

Navigation2 multi-point navigation avoid

1. Program Functionality

Note: To learn this course, you must have studied [Navigation2 Single-Point Navigation and Obstacle Avoidance] and have a basic understanding of Navigation2 navigation.

After running the program, a map will load in rviz. In the rviz interface, use the nav2 plugin for multi-point navigation.

2. Running Examples

2.1 Pre-use Instructions

This course uses a Raspberry Pi 5 as an example. For Raspberry Pi 5 and Jetson Nano boards, you need to open a terminal on the host computer and enter the command to enter the Docker container. Once inside the Docker container, enter the commands mentioned in this course in the terminal. For instructions on entering the Docker container from the host computer, refer to **[01. Robot Configuration and Operation Guide] -- [5.Enter Docker (For JETSON Nano and RPi 5)]**. For Orin boards, simply open a terminal and enter the commands mentioned in this course.

2.2 Multi-Point Navigation

Note:

- **Jetson Nano and Raspberry Pi series controllers** must first enter a Docker container (**for steps, see [Docker Course] --- [4. Docker Startup Script]**)

All the following Docker commands must be executed from the same Docker container (**for steps, see [Docker Course] --- [3. Docker Submission and Multi-Terminal Access]**)

- This section requires at least one existing map. Refer to **[5.Gmapping-SLAM mapping], [6.Cartographer-SLAM mapping], [7.slam_toolbox mapping]** or any of the SLAM Mapping courses.

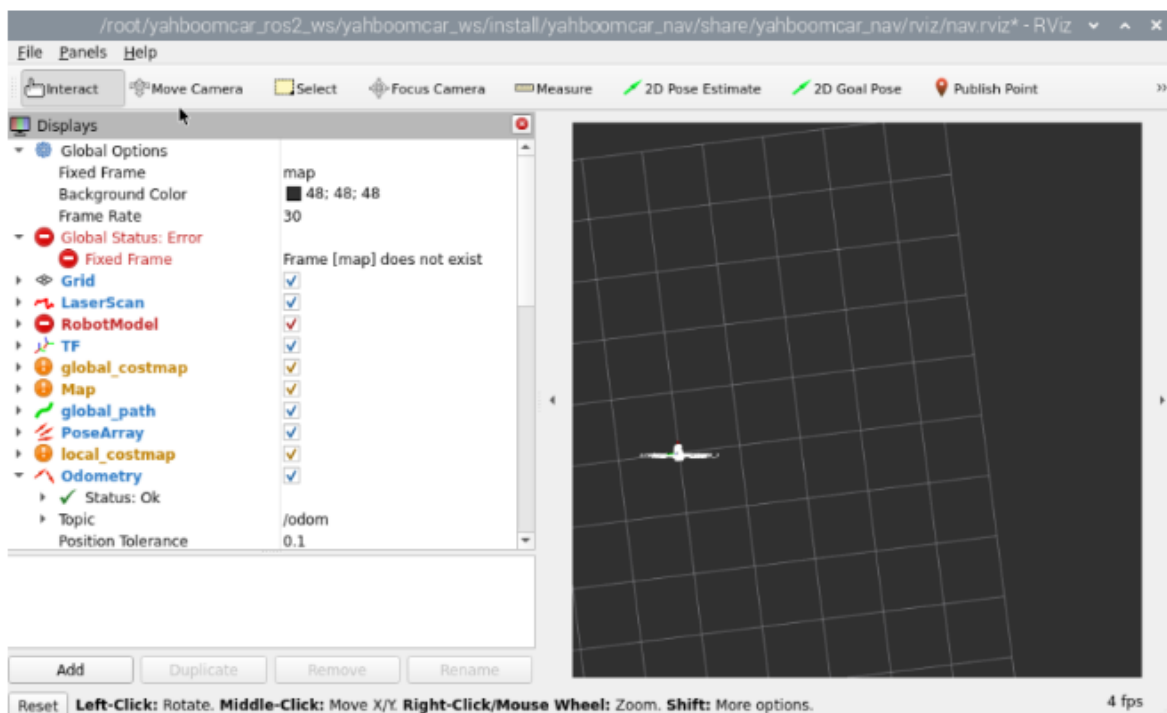
Commands for launching the underlying sensors on the robot vehicle terminal:

```
ros2 launch yahboomcar_nav laser_bringup_launch.py
```

```
root@raspberrypi: ~
File Edit Tabs Help
[ydlidar_ros2_driver_node-9] [YDLIDAR] SDK Version: 1.2.3
[static_transform_publisher-11] [INFO] [1755056541.074142877] [static_transform_publisher_hkPl67SIG9QIUxf7]: Spinning until stoppe
- publishing transform
[static_transform_publisher-11] translation: ('0.000000', '0.000000', '0.000000')
[static_transform_publisher-11] rotation: ('0.000000', '0.000000', '0.000000', '1.000000')
[static_transform_publisher-11] from 'ascamera_hp60c_camera_link_0' to 'ascamera_hp60c_color_0'
[static_transform_publisher-10] [INFO] [1755056541.084073695] [static_transform_publisher_IR46JMCUTLR00sih]: Spinning until stoppe
- publishing transform
[static_transform_publisher-10] translation: ('0.006058', '0.000000', '0.149120')
[static_transform_publisher-10] rotation: ('0.000046', '0.000046', '-1.000000', '0.000000')
[static_transform_publisher-10] from 'base_link' to 'laser'
[ydlidar_ros2_driver_node-9] [YDLIDAR] Lidar successfully connected [/dev/rplidar:230400]
[ydlidar_ros2_driver_node-9] [YDLIDAR] Lidar running correctly! The health status: good
[joint_state_publisher-1] [INFO] [1755056541.807820230] [joint_state_publisher]: Waiting for robot_description to be published on
the robot_description topic...
[ydlidar_ros2_driver_node-9] [YDLIDAR] Baseplate device info
[ydlidar_ros2_driver_node-9] Firmware version: 1.2
[ydlidar_ros2_driver_node-9] Hardware version: 1
[ydlidar_ros2_driver_node-9] Model: Tmini Plus
[ydlidar_ros2_driver_node-9] Serial: 2025021500090139
[ydlidar_ros2_driver_node-9] [YDLIDAR] Current scan frequency: 10.00Hz
[ydlidar_ros2_driver_node-9] [YDLIDAR] Lidar init success, Elapsed time 1031 ms
[imu_filter_madgwick-5] [INFO] [1755056542.843712101] [imu_filter_madgwick]: First IMU message received.
[ydlidar_ros2_driver_node-9] [YDLIDAR] Create thread 0xA68268E0
[ydlidar_ros2_driver_node-9] [YDLIDAR] Succeeded to start scan mode, Elapsed time 2097 ms
[ydlidar_ros2_driver_node-9] [YDLIDAR] Fixed Size: 404
[ydlidar_ros2_driver_node-9] [YDLIDAR] Sample Rate: 4.00K
[ydlidar_ros2_driver_node-9] [YDLIDAR] Succeeded to check the lidar, Elapsed time 0 ms
[ydlidar_ros2_driver_node-9] [2025-08-13 11:42:24][info] [YDLIDAR] Now lidar is scanning...
```

