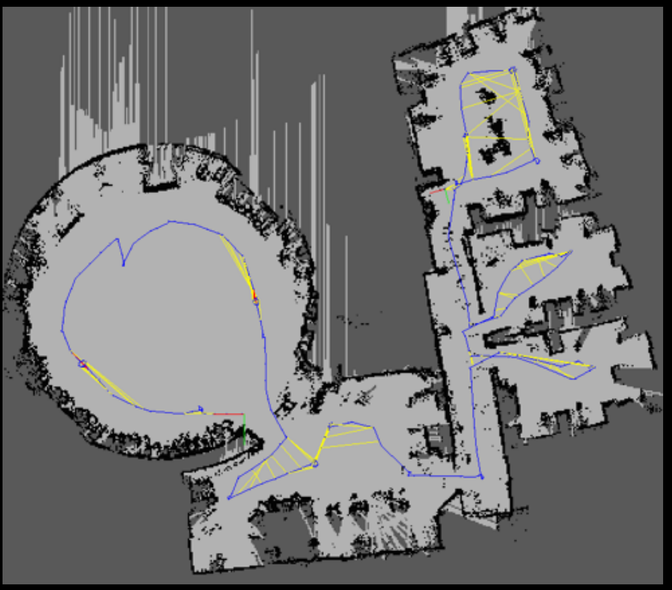
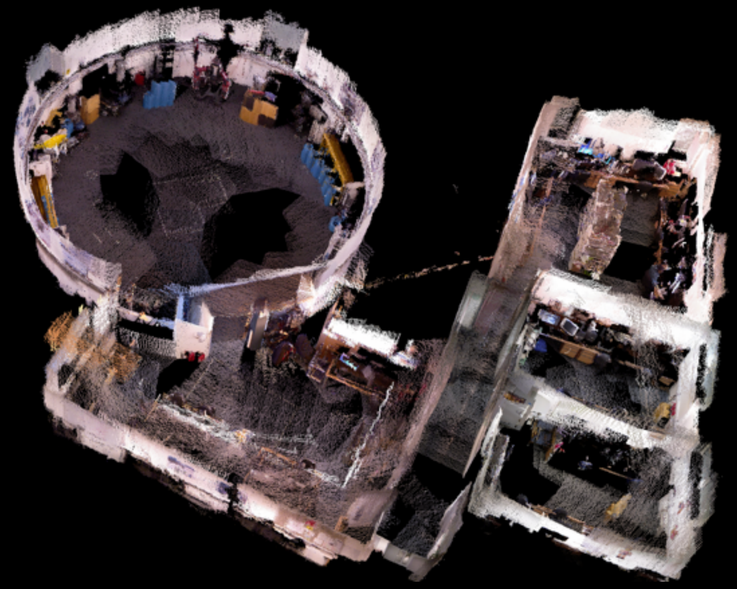
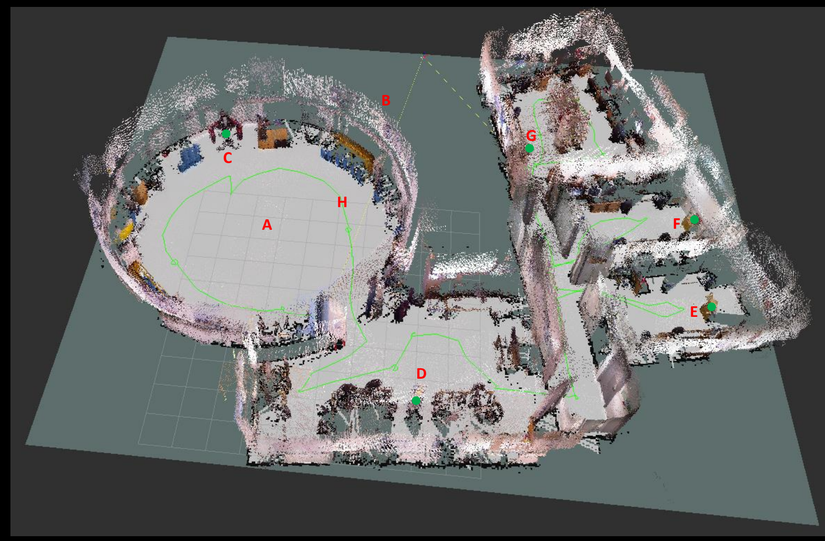
Building a grid-point cloud-semantic map based on graph for the navigation and object searching







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1. Motivation

How to make the robot find a bottle of cola in a large home?
The key is that make the robot can *mapping*, *navigation* and *object searching*.

