

## 10、RTAB 3D mapping navigation

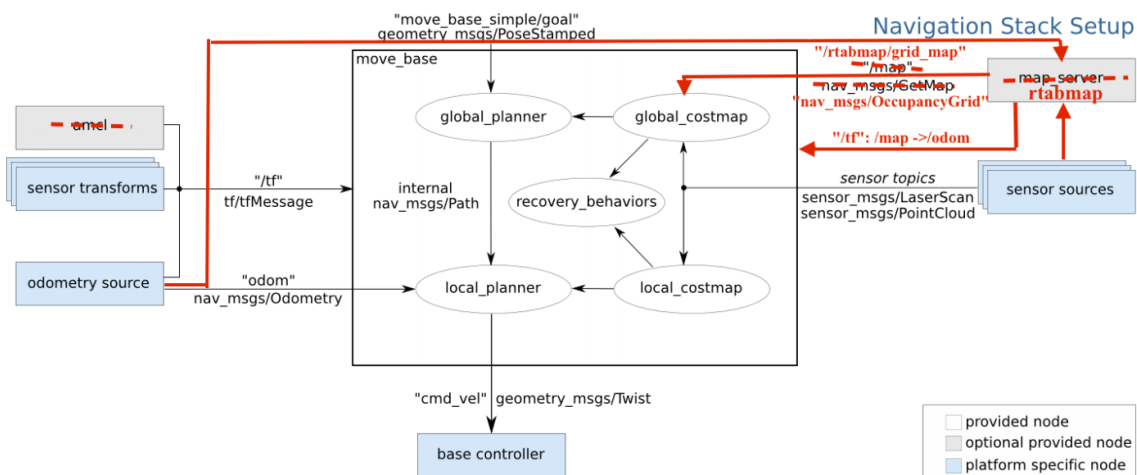
Note: This course takes the Rosmaster-X3 as an example, which needs to be operated with a depth camera, while the Rosmaster-X3 is operated with an Obi Zhongguang Astrapro depth camera.

Function package path:~/oradar\_ws/src/yahboomcar\_nav

### 10.1、Introduction

This software package is the ROS function package of RTAB Map, which is an RGB-D SLAM method based on the global loop closure detector with real-time constraints.

The software package can be used to create 3D point clouds and three-dimensional grid maps for navigation.



It can be seen from the above figure that AMCL is not required, and RTAB Map has positioning function; If you enable 用, it will cause repeated positioning and positioning failure. When using the RTAB Map navigation core framework, the initialized map is provided by RTAB Map instead of map\_server.

### 10.2、Mapping usage

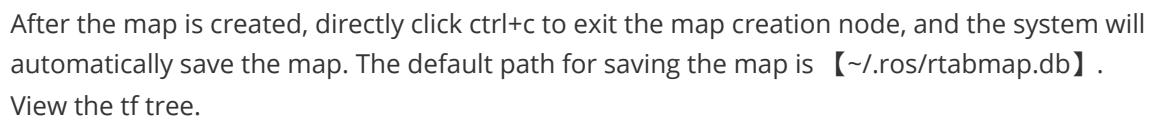
Input following command.

```
roslaunch yahboomcar_nav laser_astrapro_bringup.launch
roslaunch yahboomcar_nav yahboomcar_rtabmap.launch use_rviz:=true
```

- use\_Rviz parameter: whether to open rviz.
- Keyboard control car.

