4. Multi-machine surround

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4.1 Introduction

For the problem of how to configure multi-machine communication and synchronization time, please refer to the lesson [Multi-machine handle control] for details; if there is a network, the network system time can be directly synchronized without setting.

When using multi-machine handle control, it is first necessary to ensure that the robot is under the same local area network and configured with the same [ROS_MASTER_URI]; for multiple robots to control motion, there can only be one host. The example in this section sets the virtual machine as the host, and other robots as the slaves. There are several slaves. Of course, you can also set one robot as the master and others as the slaves.

According to different models, you only need to set the purchased model in [.bashrc], X1(ordinary four-wheel drive) X3(Mike wheel) X3plus(Mike wheel mechanical arm) R2(Ackerman differential) and so on. Section takes X3 as an example

Open the [.bashrc] file

```
sudo vim .bashrc
```

Find the [ROBOT_TYPE] parameter and modify the corresponding model

```
export  ROBOT_TYPE=X3    # ROBOT_TYPE: X1 X3 X3plus R2 X7
```

4.2 Use

Take the virtual machine as the host and the three robots as slaves as an example; a map must be available before use. The two slaves are [robot1] and [robot2] respectively, and [robot1] is set as the leader, and [robot2] is set as the follower. Make sure the field is large enough to avoid collisions when playing this feature. And no obstacle avoidance function.

4.2.1 Start the robot

virtual machine side

```
roscore
```

Start the command(robot1 side), for the convenience of operation, this section takes [mono + laser + yahboomcar] as an example.

```
#You need to enter docker first, perform this step more
#If running the script to enter docker fails, please refer to 07.Docker-orin/05,
Enter the robot's docker container
~/run_docker.sh
roslaunch  yahboomcar_multi  laser_bringup_multi.launch  ns := robot1
  # laser + yahboomcar
roslaunch  yahboomcar_multi  laser_usb_bringup_multi.launch  ns := robot1
  # mono + laser + yahboomcar
roslaunch  yahboomcar_multi  laser_astrapro_bringup_multi.launch  ns := robot1
 # Astra + laser + yahboomcar
```

Start command(robot2 side), for the convenience of operation, this section takes [mono + laser + yahboomcar] as an example.

```
#You need to enter docker first, perform this step more
#If running the script to enter docker fails, please refer to 07.Docker-orin/05,
Enter the robot's docker container
~/run_docker.sh
roslaunch  yahboomcar_multi  laser_bringup_multi.launch  ns := robot2
  # laser + yahboomcar
roslaunch  yahboomcar_multi  laser_usb_bringup_multi.launch  ns := robot2
  # mono + laser + yahboomcar
roslaunch  yahboomcar_multi  laser_astrapro_bringup_multi.launch  ns := robot2
 # Astra + laser + yahboomcar
```

More bots and so on.

4.2.2 Turn on multi-machine surround

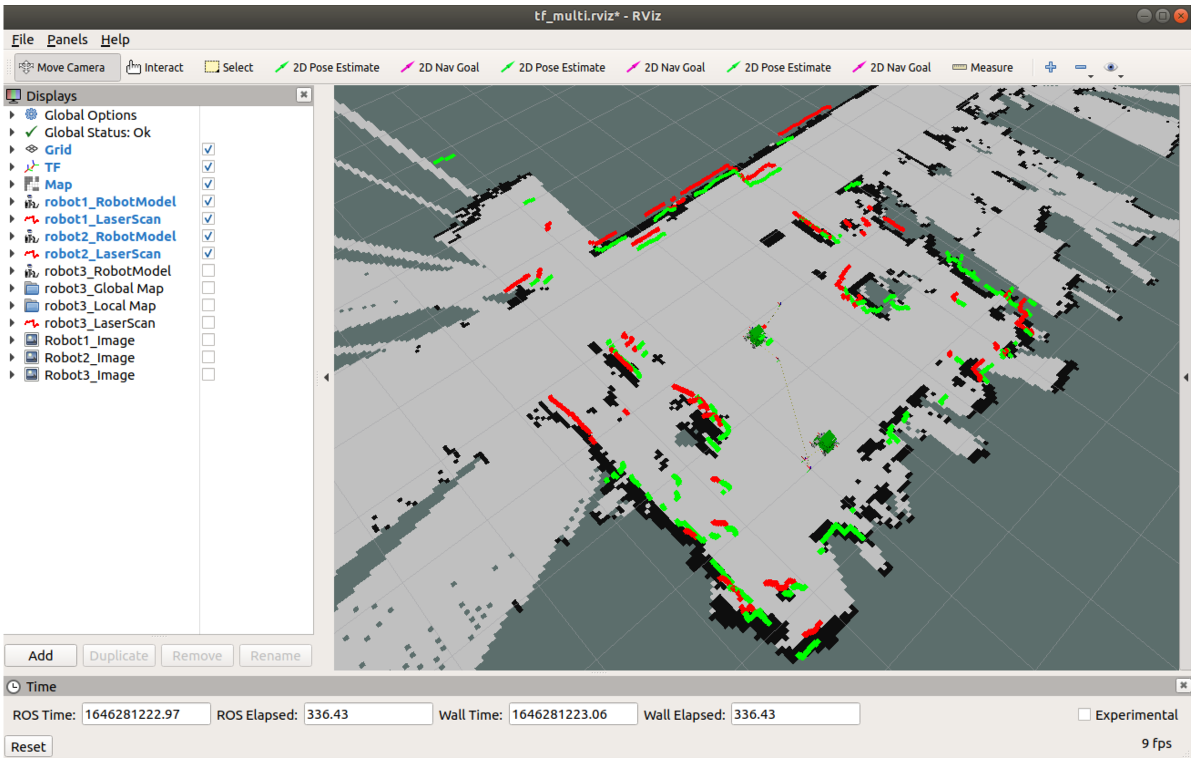
For the process of opening the handle control, please refer to the lesson [Multi-machine handle control].

