Automatic Map Building and SLAM with Object Recognition Report

ORB-SLAM2 Extension

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Outline

Automatic Map Building

Object Recognition and Segmentation

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Object Recognition and Segmentation

Motion Planning Algorithms

- Sampling-Based Motion Planning
  - Randomly explore a smaller subset of possibilities rather than exhaustively explore all possibilities
  - Apply easily to high-dimensional and continuous C-space
  - Run fast
  - Unlikely to sample nodes in narrow passages
  - Sometimes result in unusual looking and possibly inefficient paths

  Example: PRM, RRT, RRTConnect, RRT*

  Library: OMPL
- Search-Based Motion Planning
  - Guarantee an efficient solution
  - Take more computation time

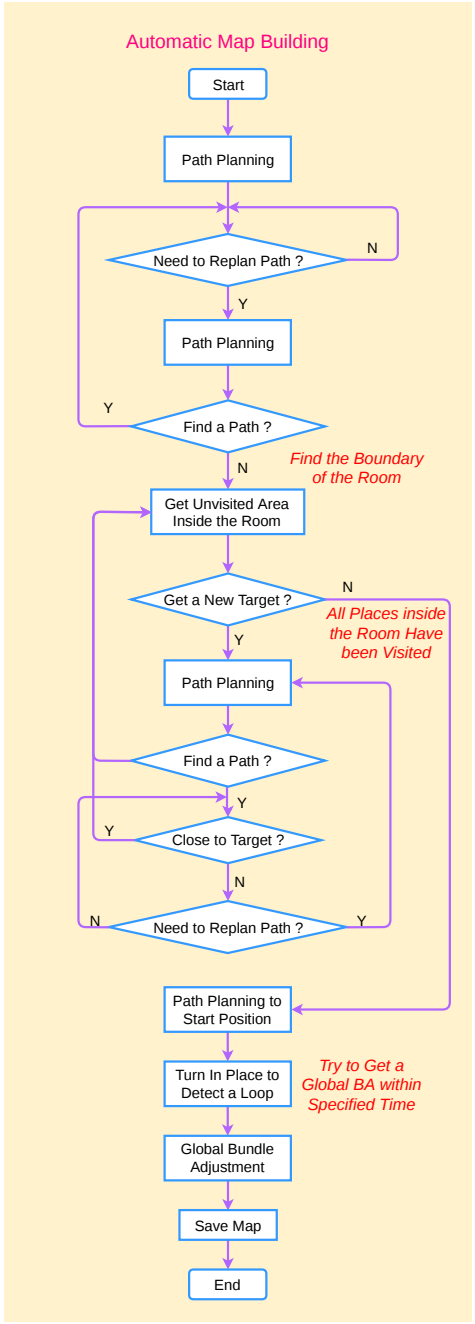
  Example: Dijkstra search, A*, D*, ARA*, AD*, D* Lite