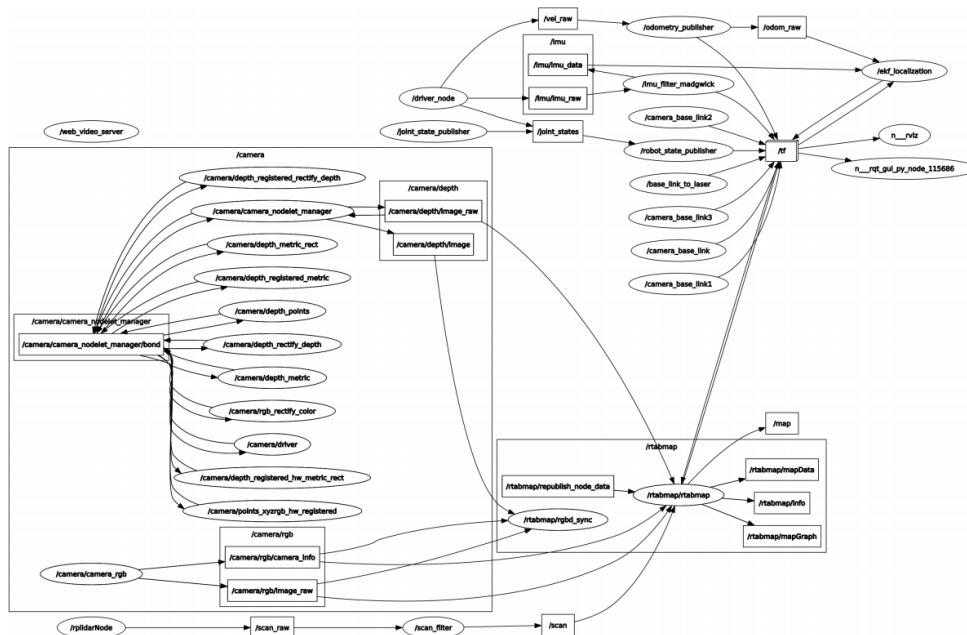
```
roslaunch yahboomcar_ctrl yahboom_keyboard.launch
```

After starting according to the above type, select any type of control drawing; The slower the speed is, the better the effect is (especially 角 speed); The machine is full of the area to be mapped, and the map should be closed as much as possible.



```
graph TD; Root["Recorded at time: 1645601245.72"] --> map["map  
Broadcaster: /tabmasi?tabmap  
Average rate: 20.909  
Buffer length: 1.1  
Most recent transform: 1645601245.7  
Oldest transform: 1645601244.8"]; map --> odom["odom"]; odom --> ahf["ahf_localization  
Average rate: 21.544  
Buffer length: 1.021  
Most recent transform: 1645601245.51  
Oldest transform: 1645601244.48"]; ahf --> base_footprint["base_footprint"]; base_footprint --> robot_state_publisher["robot_state_publisher  
Average rate: 10000.0  
Buffer length: 0.0  
Most recent transform: 0.0  
Oldest transform: 0.0"]; robot_state_publisher --> base_link["base_link"]; base_link --> front_right_wheel["front_right_wheel  
Broadcaster: /robot_state_publisher  
Average rate: 10.909  
Buffer length: 1.1  
Most recent transform: 1645601245.59  
Oldest transform: 1645601244.49"]; base_link --> laser["laser  
Broadcaster: /base_link_to_laser  
Average rate: 35.554  
Buffer length: 1.089  
Most recent transform: 1645601245.59  
Oldest transform: 1645601244.53"]; base_link --> laser_link["laser_link  
Broadcaster: /robot_state_publisher  
Average rate: 10000.0  
Buffer length: 0.0  
Most recent transform: 0.0  
Oldest transform: 0.0"]; base_link --> camera_link["camera_link  
Broadcaster: /robot_state_publisher  
Average rate: 10000.0  
Buffer length: 0.0  
Most recent transform: 0.0  
Oldest transform: 0.0"]; base_link --> imu_link["imu_link  
Broadcaster: /robot_state_publisher  
Average rate: 10000.0  
Buffer length: 0.0  
Most recent transform: 0.0  
Oldest transform: 0.0"]; base_link --> front_left_wheel["front_left_wheel  
Broadcaster: /robot_state_publisher  
Average rate: 10.909  
Buffer length: 1.1  
Most recent transform: 1645601245.59  
Oldest transform: 1645601244.49"]; base_link --> back_wheel["back_wheel  
Broadcaster: /robot_state_publisher  
Average rate: 10.909  
Buffer length: 1.1  
Most recent transform: 1645601245.59  
Oldest transform: 1645601244.49"]; base_link --> back_right_wheel["back_right_wheel  
Broadcaster: /robot_state_publisher  
Average rate: 10.909  
Buffer length: 1.1  
Most recent transform: 1645601245.59  
Oldest transform: 1645601244.49"]; camera_link --> camera_rgb_frame["camera_rgb_frame  
Broadcaster: /camera_base_link1  
Average rate: 10000.0  
Buffer length: 0.0  
Most recent transform: 0.0  
Oldest transform: 0.0"]; camera_link --> camera_depth_frame["camera_depth_frame  
Broadcaster: /camera_base_link  
Average rate: 10000.0  
Buffer length: 0.0  
Most recent transform: 0.0  
Oldest transform: 0.0"]; camera_rgb_frame --> camera_rgb_optical_frame["camera_rgb_optical_frame  
Broadcaster: /camera_base_link3  
Average rate: 10000.0  
Buffer length: 0.0  
Most recent transform: 0.0  
Oldest transform: 0.0"]; camera_depth_frame --> camera_depth_optical_frame["camera_depth_optical_frame  
Broadcaster: /camera_base_link2  
Average rate: 10000.0  
Buffer length: 0.0  
Most recent transform: 0.0  
Oldest transform: 0.0"];
```

