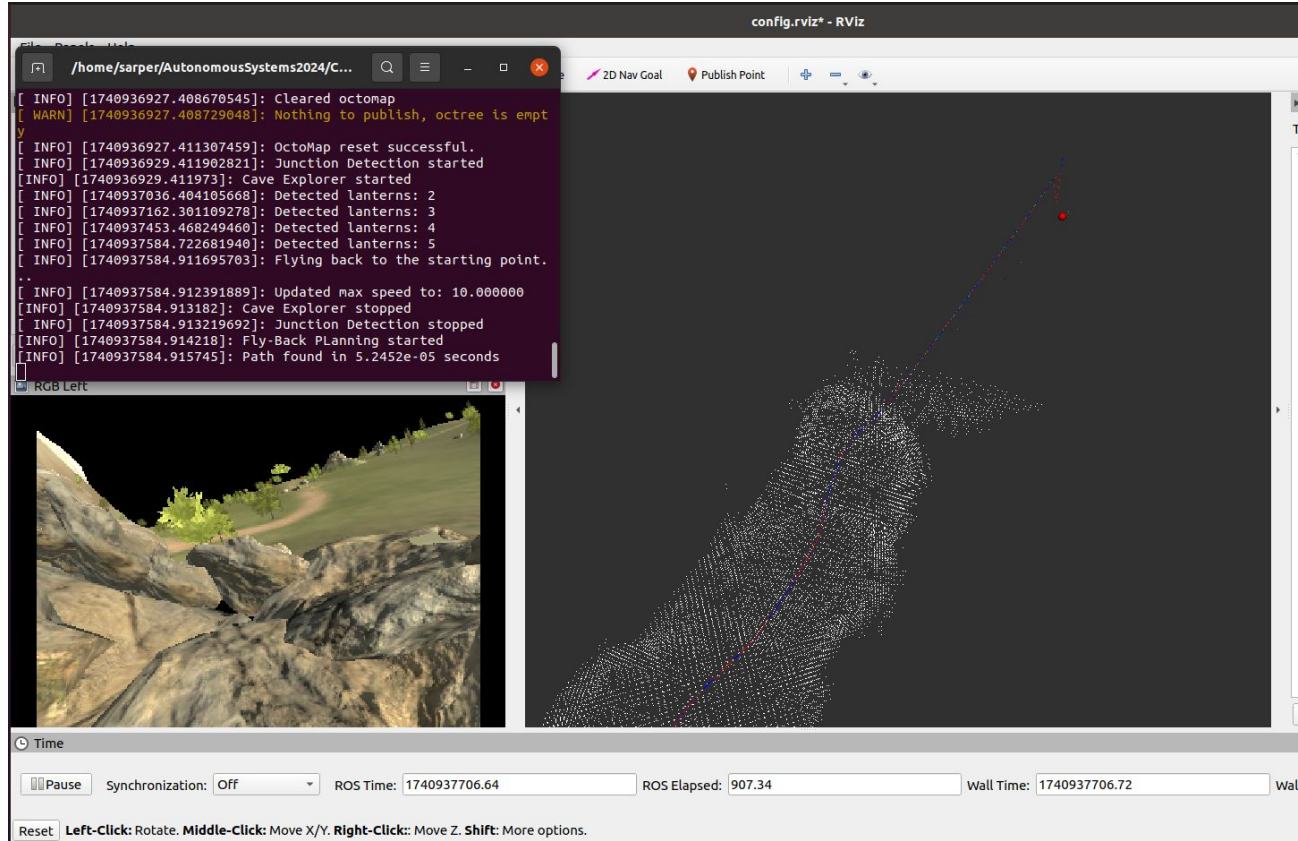
Step 9: Lantern Detection 4 and Triggering of Fly-Back



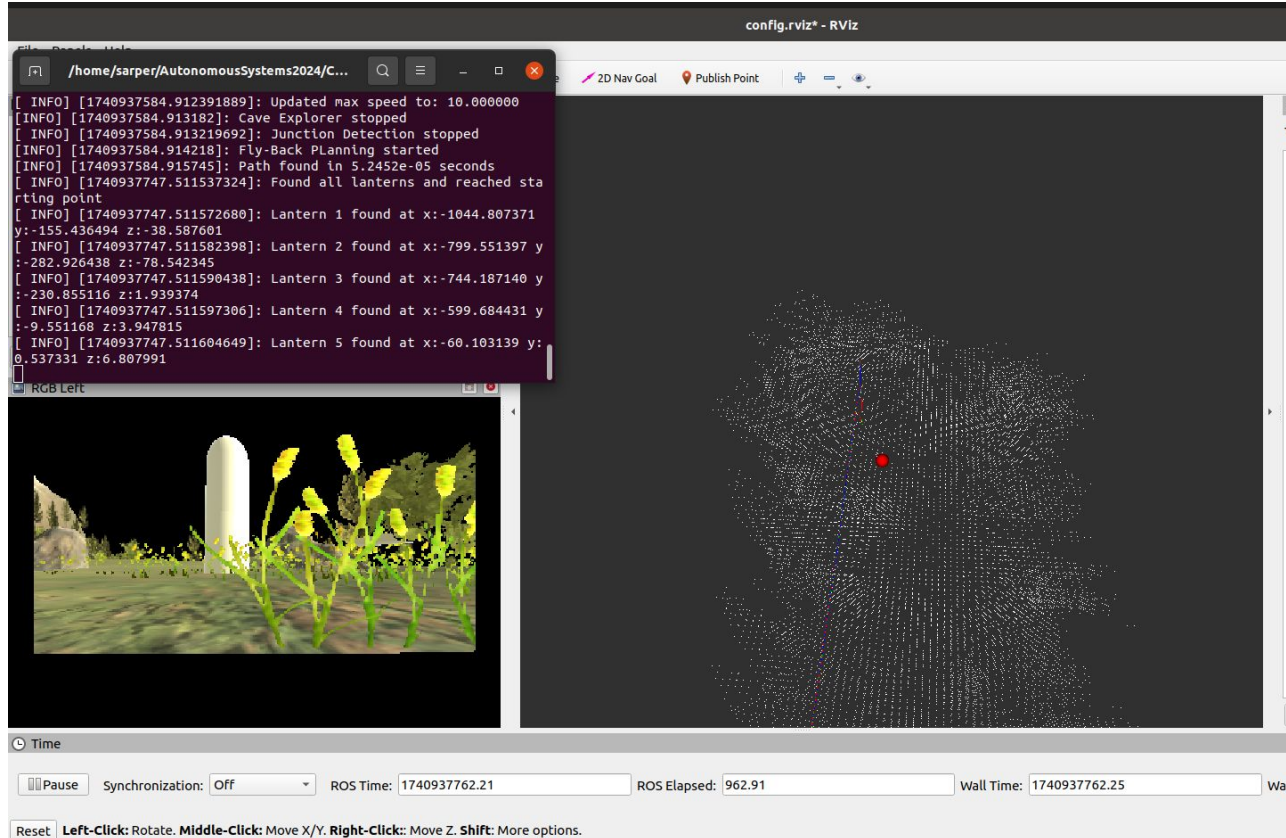
Step 10: View of Whole Explored Cave



Step 11: Exiting The Cave



Step 12: Landing and Lantern Locations



Possible issues and limitations

- Drone might shake when using low RAM devices → octomap becomes noisy → drone stops exploring because of “artificial” wall
- It is assumed that ROS Noetic and catkin is installed on the computer but we also included the installation in a build script