Homework 04: LiDAR SLAM, ROS

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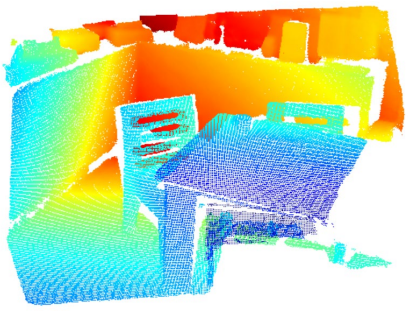
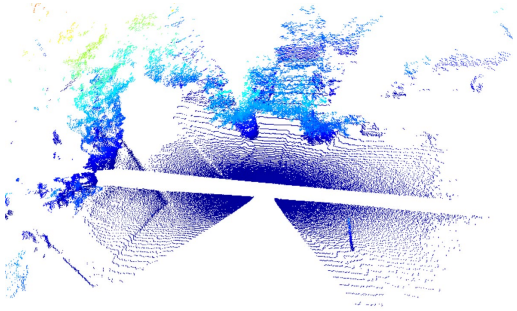
Handout: Thu, 2024-04-04
Due: Thu, 2024-04-30

This homework is designed for you to create your own (basic) LiDAR SLAM, practice ROS, and run a state-of-the-art SLAM package.

Exercise 1 (basic LiDAR SLAM): Download the code template provided in the assignment folder, and build it in a VS Code Dev Container. OpenCV and Open3D libraries are integrated for your convenience. Use the RGBD and LiDAR point clouds provided in the "data" folder to estimate the sensor trajectory for each case, and create a combined point cloud map.





Step 1: Downsample the point clouds using the appropriate voxel size (e.g., use 0.05m for RGBD and 0.1m for LiDAR).
Step 2: Register the point clouds using ICP and RANSAC algorithms and find the relative pose between consecutive point clouds. For RANSAC, compute FPFH features and obtain correspondences beforehand. Adjust the algorithm parameters as needed to obtain good results.
Step 3: Transform all point clouds using the recovered poses into the coordinate frame of the first point cloud (indexed 0).
Step 4: Fuse the transformed point clouds and display them. Take a snapshot of the results. You should obtain 2 snapshots for the RGBD and LiDAR data.

Hint: You can use ChatGPT to get help with the syntax! Several C++ examples for using Open3D (for downsampling, registration, etc.) are provided at https://github.com/isl-org/Open3D/tree/main/examples/cpp.

Exercise 2 (LIO-SAM): Implement and test the state-of-the-art LIO-SAM pipeline in ROS2.

Step 1: Follow the instructions in https://github.com/rsasaki0109/li_slam_ros2 to build LIO-SAM for ROS2 Humble in Ubuntu 22.04:

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clone

```
cd ~/ros2_ws/src
git clone --recursive https://github.com/rsasaki0109/li_slam_ros2
```

gtsam install

```
sudo add-apt-repository ppa:borglab/gtsam-release-4.1
sudo apt update
sudo apt install libgtsam-dev libgtsam-unstable-dev
```

build

```
cd ~/ros2_ws
rosdep update
rosdep install --from-paths src --ignore-src -yr
colcon build --cmake-args -DCMAKE_BUILD_TYPE=Release
```

Step 2: Download the LiDAR bag “park_dataset.bag” from Drive:
https://drive.google.com/drive/folders/1gJHwfdHCRdjP7vuT556pv8atqrCJPbUq
Convert this ROS1 bag it into a ROS2 bag using the Rosbags Python library:
https://pypi.org/project/rosbags/

Step 3: Run SLAM system using the LiDAR data stored in the bag:

```
rviz2 -d src/li_slam_ros2/scanmatcher/rviz/lio.rviz
```

```
ros2 launch scanmatcher lio.launch.py
```

```
ros2 bag play walking_dataset/
```

Note: replace the bag with park_dataset

Step 4: Take a snapshot of the final point cloud map and trajectory (shown in Rviz).