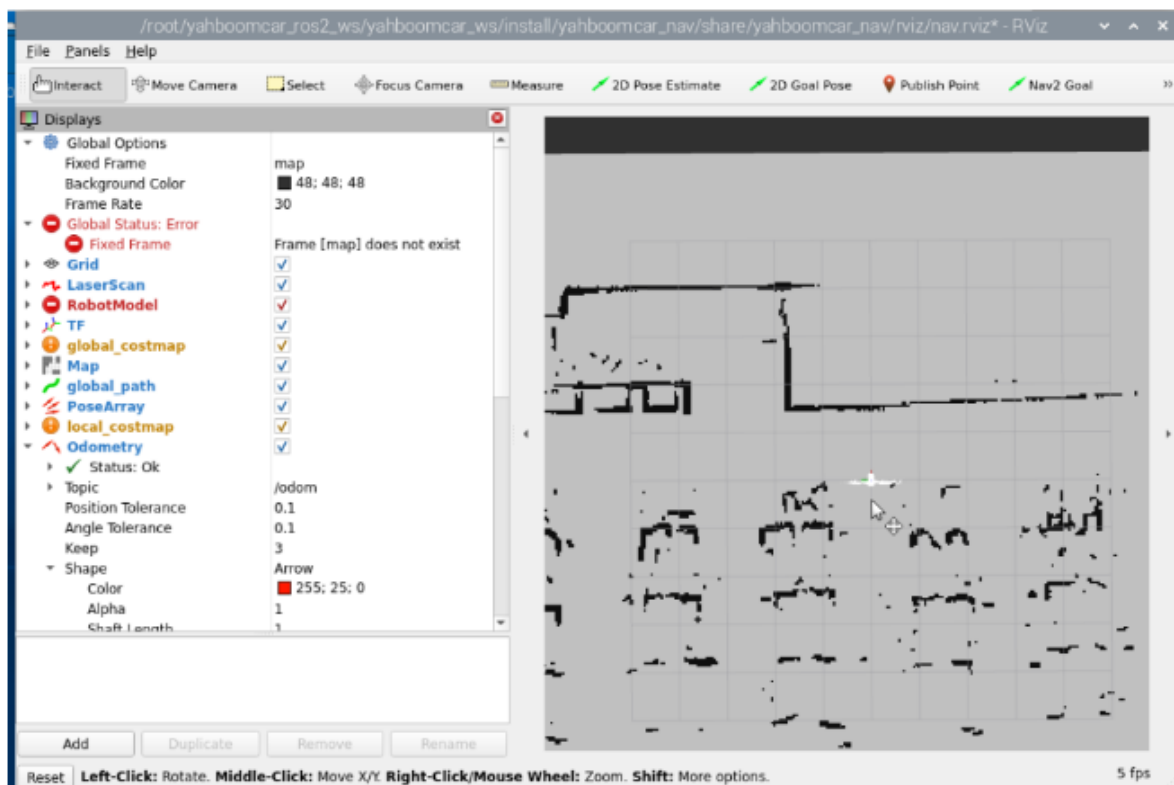
Enter this command to start rviz visualization mapping (the rviz visualization function can be started on either the car computer or the virtual machine. **Select either** method. Do not start both the virtual machine and the car computer simultaneously.). The following figure shows the command entered on the car computer.

```
ros2 launch yahboomcar_nav display_nav_launch.py
```