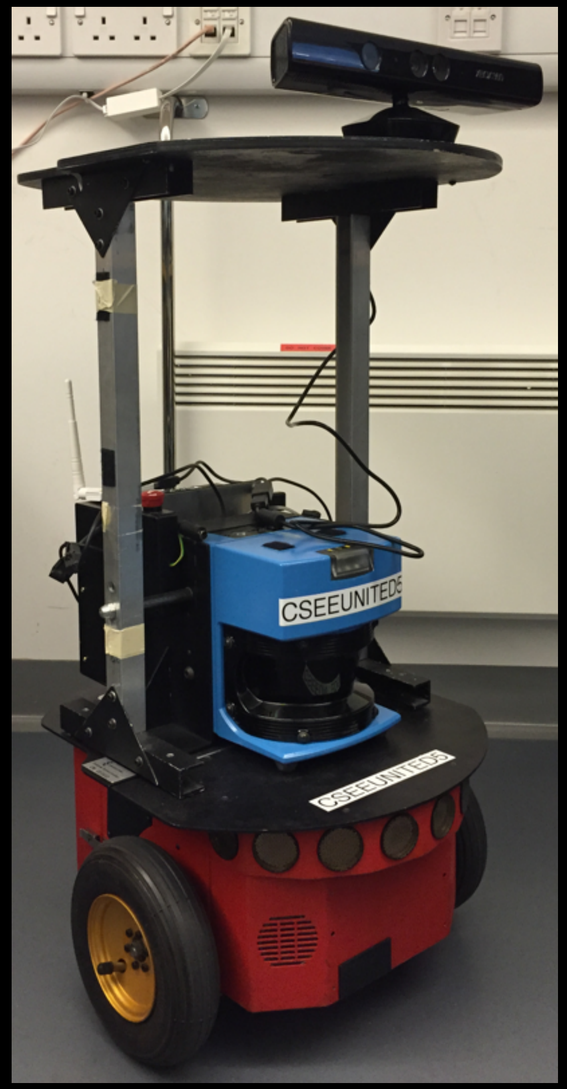
2D grid map: easy to path planning, lack of visual features and semantic information
3D point cloud map: contain rich 3D visual features, is hard to path planning and lock of semantic information
Semantic labelled map: contain semantic information for scene understanding and human-robot interaction

We built a grid-point cloud-semantic map model, which combines them together for navigation and object searching.

2. System overview and approach

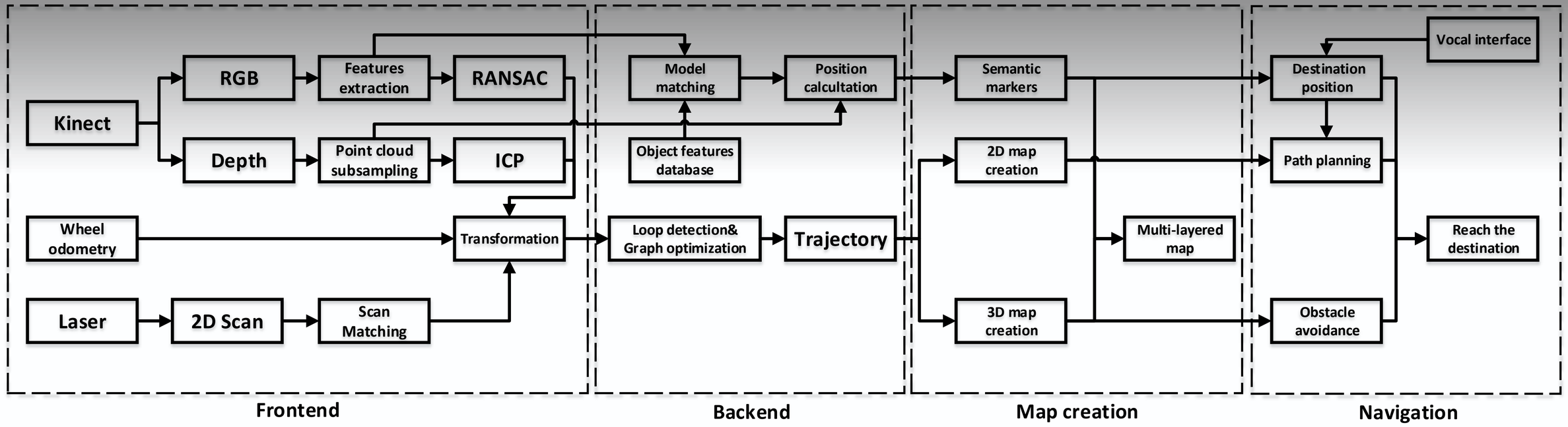
The platform is shown on the right.

P3DT robot equipped with :
Kinect (RGB and depth information)
Sick Laser (2D laser scan)
Odometry (odometry transformation)
On board PC (Ubuntu14.04 with ROS indigo)
Bluetooth earphone (vocal interaction)



2. System overview and approach

Our system can be broken up into four modules: Frontend, Backend, Map creation and Navigation. It consists of three types of map: the 2D grid map is at the bottom, the 3D point cloud map is on the grid map and the semantic markers are labelled in them. The function of those map, 2D grid map: localization and path planning, 3D point map: feature extraction and obstacle avoidance, semantic markers: scene understanding human-robot vocal interaction



2. System overview and approach

Approach:

1. 2D grid mapping: Graph optimization(G2O)

2. 3D point cloud mapping: Graph optimization(G2O), loop closure detection(3D visual word, RANSAC)