  Library: SBPL

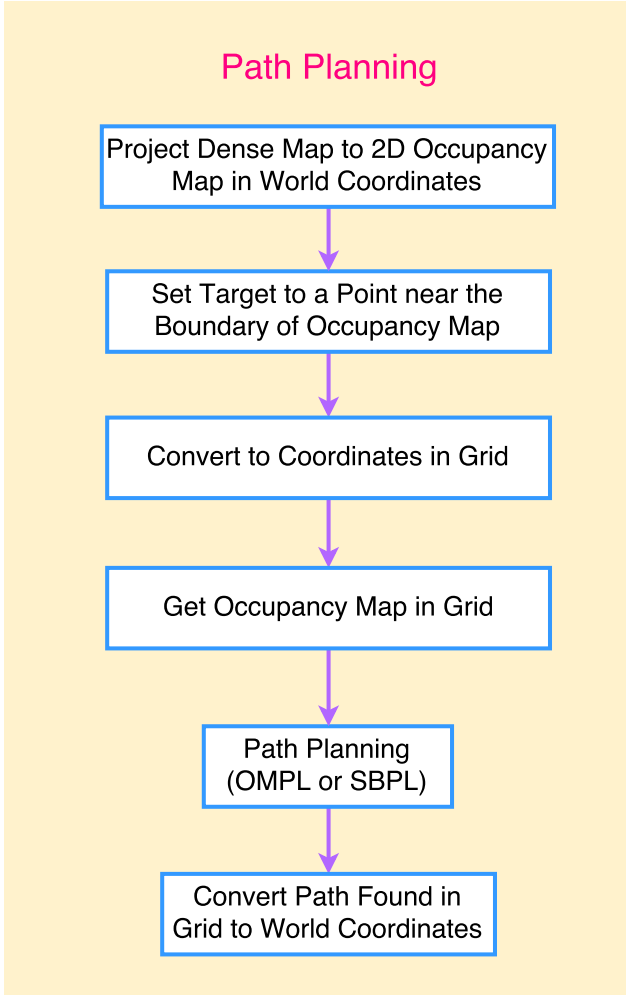
Automatic Map Exploration

- Keyidea: Use motion planning algorithms to find a path from robot's current position to a target position that's near (but outside of) the boundary of current occupancy map
  - No path found $\Longrightarrow$ boundary closed