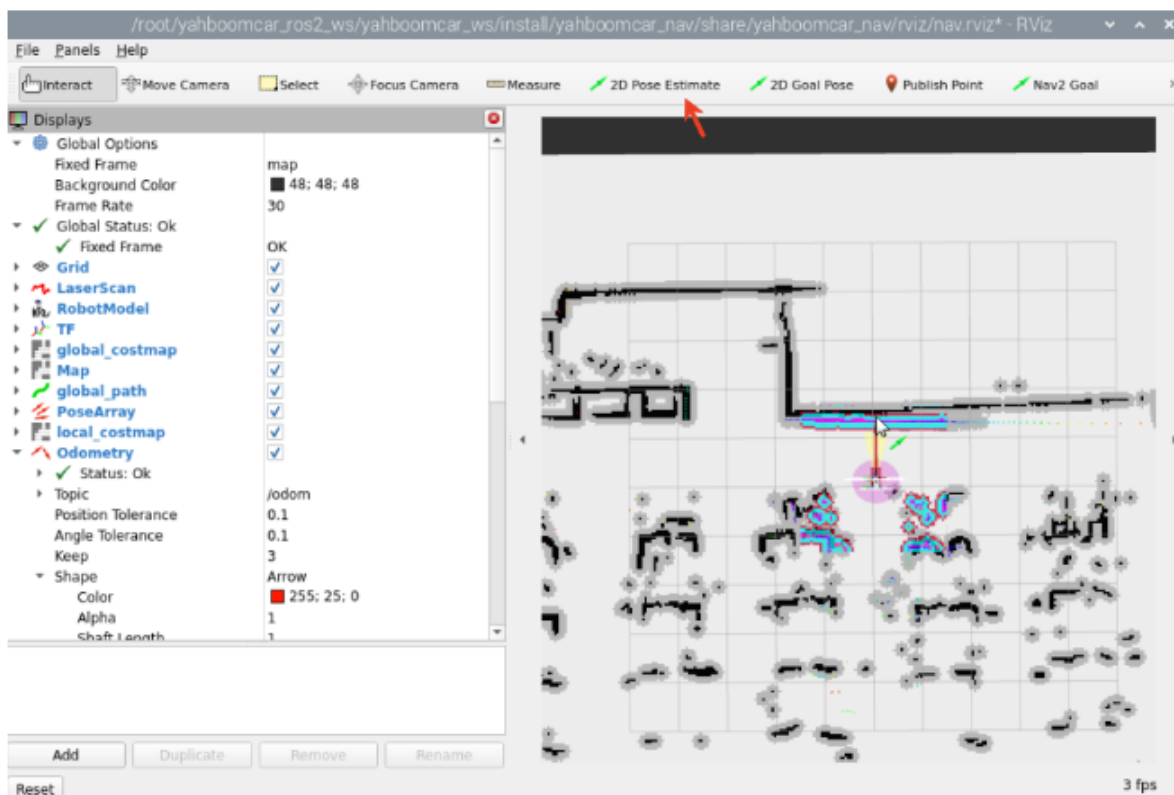


At this point, the map is not loading because the navigation program has not yet been started. Next, run the navigation node by entering ******in the terminal (you need to enter the same Docker terminal as above).