virtual machine side

```
roslaunch yahboomcar_multi tf_roundbroad.launch use_rviz:=true map:=my_map
```

- [use_rviz] parameter: whether to open rviz.
- [map] Parameters: map name, the map to be loaded.

After startup, you need to initialize the pose setting of the robot. For the specific setting method, please refer to [Multi-machine Navigation This Lesson]. After setting, the following figure is shown.

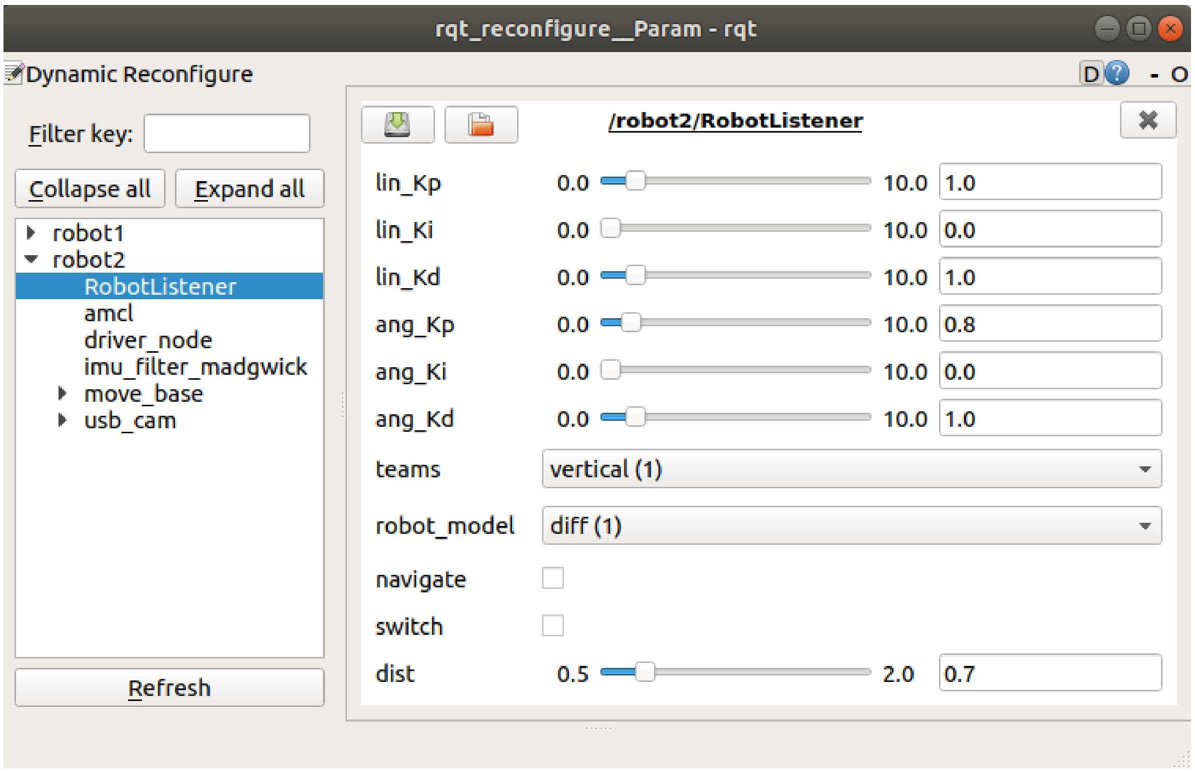


ROS Time: 1646281222.97 ROS Elapsed: 336.43 Wall Time: 1646281223.06 Wall Elapsed: 336.43

4.2.3 Formation control

Open the dynamic parameter adjustment tool

```
rosrun rqt_reconfigure rqt_reconfigure
```



/robot2/RobotListener

lin_Kp	0.0	10.0	1.0
lin_Ki	0.0	10.0	0.0
lin_Kd	0.0	10.0	1.0
ang_Kp	0.0	10.0	0.8
ang_Ki	0.0	10.0	0.0
ang_Kd	0.0	10.0	1.0
teams	vertical (1)		
robot_model	diff (1)		
navigate	☐		
switch	☐		
dist	0.5	2.0	0.7

The tool can be set individually for each robot.