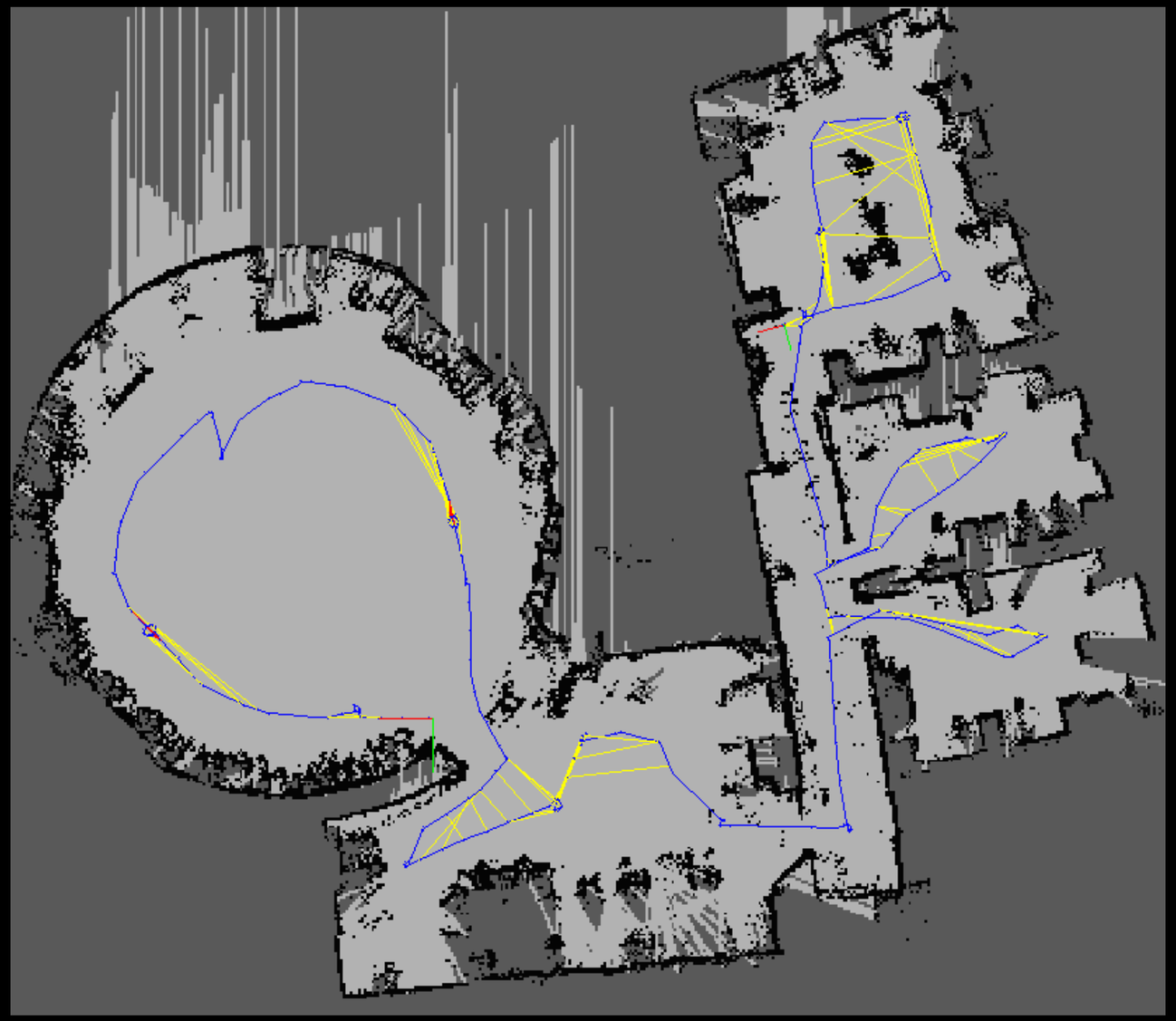
3. Vocal interaction: Pocket Sphinx for speech recognition, transform voice to text

4. Semantic labelling: model matching (ORB feature) through comparing the extracted features from RGB images and the features in the object database, calculate the centre of mass of the object form depth images, combine the semantic name with the coordinate of the centre of mass

5. Navigation: localization based on graph-base SLAM, the user tells robot the destination through vocal interface, use 2D cost map and Dijkstra for path planning, use 3D map for object avoidance (All points with normal in the z direction are labelled as ground and all the others are labelling as objects)