rqt\_graph



As can be seen from the above figure, the information that the **rtabmap** node needs to subscribe to: radar data, camera data, and tf data.

## 10.3、Navigation and avoiding

Start the drive

```
roslaunch yahboomcar_nav laser_astapro_bringup.launch
```

Start the command mapping or navigation.

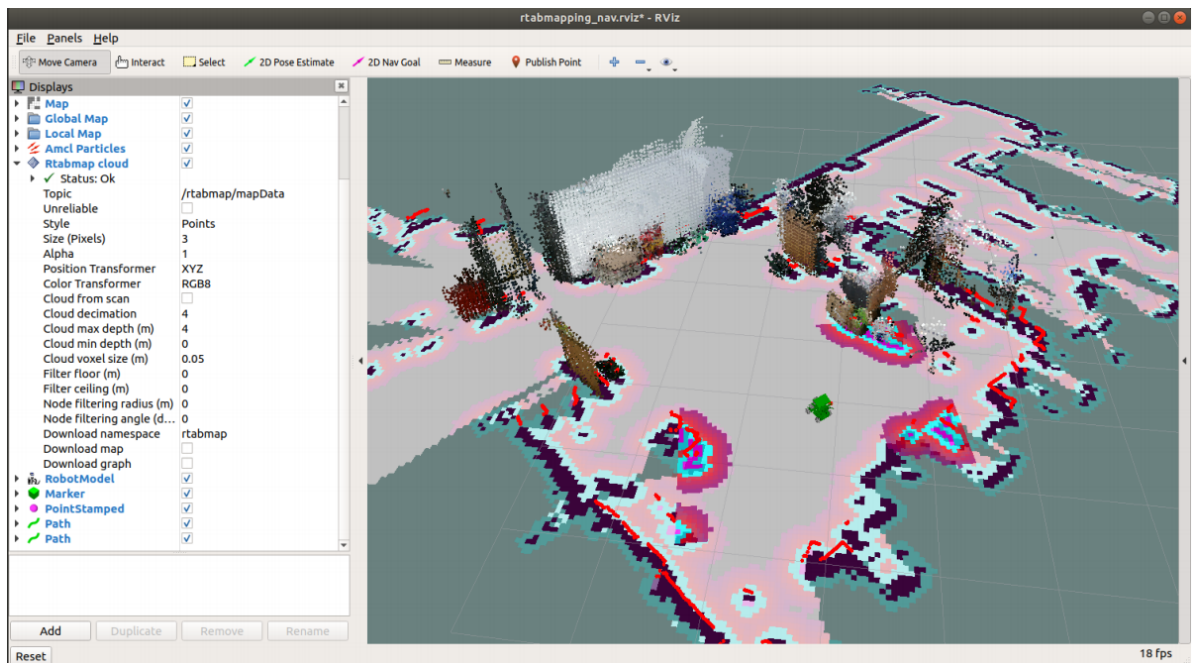
```
roslaunch yahboomcar_nav yahboomcar_rtabmap_nav.launch use_rviz:=False
```

- use\_Rviz parameter: whether to open rviz.