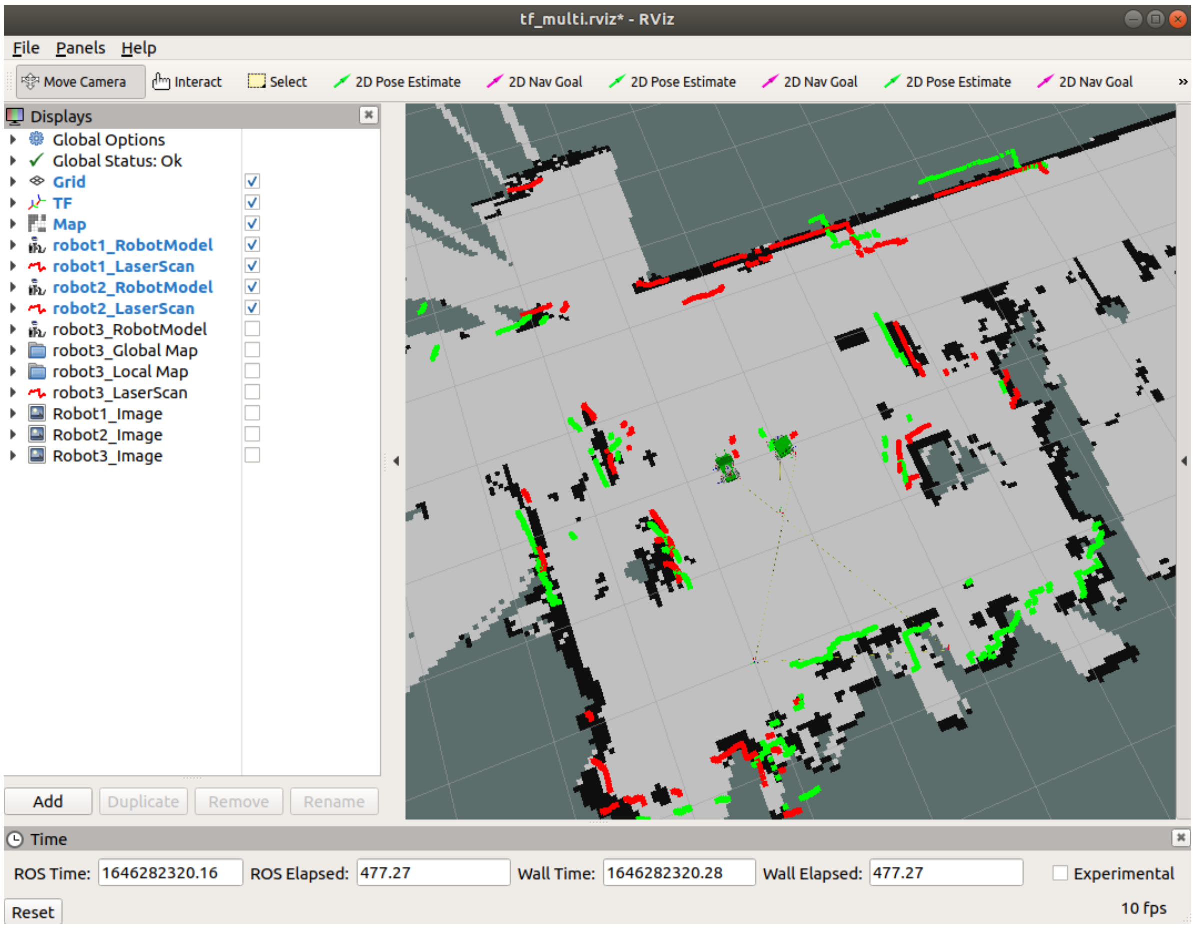
parameter parsing

[lin_Kp], [lin_Ki], [lin_Kd]: PID debugging of trolley linear speed.