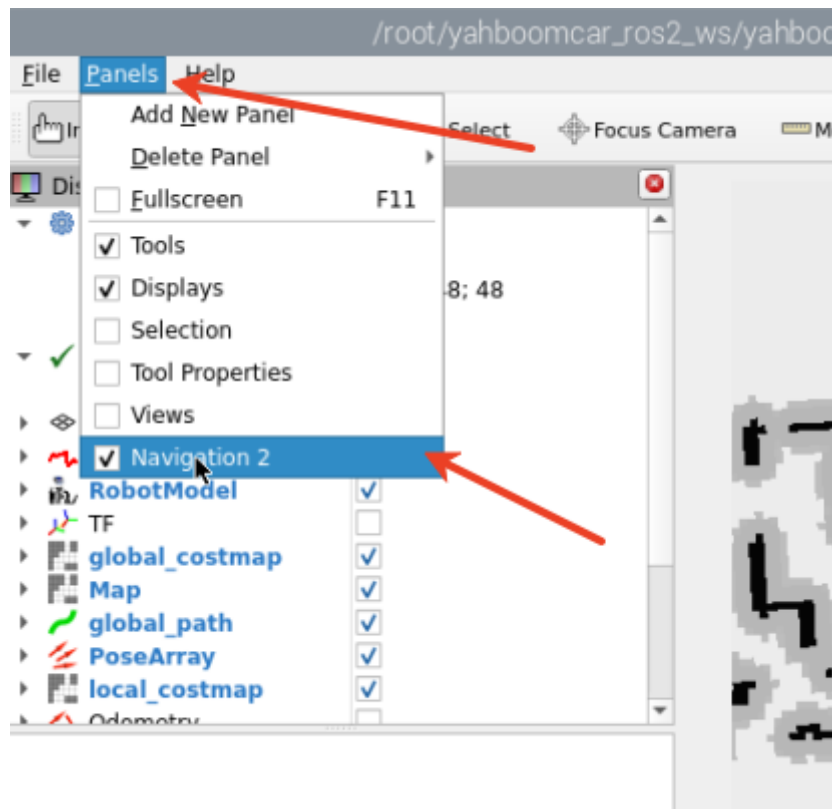
```
ros2 launch yahboomcar_nav navigation_teb_launch.py
```



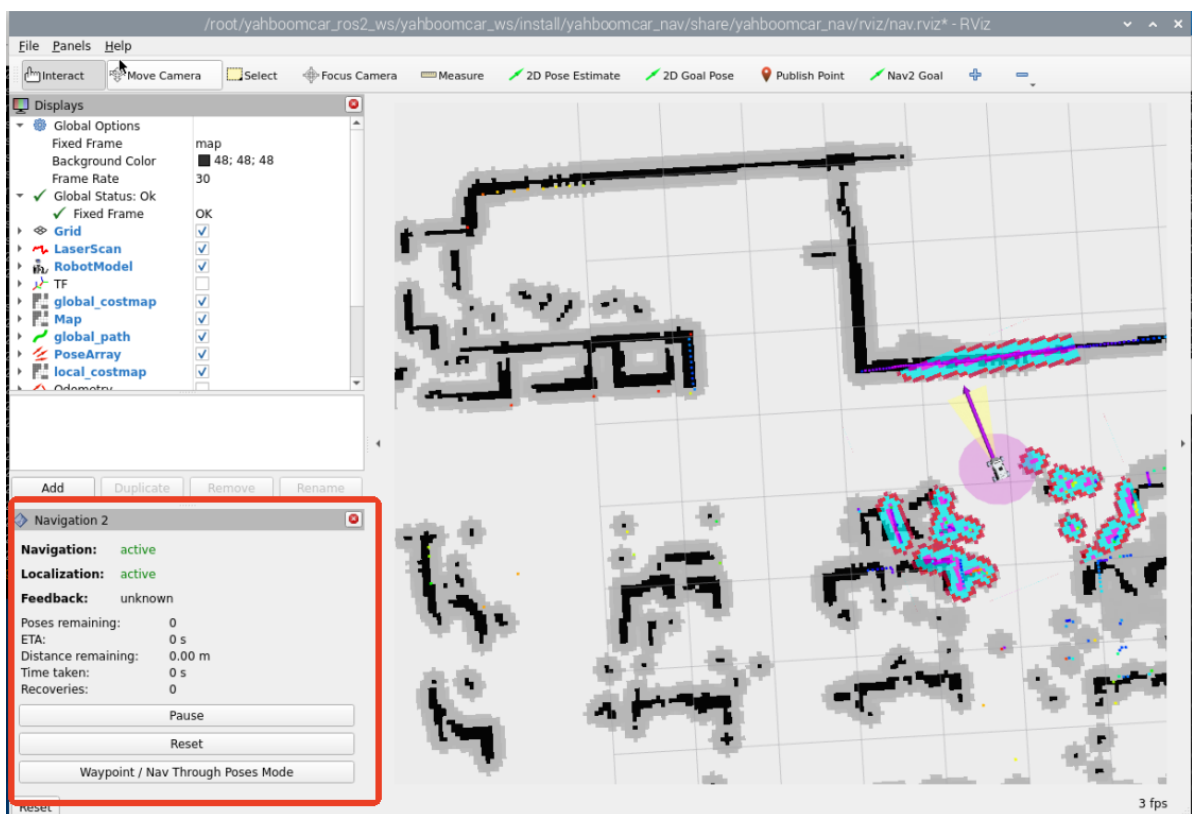
You'll see the map loaded. Click [2D Pose Estimate] to set the initial pose for the car. Based on the car's actual position in the environment, click and drag the mouse in rviz to move the car model to the set position. As shown in the figure below, if the lidar scan area roughly overlaps with the actual obstacle, the pose is accurate. After pose initialization is complete, the robot model and inflation area will appear in the rviz interface.