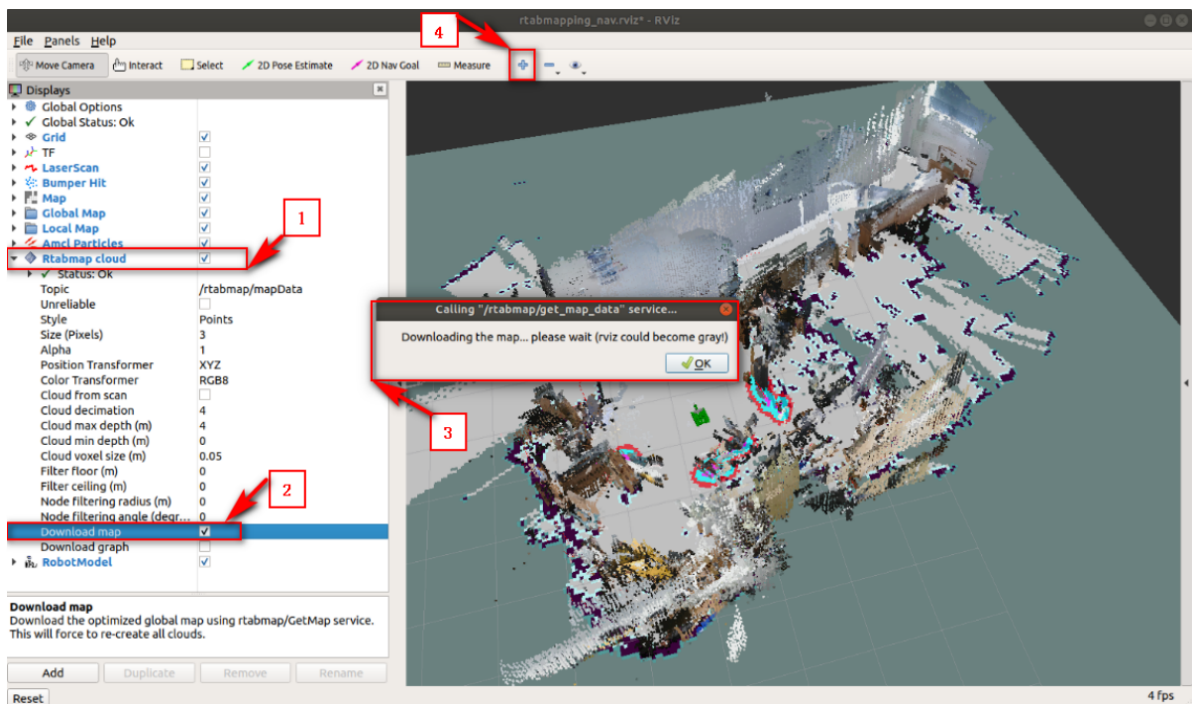
Keyboard control node.

```
roslaunch yahboomcar_ctrl yahboom_keyboard.launch
```

When the navigation mode is turned on, the system automatically loads 2D grid maps, but cannot directly load 3D maps. It needs to be loaded dynamically.



Load the 3D map (1, 2, 3), and add the rviz debugging tool.



At this time, you can add the **MarkerArray** to facilitate multi-point navigation and observation, and adjust the display parameters of the **rviz** according to the needs, for example, the display parameters of the laser lidar point.

### 10.3.1、Single point navigation

- Use the [2D Pose Estimate] of the [rviz] tool to set the initial pose until the position of the car in the simulation is consistent with the position of the actual car.
- Click the [2D Nav Goal] of the [rviz] tool, and then select the target point in the place where there is no obstacle on the map. Release the mouse to start navigation. Only one target point can be selected and stop when it is reached.

### 10.3.2、Multi-point navigation

- Set the initial position of robot car.
- Click [Publish Point] of [rviz] tool, and then select the target point in the place without obstacles on the map. Release the mouse to start navigation. Click [Publish Point] again, and then select a point. The robot will cruise between points.
- When using the [2D Pose Estimate] tool of the [rviz] tool to set the initial position and pose of the car, the multi-point navigation function is automatically canceled.

## 10.4、Rtabmap node description

This is the master node of this package. It is the wrapper of RTAB mapping core library.

In this case, when loop closure is detected, the map will be constructed and optimized in an incremental manner. The online output of the node is this map, which contains the latest data added to the map. The default location of RTAB map database is [. ros/rtabmap. db], and the work area is also set to [. ros].