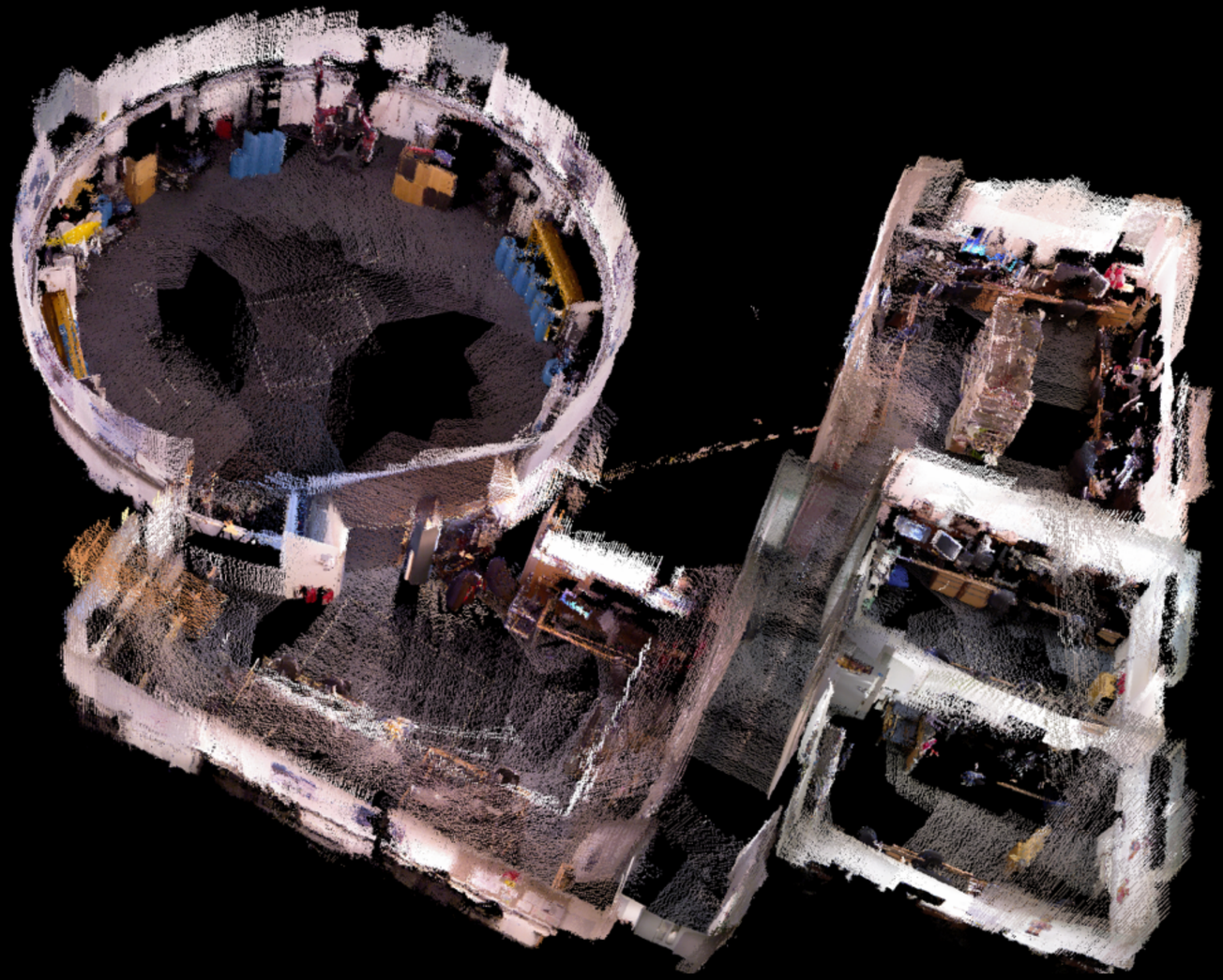
3. Experiments

2D grid mapping based on graph optimization



3. Experiments

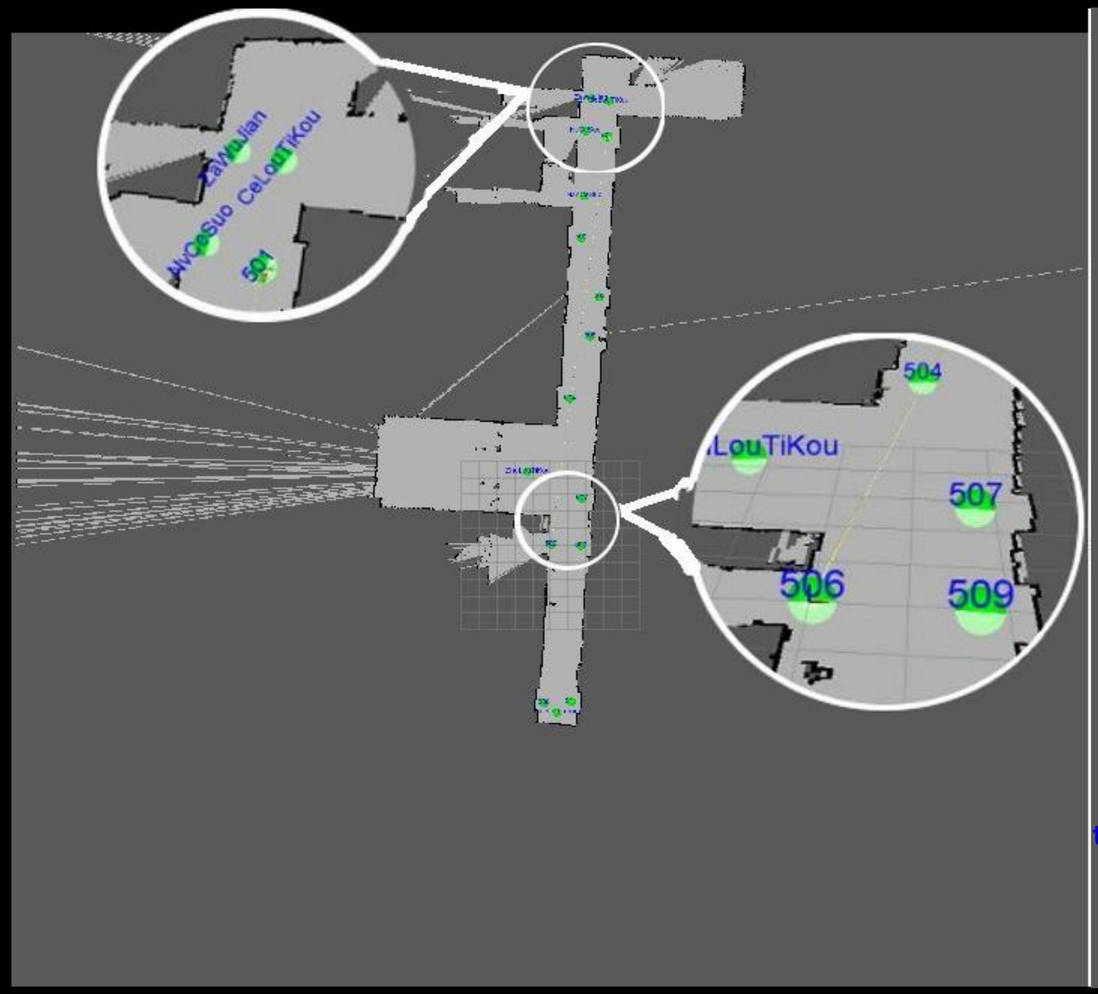
3D point cloud mapping based on graph optimization