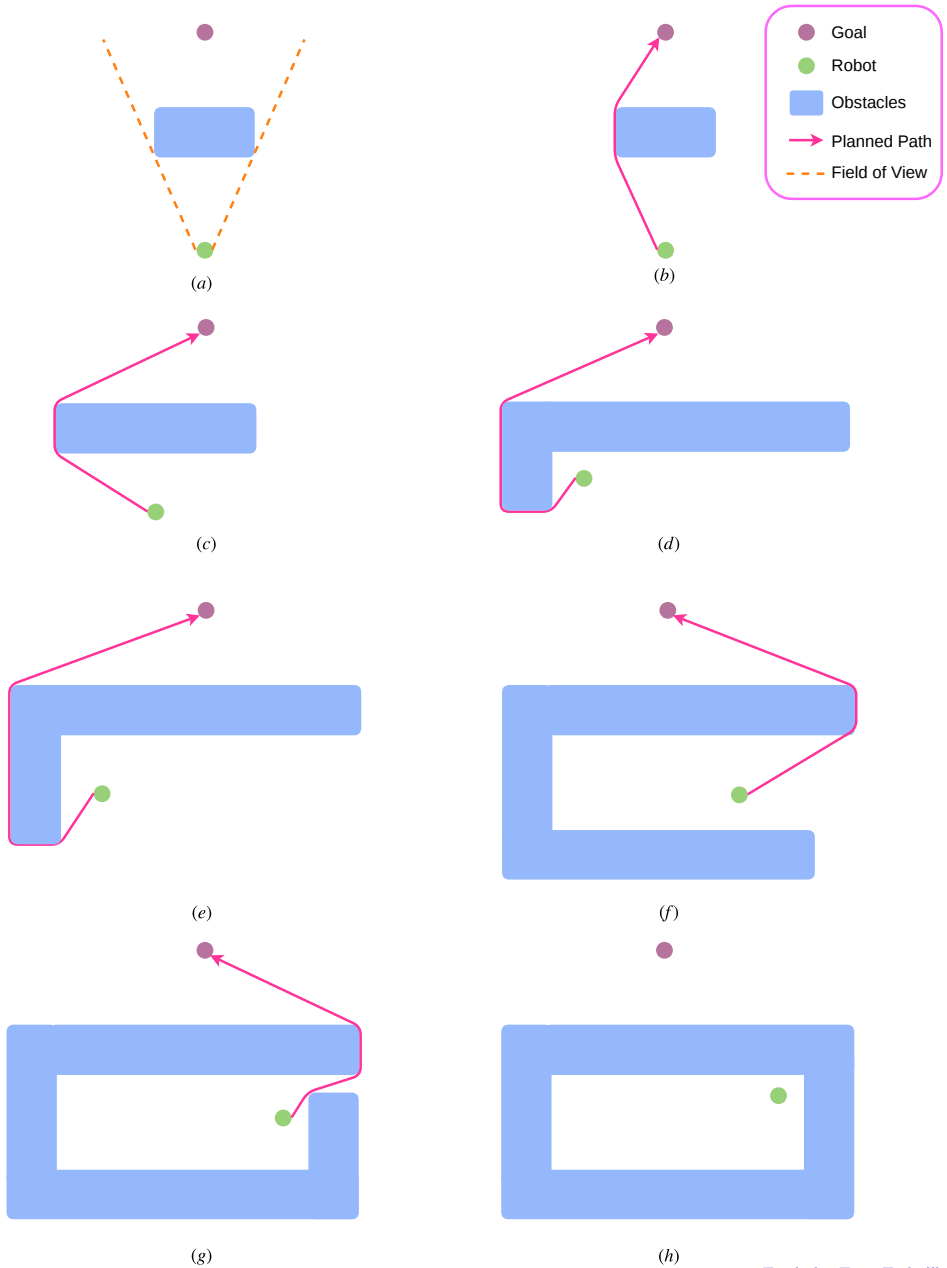
Automatic Map Exploration



Path Planning Module



Find the Closed Boundary



Get Innermost Contour

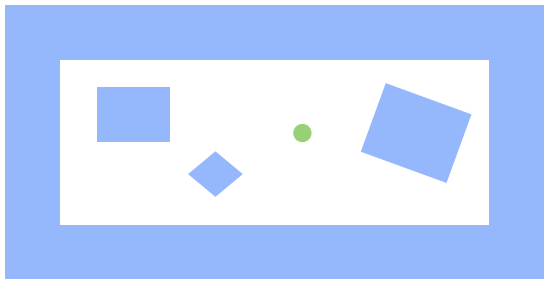


Figure: Occupancy Map