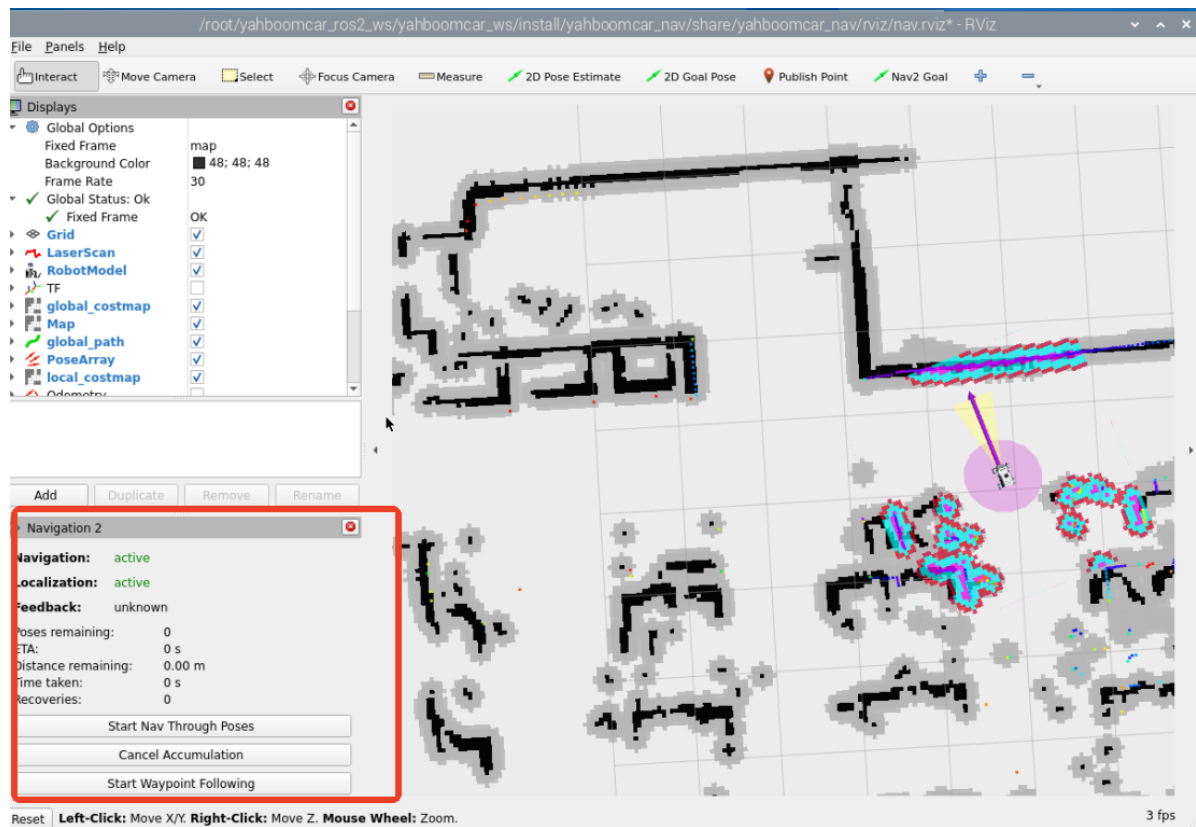
Click [Panels] in the upper left corner of rviz to add the Navigation2 plugin.