Video of mapping

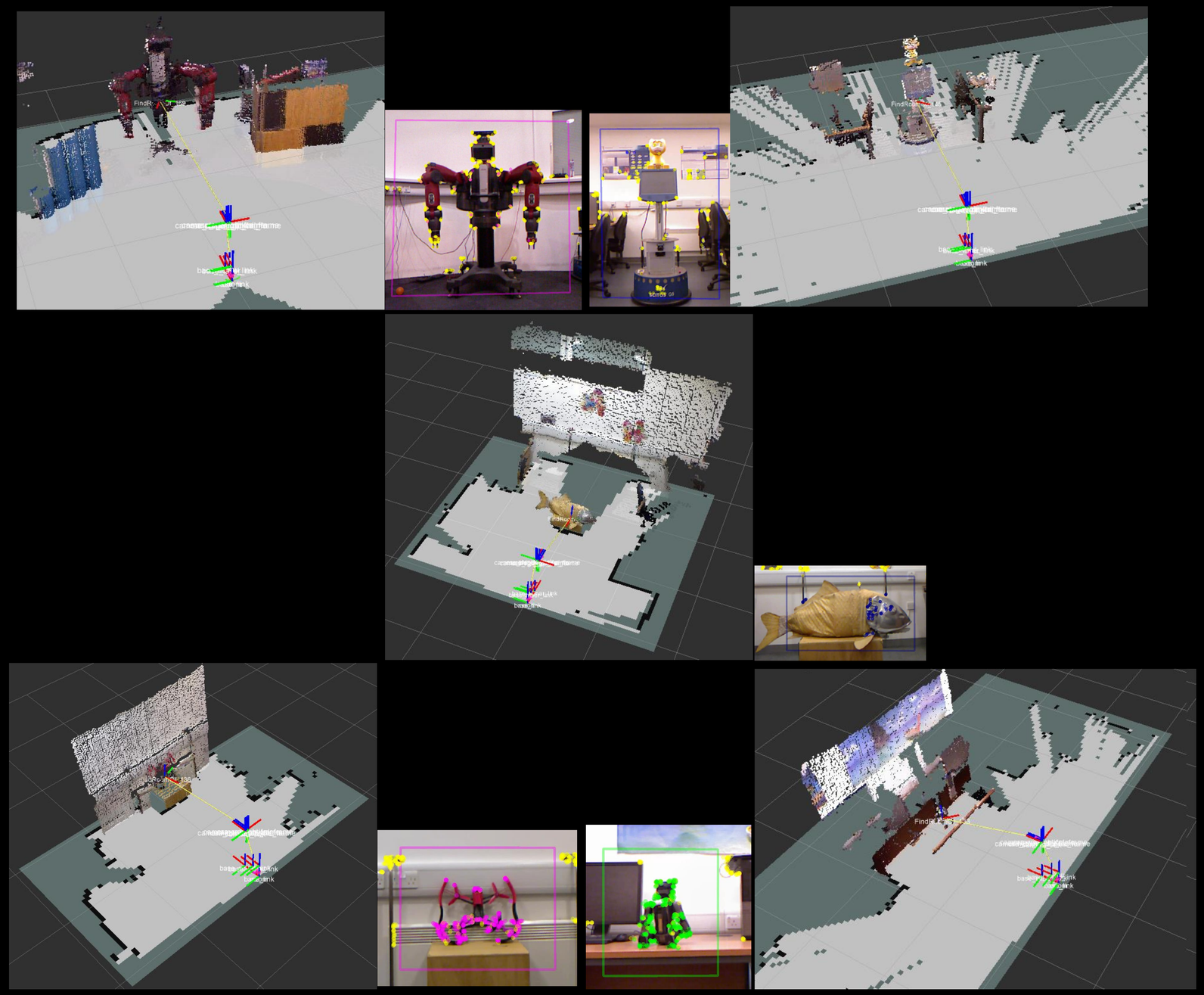
3. Experiments

A. Semantic labelling based on vocal interface
B. Semantic labelling based on modeling matching

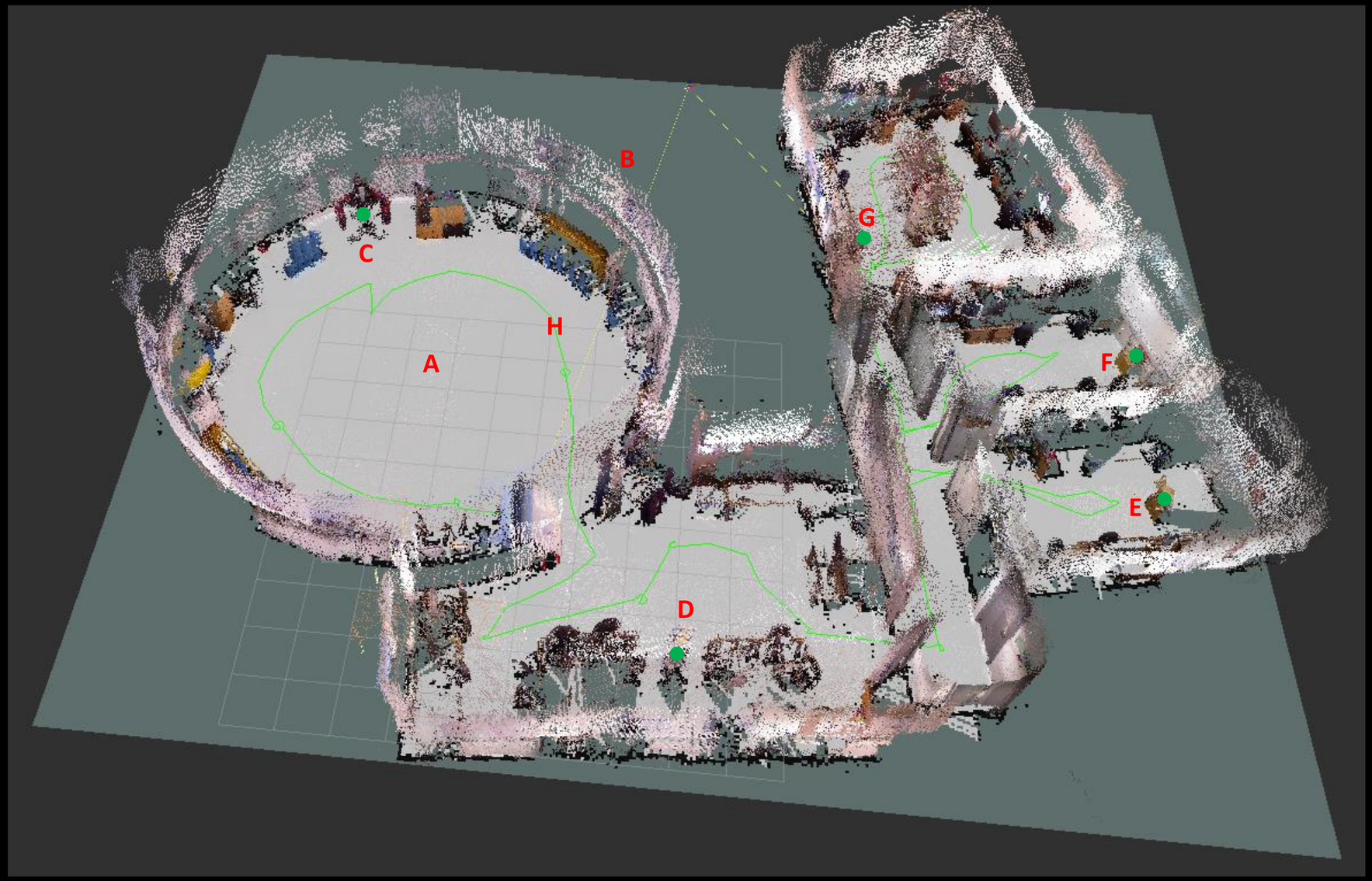


Video of semantic labelling based on vocal interface

3. Experiments



3. Experiments

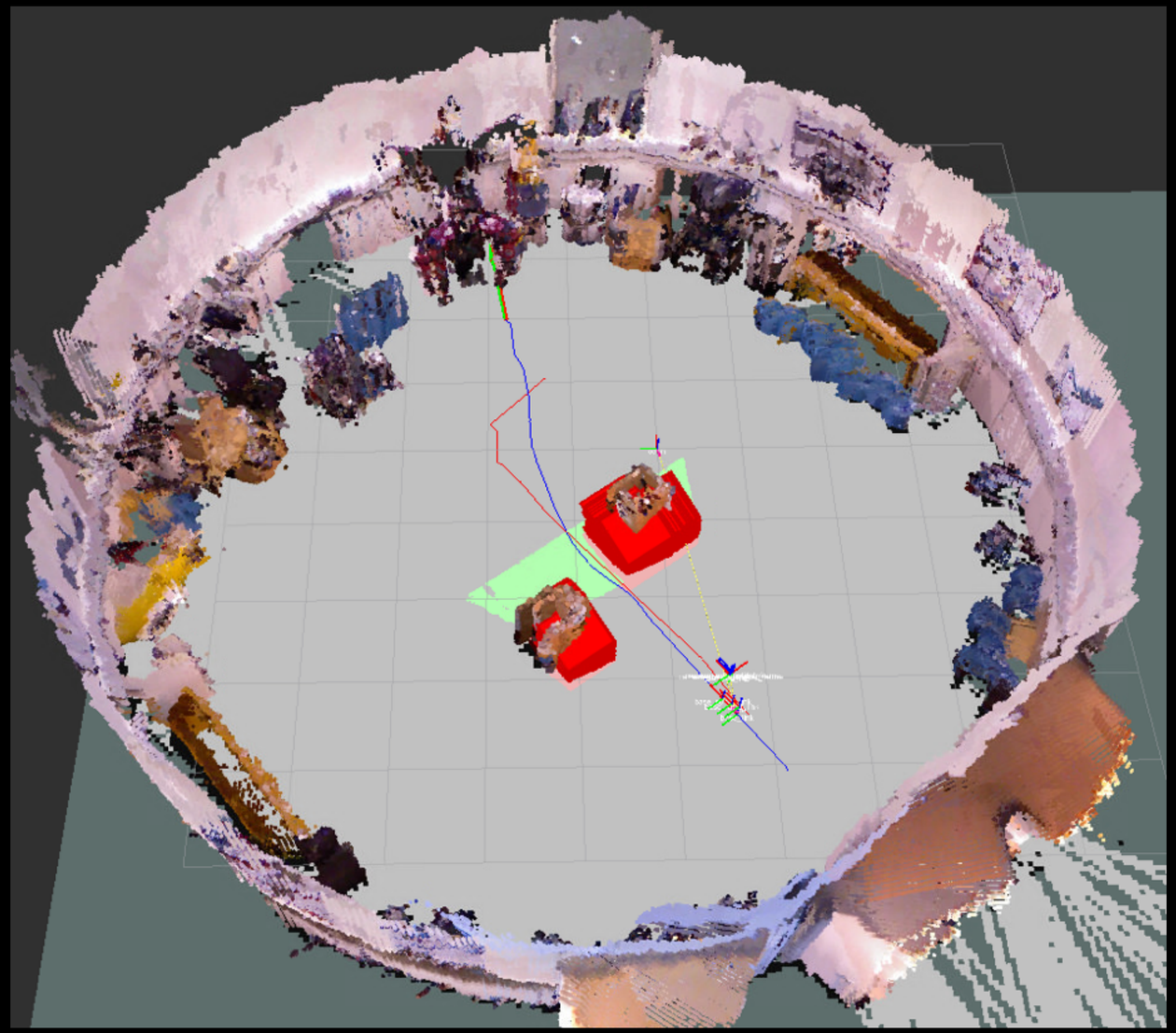


Video of semantic labelling based on model matching

3. Experiments

Navigation

A. Global localization through graph optimization trajectory.
B. Tell the robot the destination name using vocal interface.
C. Path planning based on 2D cost map and Dijkstra.
D. Obstacle avoidance based on 3D point cloud map.