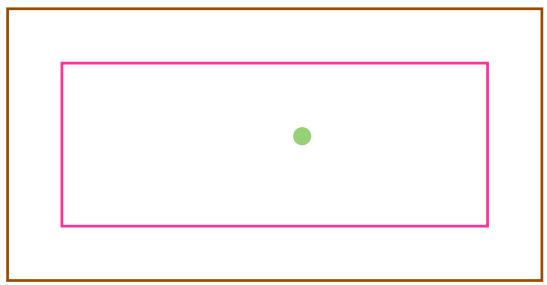


Figure: Contours that Contains the Green Point

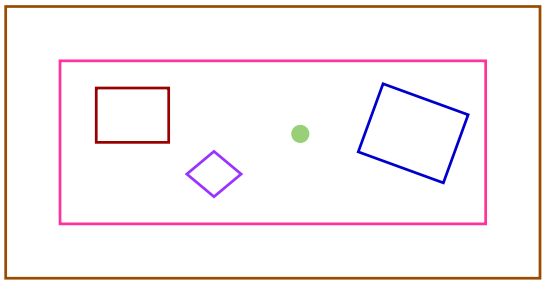


Figure: Contours of Occupancy Map

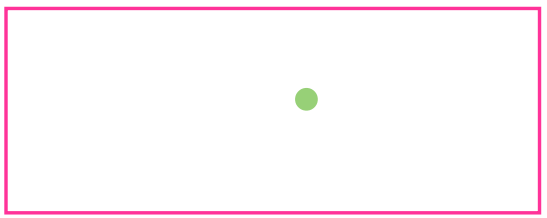
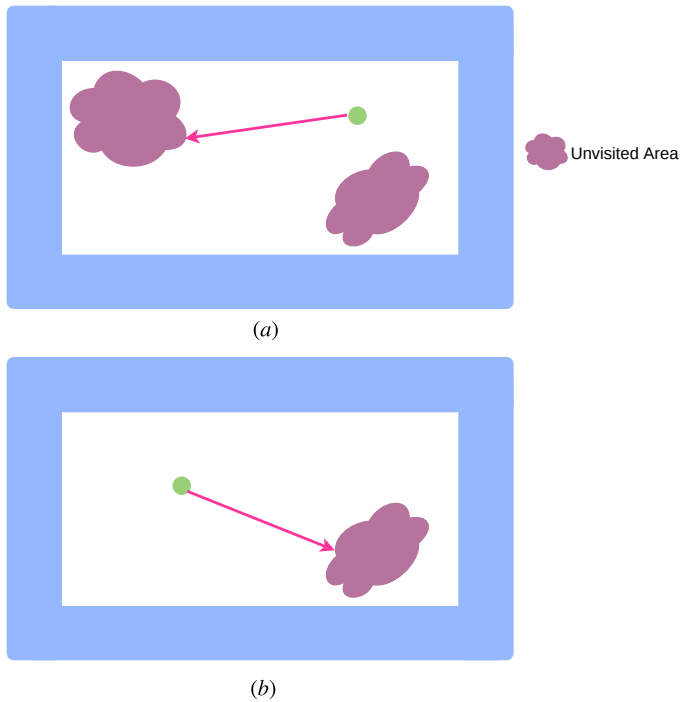