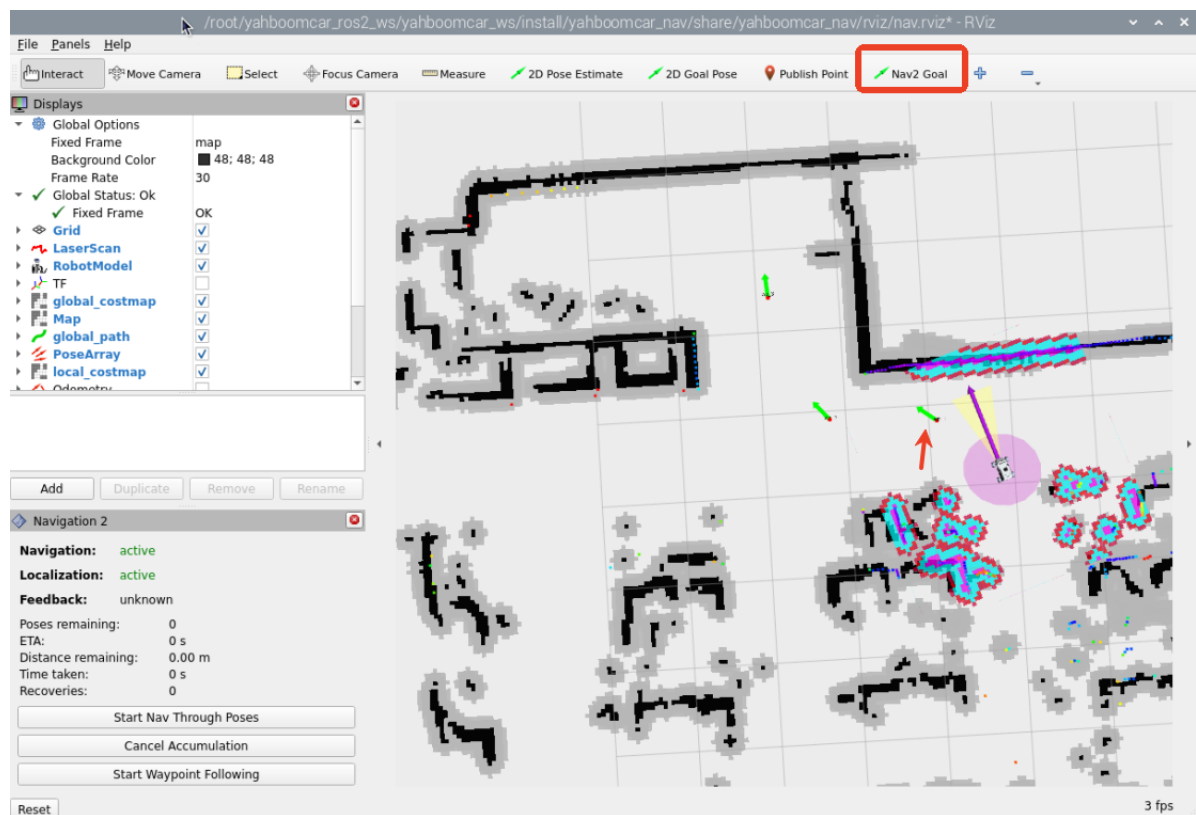
After adding, rviz will display as follows:



Then click [Waypoint/Nav Through Poses] Mode],



Use the [Nav2 Goal] button in the rviz toolbar to specify a target point, then click [Start Waypoint Following] to begin route navigation. The car will automatically proceed to the next point after reaching the target point, following the order of the selected points. No further action is required. After reaching the last point, the car will stop and await the next command.