Video of 3D navigation

Video of voice navigation

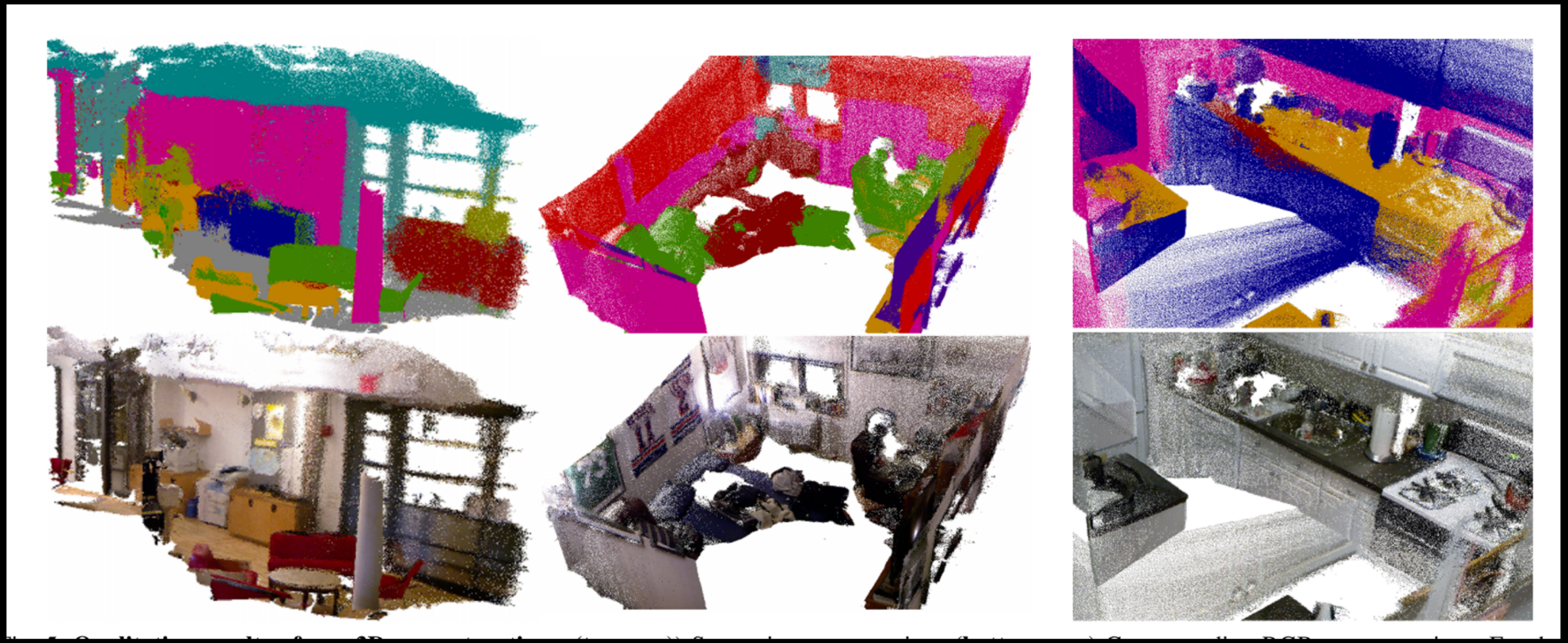
4. Conclusions

The Grid-Point Cloud-Semantic multilayer map model can make the service robot perform navigation more efficiently. It combines the advantages of different type map.