[ang_Kp], [ang_Ki], [ang_Kd]: PID debugging of car angular velocity.

parameter	scope	Parse
[teams]	Default[vertical]	This parameter is invalid under this function
[robot_model]	Default [omni]	Model: [omni, diff]
[navigate]	[False,True]	whether to run in navigation mode
[Switch]	[False,True]	Function switch [Start/Pause]
[dist]	[0.5, 2.0]	wrap radius

After the [Switch] function switch is turned on, the robot automatically obtains its own position and the position launched by the pilot robot. When it reaches the closest point for the second time, it will follow the robot to automatically circle. As shown below



ROS Time: 1646282320.16 ROS Elapsed: 477.27 Wall Time: 1646282320.28 Wall Elapsed: 477.27

10 fps

4.3 launch file

tf_roundbroad.launch

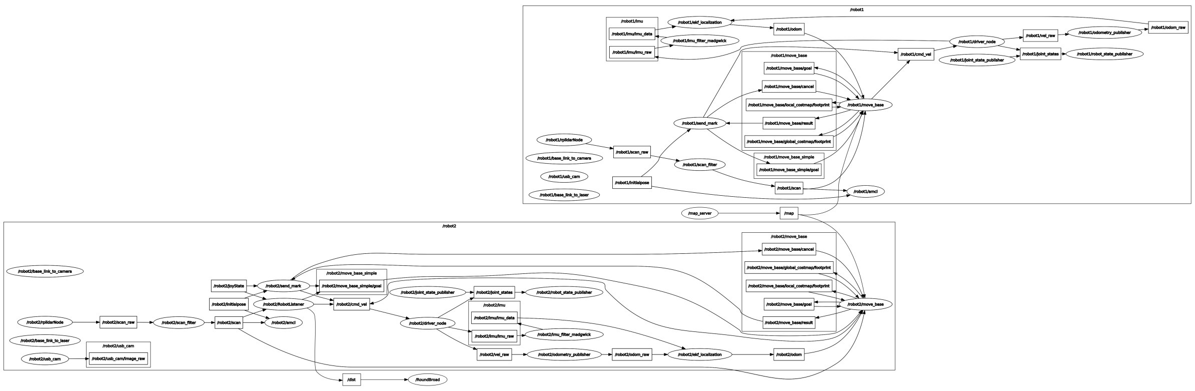
```
< launch >
    < arg  name = "first_robot1"  default = "robot1" />
    < arg  name = "second_robot2"  default = "robot2" />
    <!--  rviz  ||  Whether  to  open  rviz  -->
    < arg  name = "use_rviz"  default = "true" />
    <!--  Map name  ||  Map  name  -->
    < arg  name = "map"  default = "my_apm" />
    <!--  Load map  ||  Load  map  -->
    < node  name = "map_server"  pkg = "map_server"  type = "map_server"  args =
"$(find yahboomcar_nav)/maps/$(arg map).yaml" />
```

```
    < node  pkg = "rviz"  type = "rviz"  name = "rviz"  required = "true"  args
= "-d $(find yahboomcar_multi)/rviz/tf_multi.rviz"  if = "$(arg use_rviz)" />
    <!--  ############################# first_robot1
############################# -->
    < node  pkg = "yahboomcar_multi"  type = "broad_round.py"  name =
"RoundBroad"  output = "screen"  args = "$(arg first_robot1)" />
    < include  file = "$(find
yahboomcar_multi)/launch/library/move_base_multi.launch" >
        < arg  name = "ns"  value = "$(arg first_robot1)" />
    </ include >
    <!--  ############################# second_robot2
############################# -->
    < node  pkg = "yahboomcar_multi"  type = "listener.py"  name =
"RobotListener"  output = "screen"
          args = "$(arg second_robot2) point1"  ns = "$(arg second_robot2)/" >
        < rosparam  param = "linPIDparam" > [ 1.0, 0, 1.0 ] </ rosparam >
        < rosparam  param = "angPIDparam" > [ 0.8, 0, 1.0 ] </ rosparam >
    </ node >
    < include  file = "$(find
yahboomcar_multi)/launch/library/move_base_multi.launch" >
        < arg  name = "ns"  value = "$(arg second_robot2)" />
    </ include >
</ launch >
```

4.4 frame analysis

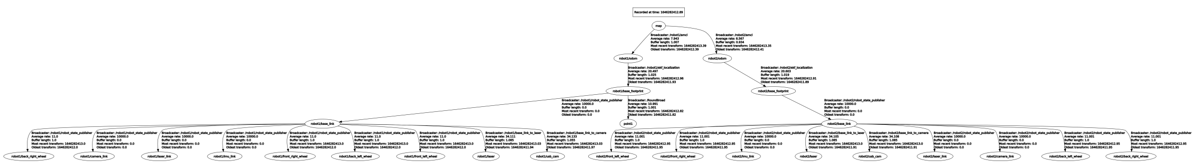
Node view

```
rqt_graph
```



View tf tree

```
rosrun rqt_tf_tree rqt_tf_tree
```



It can be seen from the above figure that [robot1] will send out the [point1] coordinate system, and [robot2] monitors the relationship between itself and the coordinate system in real time, and makes its own coordinate system coincide with the coordinate system. In the [tf_roundbroad.launch] file, we can see that [robot2] follows the [point1] coordinate system.