

快速使用 qingzhou_ws 实现自动导航

AI 航团队

*轻舟机器人出厂时 stm32 已经烧录好了完整的运动控制程序（也可以通过提供资料中的 hex 文件重新烧录），同时配合提供的导航包 qingzhou_ws 能够快速的体验自动导航功能。

*轻舟机器人的工控机 nano 需要完成一系列的环境安装，需要按照教程逐一进行配置，首先学习以下教程，依次为：教程 000、300、301、200、201、302、303、304、305、341 等，然后结合本教程 324 完成导航示例程序的测试，以上部分内容有重叠。

*如果对 ros 不熟悉的同学需要学习教程 202~214 的内容，同时配合官网等学习。

1. 下载 qingzhou_ws

将 qingzhou_ws 压缩包放到轻舟机器人的本地用户主目录（~/）下，右键解压。

2. 预备工作

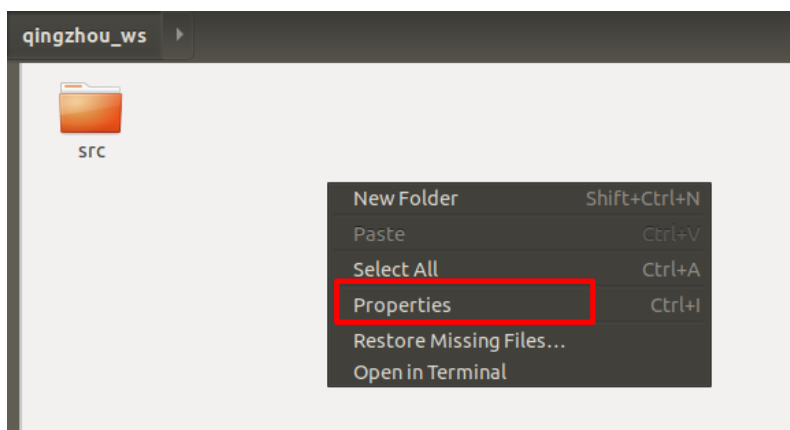
在编译前，先把 qingzhou_ws 编译过程中要依赖的包提前安装完毕（根据编译时报错的提示安装对应的软件即可）：

```
sudo apt-get install ros-melodic-serial
sudo apt-get install ros-melodic-bfl
sudo apt-get install ros-melodic-tf2-sensor-msgs
sudo apt-get install ros-melodic-voxel-grid
sudo apt-get install ros-melodic-gmapping
sudo apt-get install ros-melodic-map-server
```

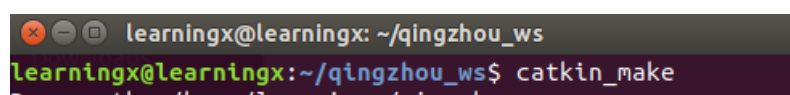
使用 sudo apt install 分别或一次全部输入安装即可。

3. 编译项目

（1） 打开 qingzhou_ws 文件夹，右键选择 open in Terminal



（2） 输入如下指令：catkin_make



回车，等待编译完成，如下图：

```

learningx@learningx: ~/qingzhou_ws
[ 83%] Built target move_slow_and_clear
[ 90%] Built target base_local_planner
[ 90%] Built target navfn
[ 91%] Built target trajectory_planner_ros
[ 91%] Built target navfn_node
[ 94%] Built target global_planner
[ 95%] Built target carrot_planner
[ 96%] Built target rotate_recovery
[ 96%] Built target planner
[ 97%] Built target dwa_local_planner
[ 97%] Built target simple_navigation_goals
[ 98%] Built target move_base
[100%] Built target move_base_node
learningx@learningx:~/qingzhou_ws$

```

4. 修改.bashrc 文件

打开终端，输入：sudo gedit ~/.bashrc

```

learningx@learningx: ~
learningx@learningx:~$ gedit ~/.bashrc

```

在文档中修改环境变量，在末尾加入如下一行，并保存：

```
source ~/qingzhou_ws/devel/setup.bash
```

```

.bashrc (~) - gedit
Open  .bashrc
~/

fi
fi

source /opt/ros/melodic/setup.bash
source ~/qingzhou_ws/devel/setup.bash