### 10.4.1、Subscribed topics

name	type	Parse
odom	nav_msgs/Odometry	Odometer. Required if parameter subscribe_depth or subscribe_stereo is true; and odom_frame_id is not set.
rgb/image	sensor_msgs/Image	RGB/monocular image.
rgb/camera_info	sensor_msgs/CameraInfo	RGB camera parameters.
depth/image	sensor_msgs/Image	depth image.
scan	sensor_msgs/LaserScan	Single line laser.
scan_cloud	sensor_msgs/PointCloud2	Laser scan point cloud stream.
left/image_rect	sensor_msgs/Image	Left eye corrected image.
left/camera_info	sensor_msgs/CameraInfo	Left eye camera parameters.

name	type	Parse
right/image_rect	sensor_msgs/Image	Right eye corrected image.
right/camera_info	sensor_msgs/CameraInfo	Right eye camera parameters.
goal	geometry_msgs/PoseStamped	Plan a path to this goal using the current online map.
rgb_image	rtabmap_ros/RGBDImage	RGB-D sync image, only if subscribe_rgb is true.

#### 10.4.2、 Post topic

name	type	Parse
info	rtabmap_ros/Info	rtabmap information.
mapData	rtabmap_ros/MapData	Graph and latest node data for rtabmap.
mapGraph	rtabmap_ros/MapGraph	rtabmap graphics
grid_map	nav_msgs/OccupancyGrid	Maps generated by laser scanning occupy the grid.
proj_map	nav_msgs/OccupancyGrid	Deprecated, use /grid_map instead of Grid/FromDepth=true
cloud_map	sensor_msgs/PointCloud2	A 3D point cloud generated from a local grid.
cloud_obstacles	sensor_msgs/PointCloud2	Generate a 3D point cloud of obstacles from a local mesh.
cloud_ground	sensor_msgs/PointCloud2	A 3D ground point cloud generated from a local grid.
scan_map	sensor_msgs/PointCloud2	2D scans or 3D point clouds generated from 3D scans.
labels	visualization_msgs/MarkerArray	Convenience method for displaying graph labels in RVIZ.
global_path	nav_msgs/Path	The planned pose of the planned global path. Published only once per planned path.
local_path	nav_msgs/Path	Plan future local poses corresponding to the global path. Posted every time the map is updated.
goal_reached	std_msgs/Bool	A plan status message whether the goal was successfully achieved.
goal_out	geometry_msgs/PoseStamped	Plan the current metric target sent from rtabmap's topology planner. For example, you can connect to move_base via move_base_simple/goal.
octomap_full	octomap_msgs/Octomap	Get octomap. Available only when rtabmap_ros is built with octomap.

name	type	Parse
octomap_binary	octomap_msgs/Octomap	Get octomap. Available only when rtabmap_ros is built with octomap.
octomap_occupied_space	sensor_msgs/PointCloud2	octomap The point cloud of the occupied space(obstacles and ground). Available only when rtabmap_ros is built with octomap.
octomap_obstacles	sensor_msgs/PointCloud2	A point cloud of obstacles on the octomap. Available only when rtabmap_ros is built with octomap.
octomap_ground	sensor_msgs/PointCloud2	octomap's point cloud. Available only when rtabmap_ros is built with octomap.
octomap_empty_space	sensor_msgs/PointCloud2	Blank point cloud for octomap. Available only when rtabmap_ros is built with octomap.
octomap_grid	nav_msgs/OccupancyGrid	Project the octomap into a 2D occupancy raster map. Available only when rtabmap_ros is built with octomap.

### 10.4.3、Service



name	type	Parse
get_map	rtabmap_ros/GetMap	Call this service to get a standard 2D occupancy grid.
get_map_data	rtabmap_ros/GetMap	Call this service to get map data.
publish_map	rtabmap_ros/PublishMap	Call this service to publish map data.
list_labels	rtabmap_ros/ListLabels	Get the current label of the graph.
update_parameters	std_srvs/Empty	The node will be updated with the current parameters of the rosparam server.
reset	std_srvs/Empty	Delete the map.
pause	std_srvs/Empty	Pause building.
resume	std_srvs/Empty	Restoring the map.
trigger_new_map	std_srvs/Empty	A new map will start.
backup	std_srvs/Empty	Backup the database to "database_path.back"(default ~/.ros/rtabmap.db.back).
set_mode_localization	std_srvs/Empty	Set location-only mode.
set_mode_mapping	std_srvs/Empty	Set the mapping mode.
set_label	rtabmap_ros/SetLabel	Set the label to the latest node or the specified node.

