

Realtime Appearance Based Mapping [RTAB Map]

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SLAM Basics

- Simultaneous Localization and Mapping (SLAM) is the process by which a robot creates a map of an environment, while localizing within the map that is being created.
- There are many methods by which SLAM is performed. The major difference is in the type of sensor(s) used. According to the sensor being used, the underlying principle of SLAM algorithm also changes.
- Loop closure is a feature of slam algorithms. It is the ability of an algorithm to recognize a location that was previously visited by the robot while mapping.
- SLAM algorithms normally provide the following results:
 - A map of the environment(3D / 2D)
 - Robot odometry(the pathway through which the robot travelled in the map)

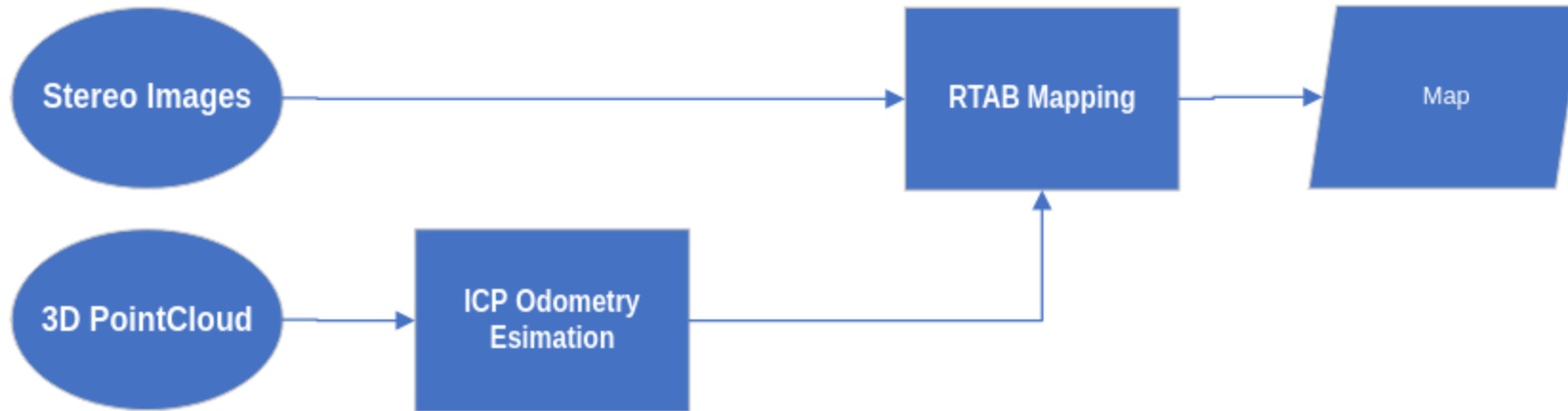
SLAM Basics

- The fundamental process in all kind of SLAM algorithms is to identify trackable features from the sensor data(visual / point cloud) and estimate the motion of the sensor with respect to the features detected earlier.
- For this different algorithms use different methods: using wheel encoder data, using IMU's , using other sources of odometry etc
- With the odometry information available, the motion of the sensor/ robot could be estimated and there by the relationship between the features extracted from sensor data.

RTAB Map

- RTAB Map is an appearance based graph SLAM approach.
- The primary input is images from stereo / RGB-D camera images
- The algorithm can also take 2D Laser Scans and 3D point cloud as inputs.
- Like every SLAM algorithm, RTAB map has a front end and backed that take care of odometry estimation + loop closure and mapping + graph optimization respectively

Using Stereo Camera and 3D Lidar with RTAB-Map

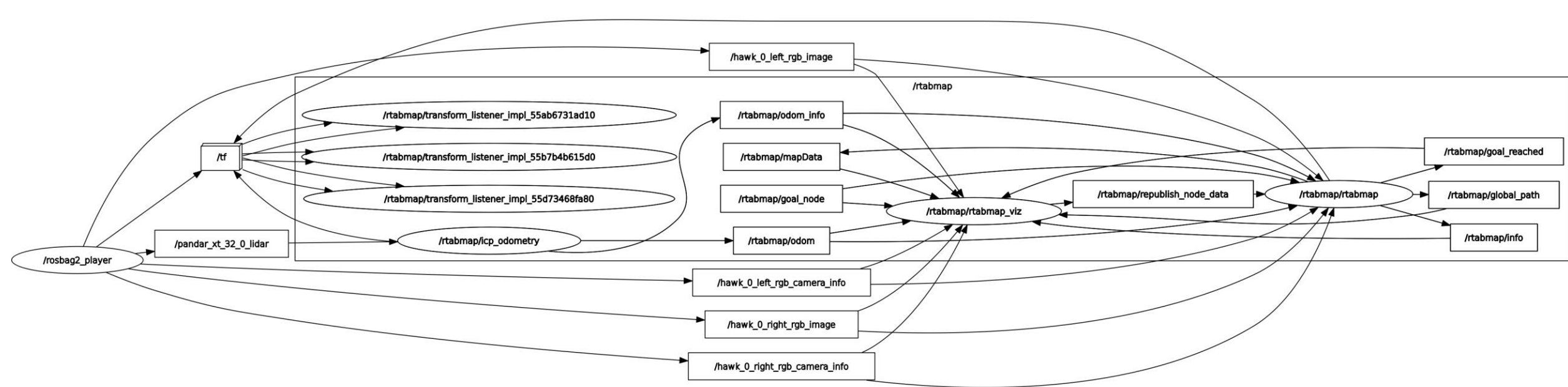


The primary requirement of 3d point cloud from the lidar is to estimate the odometry of the robot. The estimated odometry is then used as a guide to do the mapping using the stereo images. The feature extraction-based pipeline processes the stereo image and generates the map using the odometry generated by the point cloud.