Figure: Closest Contour that Contains the Green Point

- Green Point can be the robot's starting position or current position

Clear Unvisted Area

- Project dense map onto a plane A (filter out ceiling and ground)
- Find the Inner-Most contour X in A
- Project dense map onto a plane B (filter out ceiling)
- Find the connected components in B inside the inner-most contour found in A
- Loop over all connected components whose areas are greater than a specified threshold value
  - Randomly pick a point in the connected component
  - Control the robot to go to that point



Contours in Pratice 1

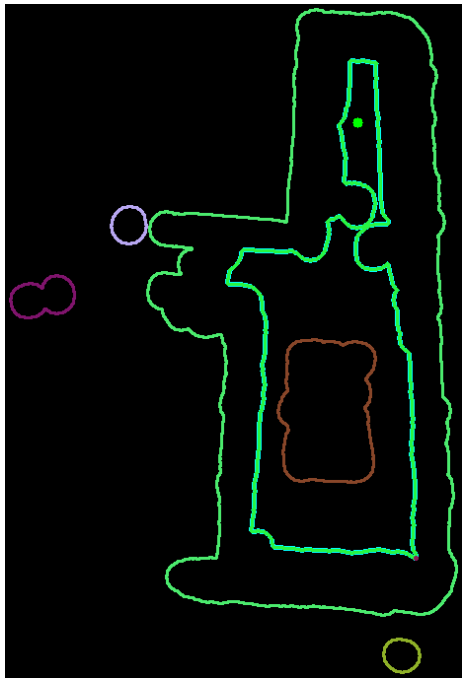


Figure: All contours found

Figure: Inner-most contour

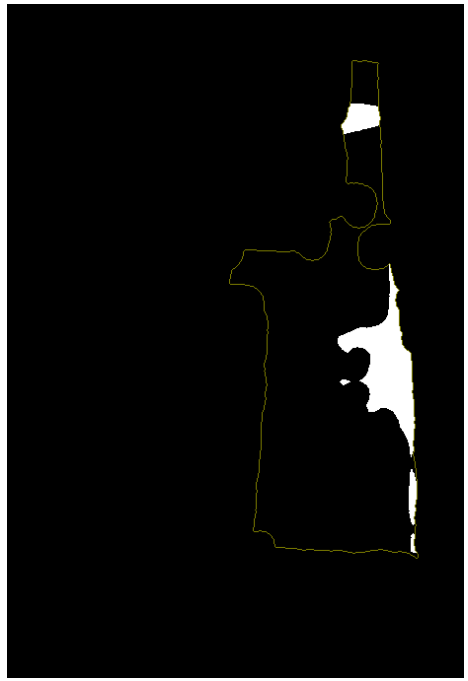


Figure: Unvisited Area

- Control robot to go to a position inside the unvisited area

Contours in Pratice 2

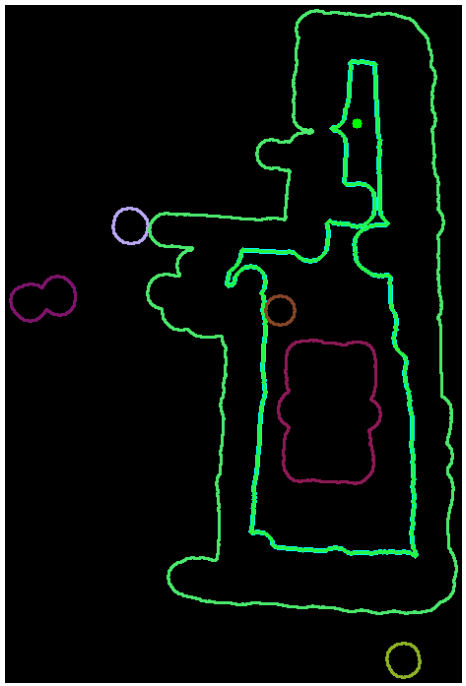


Figure: All contours found

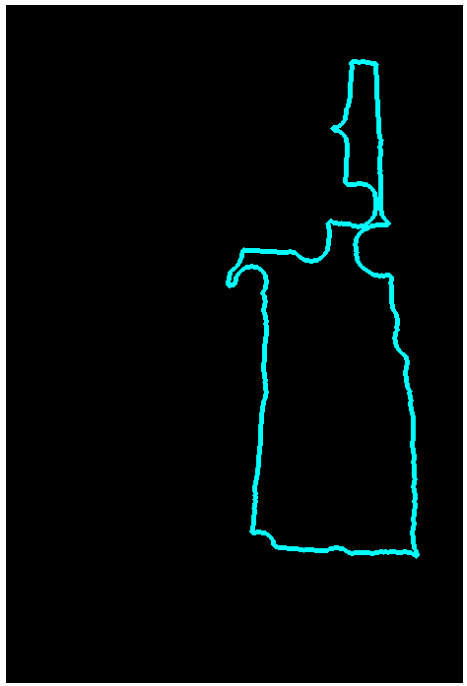


Figure: Inner-most contour

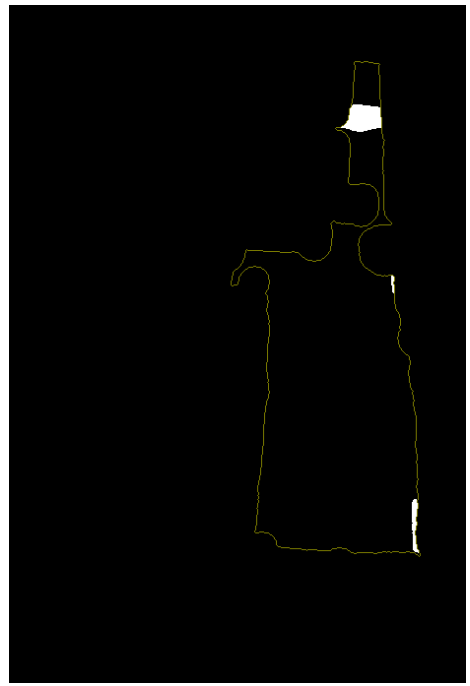
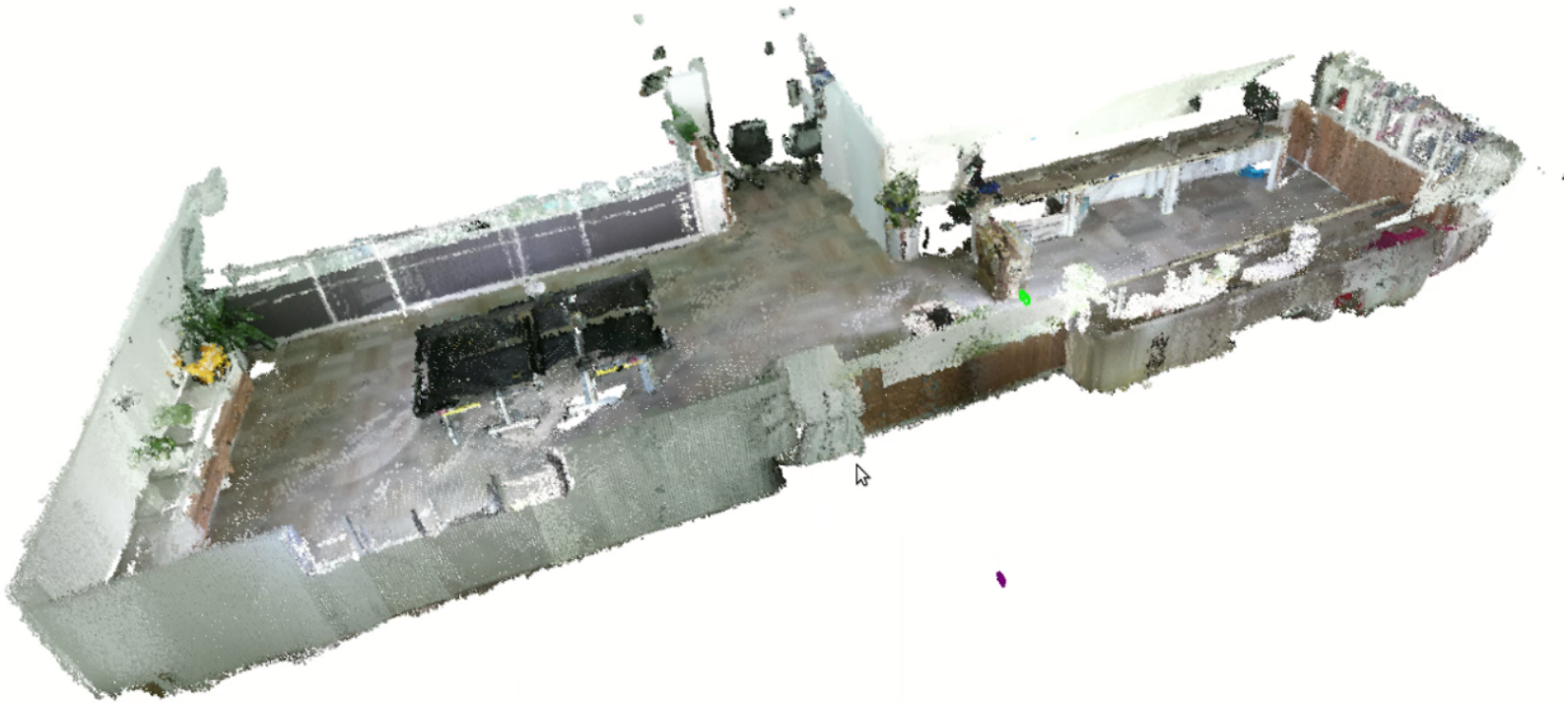