If navigation to all three points is successful, the terminal will display [Completed all 3 waypoints requested].

```
root@raspberrypi: /
File Edit Tabs Help
[component_container_isolated-1] [INFO] [1755057180.508864646] [waypoint_follower]: Processing waypoint 2...
[component_container_isolated-1] [INFO] [1755057180.560254108] [waypoint_follower]: Processing waypoint 2...
[component_container_isolated-1] [INFO] [1755057180.608988191] [waypoint_follower]: Processing waypoint 2...
[component_container_isolated-1] [INFO] [1755057180.658931881] [waypoint_follower]: Processing waypoint 2...
[component_container_isolated-1] [INFO] [1755057180.709479921] [waypoint_follower]: Processing waypoint 2...
[component_container_isolated-1] [INFO] [1755057180.759018724] [waypoint_follower]: Processing waypoint 2...
[component_container_isolated-1] [INFO] [1755057180.808977506] [waypoint_follower]: Processing waypoint 2...
[component_container_isolated-1] [WARN] [1755057180.832270700] [BehaviorTreeEngine]: Behavior Tree tick rate 100.00 was exceeded!
[component_container_isolated-1] [INFO] [1755057180.866733260] [waypoint_follower]: Processing waypoint 2...
[component_container_isolated-1] [INFO] [1755057180.912875408] [waypoint_follower]: Processing waypoint 2...
[component_container_isolated-1] [INFO] [1755057180.958986834] [waypoint_follower]: Processing waypoint 2...
[component_container_isolated-1] [WARN] [1755057181.136988414] [BehaviorTreeEngine]: Behavior Tree tick rate 100.00 was exceeded!
[component_container_isolated-1] [INFO] [1755057181.504823382] [controller_server]: Passing new path to controller.
[component_container_isolated-1] [INFO] [1755057181.557384914] [controller_server]: Reached the goal!
[component_container_isolated-1] [INFO] [1755057181.597266881] [bt_navigator]: Goal succeeded
[component_container_isolated-1] [INFO] [1755057182.210766129] [waypoint_follower]: Succeeded processing waypoint 2, processing waypoint
task execution
[component_container_isolated-1] [INFO] [1755057182.210841110] [waypoint_follower]: Arrived at 2'th waypoint, sleeping for 200 millisecon
onds
[component_container_isolated-1] [INFO] [1755057182.411099091] [waypoint_follower]: Task execution at waypoint 2 succeeded
[component_container_isolated-1] [INFO] [1755057182.411332312] [waypoint_follower]: Handled task execution on waypoint 2, moving to next
t.
[component_container_isolated-1] [INFO] [1755057182.411353127] [waypoint_follower]: Completed all 3 waypoints requested.
```

3. Principle Analysis

3.1 Waypoint Data

When the user turns on **[Waypoint/Nav Through PoseMode]** and enters multi-point navigation mode, the user's marked point information will be published to the **/waypoints** topic (the rviz waypoint navigation plugin adds additional waypoints between target waypoints to smooth the path). We can view this **waypoint data** through the RQT interface.

Terminal startup command:

```
ros2 run rqt_topic rqt_topic
```

In the rqt interface, we can see the topic **/waypoints**. After checking it, we can observe the data on the topic (you need to check the topic first, then publish the waypoints in the rviz interface). The waypoints we manually mark in rviz will be published to this topic.

