EECE 5554: Final Project Report
Group I: RTAB-MAP SLAM

Aim: To implement the RTAB-MAP SLAM Algorithm in the following scenarios:

1. Developer Dataset
2. Northeastern Outdoor Dataset
3. Northeastern Indoor Dataset

Implementation:

For theory on RTAB-Map SLAM, refer to the slide deck in the repository. The following report complements the slide deck and delves into the implementation aspect of the RTAB-Map SLAM.

Part 1: Developer Dataset

The following two commands can execute the Developer dataset.

```
$ roslaunch rtabmap_demos demo_robot_mapping.launch
$ rosbag play --clock demo_mapping.bag
```

Part 2: Northeastern Outdoor Dataset

The dataset provided by Prof Hanumant Singh, car_IR_RGB_lidar has been used for this part of the implementation. The launch file stereo_rtab.launch according to the instructions provided in the Documentation[1][. The following command launches the relevant nodes and plays the rosbag when given the path to the rosbag. The viso2 and image_pipeline packages are used for stereo-image processing.

```
$ roslaunch slam_pkg stereo_rtab.launch path:=<path-to-neu-rosbag>
```

The following steps were taken to run the dataset successfully:

- CMakeLists of viso2_ros directory

The viso2_ros directory had a dependency on the Boost signals library, which has been deprecated. The dependency was changed to the parent Boost library, which resolved the issue.

```
# find_package(Boost REQUIRED COMPONENTS signals thread)
find_package(Boost REQUIRED)
```

- Migrating the rules of the rosbag

The morning_stereo_rgb_ir_lidar_gps.bag has compatibility issues with the ROS Noetic system, which was identified with the rosbag check command. The rosbag was migrated to a compatible version with the rosbag fix command.

```
$ rosbag check morning_stereo_rgb_ir_lidar_gps.bag
$ rosbag fix morning_stereo_rgb_ir_lidar_gps.bag output.bag
```

- Running the Dataset at Simulation Time

These configurations become relevant in replaying recorded data in a way that respects the timestamps in the bag file and allows synchronization with simulated time. The clock parameter runs the rosbag on simulation time, while the use_sim_time parameter is required to run the launch file in simulation time. For this to be possible, the /clock rostopic must be published.

```
<param name="/use_sim_time" value="true" />
<node pkg="rosbag" type="play" name="player" output="screen" args="--clock $(arg path)"/>
```

- Running the /tf_static nodes

The static transformations for the vehicle frames are only published once at the start of the launch of rosbag, which can't be interpreted by the RTAB-Map Nodes. To resolve the issue, the launch file called static_tf.launch was created and called from the main launch file.

```
  <node pkg="tf" type="static_transform_publisher" name="cam_array_base_link_to_cam_0_link" args="0.0
0.0 0.0 0.0 0.0 0.0 1.0 cam_array_base_link cam_0_link 100" />
```

- Remapping Rostopic names

Using the <remap> tag allows you to easily configure and launch nodes with different topic names based on your specific use case without modifying the source code of the nodes. The sensor topics of the rosbag had to be remapped for them to be integrated with the RTAB-Map package nodes.

```
  <remap from="left/image_rect"   to="/camera_array/cam0/image_raw"/>
```

Part 3: Northeastern Indoor Dataset

The indoor dataset was recorded in the Snell Library Basement using the RTAB-Map App[3] on iPhone 14 Pro. The application allows users to record and simultaneously perform RTAB-Map SLAM on the mobile system. The optimization was performed with the tool discussed in the section below.

Visualization:

The post-execution optimization and visualization are handled by the Database Viewer Tool of the RTAB-Map Package[3]. After executing the RTAB-Map algorithm, the results and maps are stored in a database file (.db extension):

1. For rtabmap_ros package: The file is saved in the .ros directory under the nomenclature 'rtabmap.db' and is overwritten with each package execution.
2. For RTAB-Map App: After every execution, the file is saved in the date-time format in the phone storage.

The database file can be accessed via the following command in an Interactive Environment.

```
$ rtabmap-databaseViewer <path-to-db-file>
```

The following steps were taken in the Database Viewer Tool to optimize the algorithm's results.

- Regenerate optimized 2D Map
- Update Optimized Mesh
- Detect More Loop Closures
- Regenerate Local Grid Maps

References:

[1] Setup RTAB-Map on Your Robot! - WikiROS
[2] RTAB-Map - Mathieu Labbe - App Store
[3] RTAB-Map Tools - Introlab - Github