```

关闭文档，然后在终端输入：source ~/.bashrc

```

learningx@learningx: ~
learningx@learningx:~$ gedit ~/.bashrc
learningx@learningx:~$ source ~/.bashrc
learningx@learningx:~$

```

5. 测试建图

打开终端，输入如下指令：roslaunch qingzhou_nav qingzhou_bringup.launch

```

/home/learningx/qingzhou_ws/src/qingzhou_nav/launch/qingzhou_bringup.launch http://loc
learningx@learningx:~$ roslaunch qingzhou_nav qingzhou_bringup.launch
... logging to /home/learningx/.ros/log/fb7ec810-bdd9-11eb-90c4-8236f8c5b531/ros
launch-learningx-32074.log
Checking log directory for disk usage. This may take a while.
Press Ctrl-C to interrupt
Done checking log file disk usage. Usage is <1GB.

started roslaunch server http://learningx:34143/

SUMMARY
=====
PARAMETERS
* /apply_calib/calib_file: /home/learningx/q...
* /apply_calib/calibrate_gyros: True
* /calibrate_angularSpeed: 0
* /calibrate_lineSpeed: 0
* /imu_filter_madgwick/fixed_frame: odom
* /imu_filter_madgwick/publish_tf: False
* /imu_filter_madgwick/use_mag: False
* /imu_filter_madgwick/use_magnetic_field_msg: True
* /imu_filter_madgwick/world_frame: enu
* /mcubaudrate: 115200
* /mcuserialport: /dev/stm32board

```

再打开另外一个终端，输入如下指令：roslaunch qingzhou_nav qingzhou_hdmap.launch

```

/home/learningx/qingzhou_ws/src/qingzhou_nav/launch/qingzhou_hdmap.launch http://loca
learningx@learningx:~$ roslaunch qingzhou_nav qingzhou_hdmap.launch
... logging to /home/learningx/.ros/log/fb7ec810-bdd9-11eb-90c4-8236f8c5b531/ros
launch-learningx-32471.log
Checking log directory for disk usage. This may take a while.
Press Ctrl-C to interrupt
Done checking log file disk usage. Usage is <1GB.

started roslaunch server http://learningx:38381/

SUMMARY
=====

PARAMETERS
* /rostdistro: melodic
* /rosversion: 1.14.11
* /slam_gmapping/angularUpdate: 0.5
* /slam_gmapping/astep: 0.05
* /slam_gmapping/base_frame: /base_link
* /slam_gmapping/delta: 0.05
* /slam_gmapping/iterations: 5
* /slam_gmapping/kernelSize: 1
* /slam_gmapping/lasamplerange: 0.005
* /slam_gmapping/lasamplestep: 0.005
* /slam_gmapping/linearUpdate: 1.0