rqt_topic__TopicPlugin - rqt				
Topic	Type	Bandwidth	Hz	Value
/initialpose	geometry_msgs/msg/PoseWithCovarianceStamped			not monitored
/intel_realsense_r200_depth/points	sensor_msgs/msg/PointCloud2			not monitored
/joint_states	sensor_msgs/msg/JointState			not monitored
/joy	sensor_msgs/msg/Joy			not monitored
/joy/set_feedback	sensor_msgs/msg/JoyFeedback			not monitored
/local_costmap/clearing_endpoints	sensor_msgs/msg/PointCloud2			not monitored
/local_costmap/costmap	nav_msgs/msg/OccupancyGrid			not monitored
/local_costmap/costmap_raw	nav2_msgs/msg/Costmap			not monitored
/local_costmap/costmap_updates	map_msgs/msg/OccupancyGridUpdate			not monitored
/local_costmap/footprint	geometry_msgs/msg/Polygon			not monitored
/local_costmap/local_costmap/transition_event	lifecycle_msgs/msg/TransitionEvent			not monitored
/local_costmap/published_footprint	geometry_msgs/msg/PolygonStamped			not monitored
/local_costmap/voxel_grid	nav2_msgs/msg/VoxelGrid			not monitored
/local_plan	nav_msgs/msg/Path			not monitored
/map	nav_msgs/msg/OccupancyGrid			not monitored
/map_server/transition_event	lifecycle_msgs/msg/TransitionEvent			not monitored
/map_updates	map_msgs/msg/OccupancyGridUpdate			not monitored
/move_base/cancel	actionlib_msgs/msg/GoalID			not monitored
/navigate_through_poses/action/feedback	nav2_msgs/action/NavigateThroughPoses_FeedbackMessage			can not get message class for type "nav2_msgs/action/NavigateThroughPoses_F
/navigate_through_poses/action/status	action_msgs/msg/GoalStatusArray			not monitored
/navigate_to_pose/action/feedback	nav2_msgs/action/NavigateToPose_FeedbackMessage			can not get message class for type "nav2_msgs/action/NavigateToPose_Feedbac
/navigate_to_pose/action/status	action_msgs/msg/GoalStatusArray			not monitored
/obstacles	costmap_converter_msgs/msg/ObstacleArrayMsg			not monitored
/odom	nav_msgs/msg/Odometry			not monitored
/odom_raw	nav_msgs/msg/Odometry			not monitored
/parameter_events	rc1_interfaces/msg/ParameterEvent			not monitored
/particle_cloud	nav2_msgs/msg/ParticleCloud			not monitored
/particlecloud	geometry_msgs/msg/PoseArray			not monitored
/plan	nav_msgs/msg/Path			not monitored
/plan_smoothed	nav_msgs/msg/Path			not monitored
/planner_server/transition_event	lifecycle_msgs/msg/TransitionEvent			not monitored
/point_cloud	sensor_msgs/msg/PointCloud			not monitored
/robot_description	std_msgs/msg/String			not monitored
/rosout	rc1_interfaces/msg/Log			not monitored
/scan	sensor_msgs/msg/LaserScan			not monitored
/set_pose	geometry_msgs/msg/PoseWithCovarianceStamped			not monitored
/smooth_path/action/feedback	nav2_msgs/action/SmoothPath_FeedbackMessage			can not get message class for type "nav2_msgs/action/SmoothPath_FeedbackMe
/smooth_path/action/status	action_msgs/msg/GoalStatusArray			not monitored
/smoother_server/transition_event	lifecycle_msgs/msg/TransitionEvent			not monitored
/speed_limit	nav2_msgs/msg/SpeedLimit			not monitored
/teb_feedback	teb_msgs/msg/FeedbackMsg			not monitored
/teb_markers	visualization_msgs/msg/Marker			not monitored
/teb_poses	geometry_msgs/msg/PoseArray			not monitored
/tf	tf2_msgs/msg/TFMessage			not monitored
/tf_static	tf2_msgs/msg/TFMessage			not monitored
/vel_raw	geometry_msgs/msg/Twist			not monitored
/velocity_smoother/transition_event	lifecycle_msgs/msg/TransitionEvent			not monitored
/via_points	nav_msgs/msg/Path			not monitored
/voltage	std_msgs/msg/Float32			not monitored
/waypoint_follower/transition_event	lifecycle_msgs/msg/TransitionEvent			not monitored
✓ /waypoints	visualization_msgs/msg/MarkerArray	unknown	unknown	
- markers	sequence<visualization_msgs/Marker>			
> [0]	visualization_msgs/Marker			
> [1]	visualization_msgs/Marker			
> [2]	visualization_msgs/Marker			
> [3]	visualization_msgs/Marker			
> [4]	visualization_msgs/Marker			
> [5]	visualization_msgs/Marker			
> [6]	visualization_msgs/Marker			
> [7]	visualization_msgs/Marker			
> [8]	visualization_msgs/Marker			
/joy/initialpose	geometry_msgs/msg/PoseWithCovarianceStamped			not monitored

Click on a waypoint to view the waypoint data. Here, we take [0] as an example, where pose is the coordinate data.

✓ /waypoints	visualization_msgs/msg/MarkerArray	unknown	unknown
markers	sequence<visualization_msgs/Marker>		
[0]	visualization_msgs/Marker		
action	int32		0
color	std_msgs/ColorRGBA		
colors	sequence<std_msgs/ColorRGBA>		[]
frame_locked	boolean		False
header	std_msgs/Header		
id	int32		0
lifetime	builtin_interfaces/Duration		
mesh_file	visualization_msgs/MeshFile		
mesh_resource	string		"
mesh_use_embedded_materials	boolean		False
ns	string		"
points	sequence<geometry_msgs/Point>		[]
pose	geometry_msgs/Pose		
orientation	geometry_msgs/Quaternion		
w	double		0.9897298469191461
x	double		0.0
y	double		0.0
z	double		0.14295044637007442
position	geometry_msgs/Point		
x	double		1.0541921854019165
y	double		2.462282657623291
z	double		0.0
scale	geometry_msgs/Vector3		
text	string		"
texture	sensor_msgs/CompressedImage		
texture_resource	string		"
type	int32		0
z_coordinates	sequence<visualization_msgs/Coordinates>		[]

3.2 Data Sending Execution

After setting the waypoint coordinates, click ****Start Waypoint** When following a waypoint, the rviz plugin packages the waypoint coordinate sequence into a `FollowWaypoints` action request and sends it to the `/follow_waypoint` action server, which executes all waypoints in sequence.

Enter the following command in the terminal:

```
ros2 run rqt_graph rqt_graph
```

In the node relationship graph, you can see the **/follow_waypoint** action server. This action server receives the waypoint sequence and then navigates sequentially.