name	type	Parse
set_goal	rtabmap_ros/SetGoal	Plan to set topology goals.
octomap_full	octomap_msgs/GetOctomap	Get octomap. Only available if rtabmap_ros was built with octomap
octomap_binary	octomap_msgs/GetOctomap	Get octomap. Only available if rtabmap_ros was built with octomap

#### 7.4.4、Parameters

name	type	Defaults	Parse
subscribe_depth	bool	true	Subscribe to depth images
subscribe_scan	bool	false	Subscribe to lidar data
subscribe_scan_cloud	bool	false	Subscribe to Laser 3D Point Cloud
subscribe_stereo	bool	false	Subscribe to binocular images
subscribe_rgbd	bool	false	Subscribe to the rgbd_image topic

name	type	Defaults	Parse
frame_id	string	base_link	Frame attached to mobile base.
map_frame_id	string	map	The coordinate system attached to the map.
odom_frame_id	string	''	The coordinate system attached to the odometer.
odom_tf_linear_variance	double	0.001	When using odom_frame_id, the first 3 values of the diagonal of the 6x6 covariance matrix are set to this value.
odom_tf_angular_variance	double	0.001	When using odom_frame_id, the last 3 values of the diagonal of the 6x6 covariance matrix are set to this value
queue_size	int	10	The size of the message queue for each synchronization topic.
publish_tf	bool	true	Publish TF from /map to /odom.
tf_delay	double	0.05	
tf_prefix	string	''	The prefix to add to the generated tf.
wait_for_transform	bool	true	The wait for the transform when the tf transform is still unavailable(the maximum wait time for a transform is seconds).
wait_for_transform_duration	double	0.1	wait_for_transform wait time.
config_path	string	''	Path to a configuration file containing RTAB mapping parameters. Parameters set in the startup file will override those in the configuration file.
database_path	string	.ros/rtabmap.db	Path to the rtabmap database.

name	type	Defaults	Parse
gen_scan	bool	false	Generate a laser scan from a depth image(using the middle horizontal line of the depth image). Not generated if subscribe_scan or subscribe_scan_cloud is true.
gen_scan_max_depth	double	4.0	The maximum depth of the generated laser scan.
approx_sync	bool	false	Use approximate time synchronization of incoming messages. If false, note that the odometry input must have the exact same timestamp as the input image
rgbd_cameras	int	1	The number of RGB-D cameras to use(when subscribe_rgbd is true). Currently, up to 4 cameras can be synchronized simultaneously.
use_action_for_goal	bool	false	Use actionlib to send metrics targets to move_base.
odom_sensor_sync	bool	false	For each node added to the graph, adjust the image and scan pose relative to the odometry pose.
gen_depth	bool	false	A depth image is generated from a scanned cloud projection to an RGB camera, taking into account the displacement of the RGB camera from the odometry and lidar frames.
gen_depth_decimation	int	1	Reduce the image size of the received camera information(creates a smaller depth image)

name	type	Defaults	Parse
gen_depth_fill_holes_size	int	0	Fill empty pixels to that size. Interpolate values from adjacent depth values. 0 means disabled.
gen_depth_fill_iterations	double	0.1	Maximum depth error(m) to interpolate.
gen_depth_fill_holes_error	int	1	The number of iterations to fill blanks.
map_filter_radius	double	0.0	Loads data for only one node within the filter radius(use the latest data) up to the filter angle(map filter angle).
map_filter_angle	double	30.0	The angle to use when filtering nodes before creating the map. Reference map_filter_radius
map_cleanup	bool	true	If you are not subscribed to any map cloud maps, raster maps, or project maps, clear the corresponding data.
latch	bool	true	If true, the last message published on the map topic will be saved.
map_always_update	bool	true	Always update occupancy raster map
map_empty_ray_tracing	bool	true	Perform ray tracing to fill the unknown space of invalid 2D scan rays(assuming invalid rays to be infinite). Only used if map_always_update is also true.

### 7.4.5、TF conversion

- base\_link → sensor coordinate system
- odom → base\_link
- map → odom