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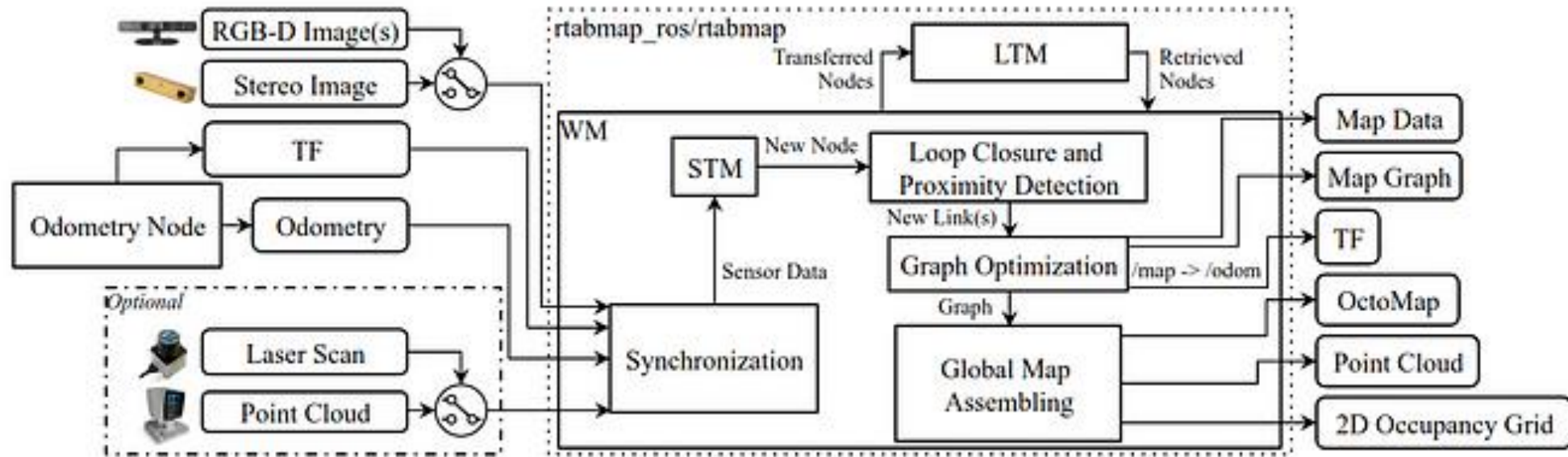
- The advantage of using an odometry based on lidar are :
 - More accurate odometry estimation
 - Immune to lighting conditions and variations as in visual odometry
 - Longer range and coverage of lidar makes long range tracking easier.
 - Along with it, RTAB map can use laser data to create occupancy maps as well.
- The iterative closest point algorithm (ICP) used in the odometry module, works by trying to minimize the difference between two clouds of points from the lidar, by estimating the rigid body transformations between them With these rigid body transformations, we can get the odometry of the robot.

RQT_Graph plot



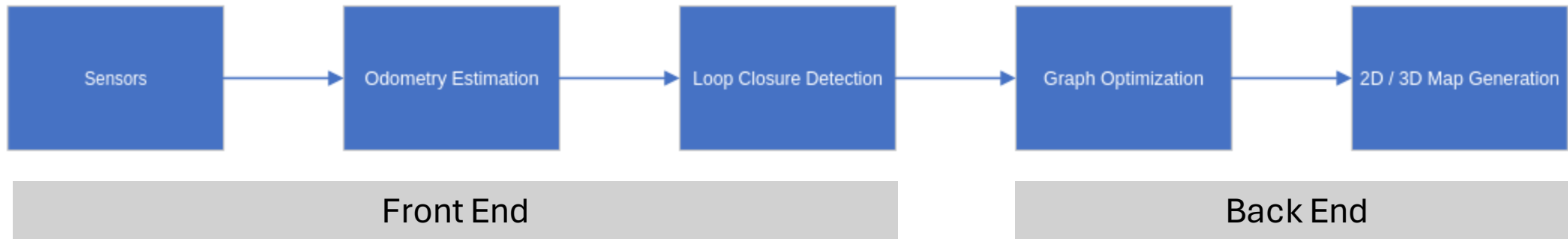
RQT graph plot showing the nodes and topics while running the Stereo + 3D lidar SLAM

RTAB Map Working



Block Diagram

RTAB Map Working



- Front End deals with odometry estimation from the sensor data from camera, lidar and laser scanner
- The feature detection based on visual odometry and different feature detectors in OpenCV are used.(need to build with older versions since the feature detectors like SIFT and SURF are not free in latest versions.
- Based on the feature descriptor data, there is a Bag of Word representation for the feature vectors is matched with the previously obtained feature vector to get the loopclosure.

- There are multiple graph optimization methodologies available in RTAB for minimizing the error in the pose graph. Graph optimization is done when the loop closure is detected.
- RTAB Map can give out both 2D and 3D maps(occupancy and octomap)