Figure: Unvisited Area

- Unvisited area gets smaller

Dense Map Built by Automatic Map Building



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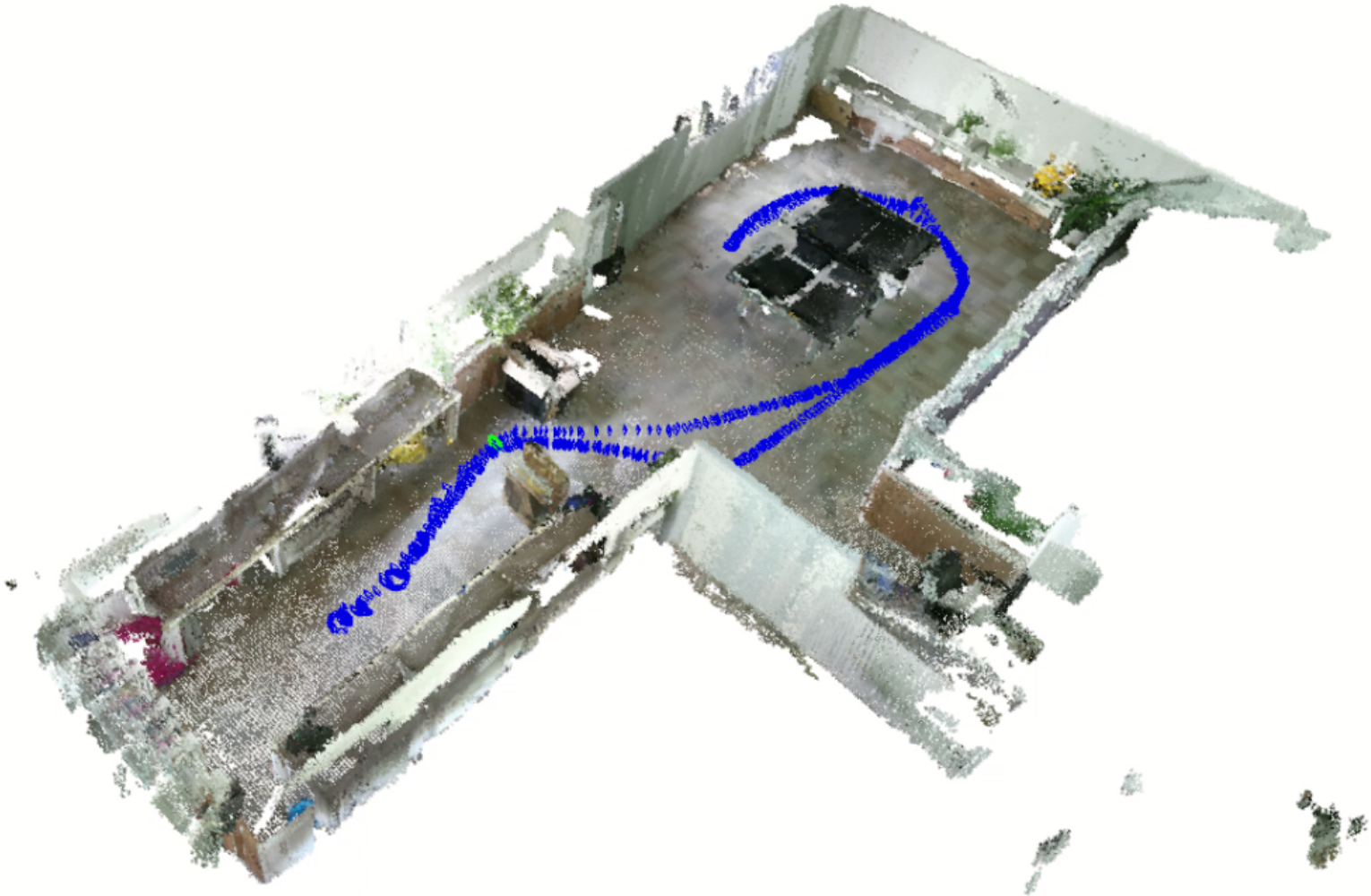


Outline

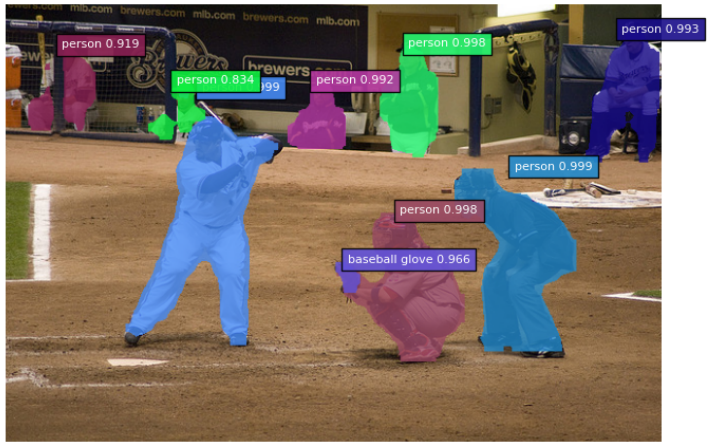
Automatic Map Building

Object Recognition and Segmentation

Object Recognition and Segmentation

- Built upon FCIS (Fully Convolutional Instance-aware Semantic Segmentation)
- SLAM sends color image and depth image to FCIS via socket
- FCIS performs object recognition and segmentation
- Calculate the center (from mean value or median value) of the segmented objects, send them back to SLAM
- SLAM can then control the robot to approach the object given user-specified object's name

FCIS Demo



- Segmentation and object recognition on color images