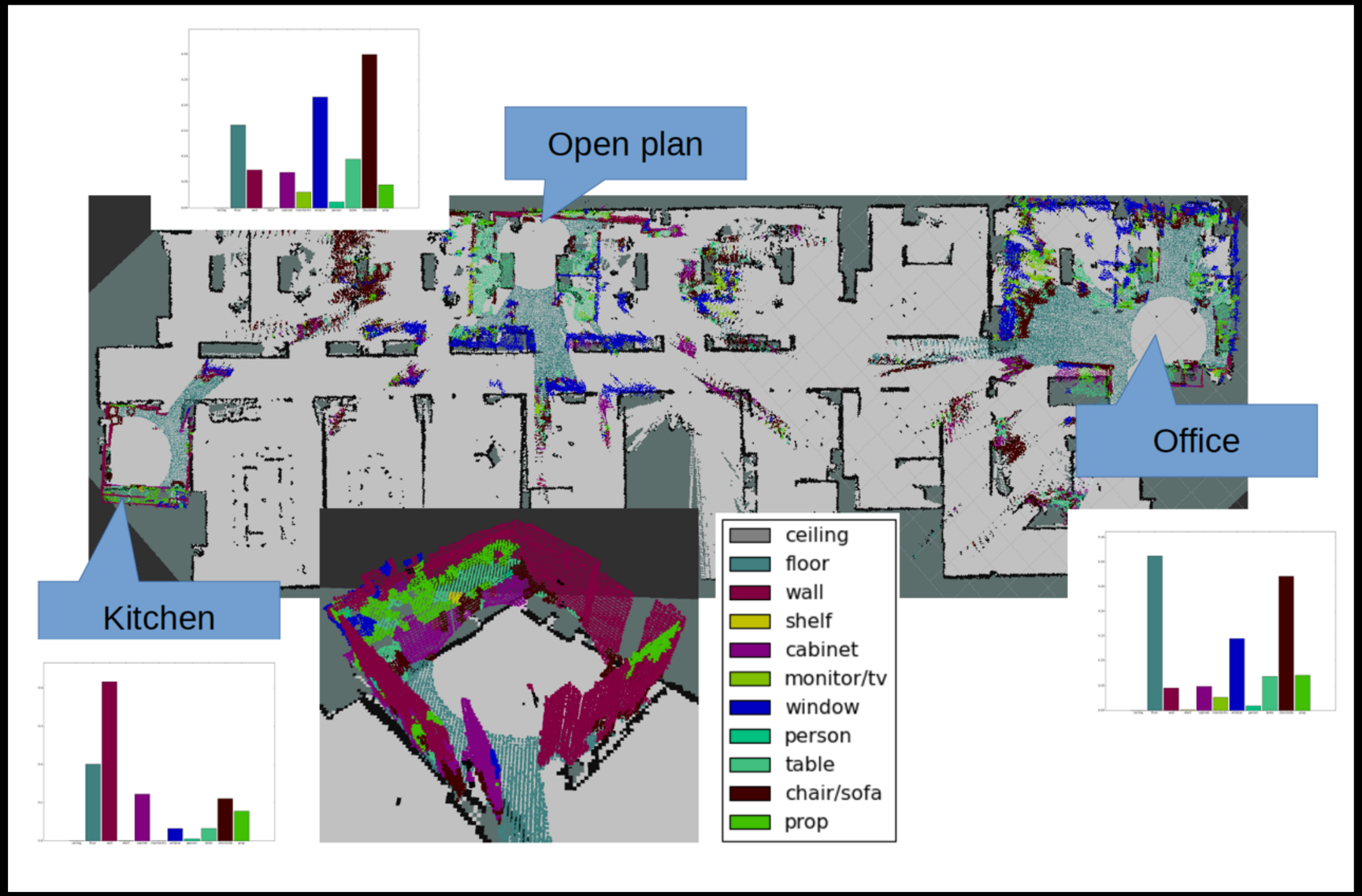
The 2D grid map at the bottom is used for localization and path planning.
The 3D point map on the grid map is used for feature extraction and obstacle avoidance.
The semantic markers are used for scene understanding human-robot vocal interaction.

6. The future work

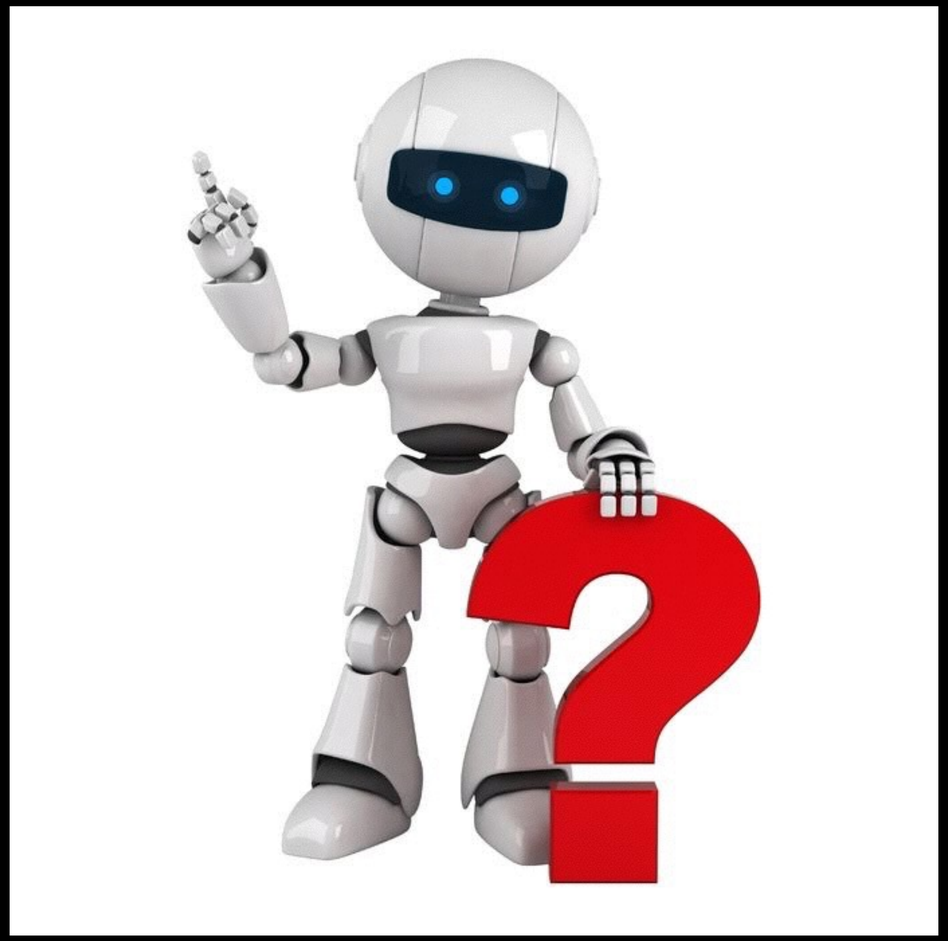
Next work: Dense semantic mapping for object searching



6. The future work



Questions?



Thanks for your attention