```

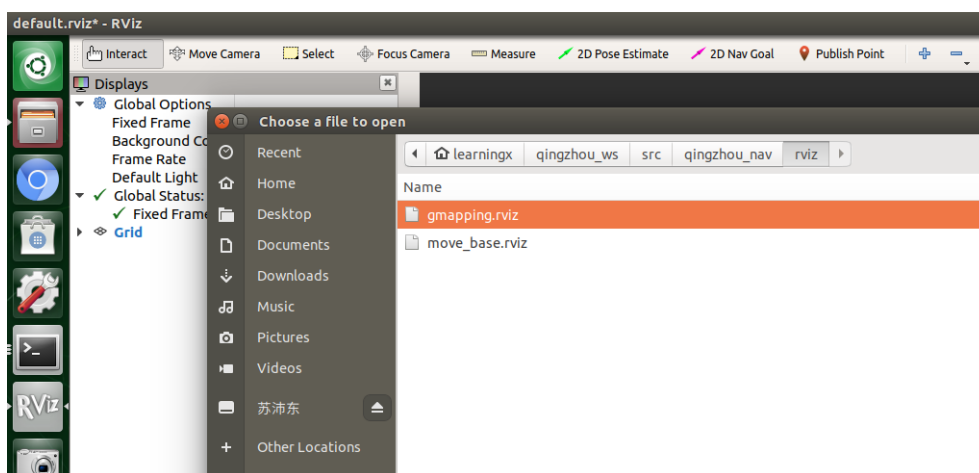
打开第三个终端，输入 rviz 并回车：

```

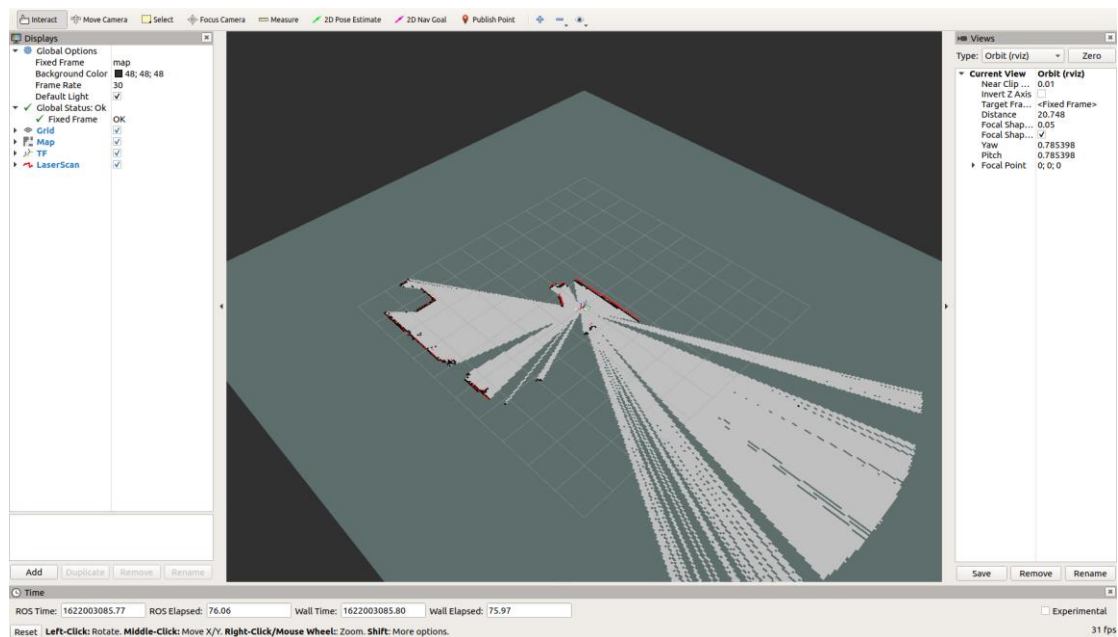
learningx@learningx: ~
learningx@learningx:~$ rviz
[ INFO] [1622003008.492817518]: rviz version 1.13.17
[ INFO] [1622003008.492951476]: compiled against Qt version 5.9.5
[ INFO] [1622003008.492992518]: compiled against OGRE version 1.9.0 (Ghadamon)
[ INFO] [1622003008.507615591]: Forcing OpenGL version 0.
[ INFO] [1622003009.336580174]: Stereo is NOT SUPPORTED
[ INFO] [1622003009.336786476]: OpenGL device: NVIDIA Tegra X1 (nvgpu)/integrate
d
[ INFO] [1622003009.337060018]: OpenGL version: 4.6 (GLSL 4.6).
Add
Time

```

打开 rviz 后，窗口最大化，点击左上角的 File，选择 Open Config，找到如下目录：



gmapping.rviz 是预先设定好的建图信息格式，选中后，将出现地图信息：



建图测试完毕，出现地图证明建图功能正常，关闭所有终端和窗口。

6. 测试启动导航程序

打开一个终端，输入如下命令：

```
roslaunch qingzhou_nav qingzhou_bringup.launch
```

```

/home/learningx/qingzhou_ws/src/qingzhou_nav/launch/qingzhou_bringup.launch http://loc
learningx@learningx:~$ roslaunch qingzhou_nav qingzhou_bringup.launch
... logging to /home/learningx/.ros/log/fb7ec810-bdd9-11eb-90c4-8236f8c5b531/ros
launch-learningx-32074.log
Checking log directory for disk usage. This may take a while.
Press Ctrl-C to interrupt
Done checking log file disk usage. Usage is <1GB.

started roslaunch server http://learningx:34143/

SUMMARY
=====

PARAMETERS
* /apply_calib/calib_file: /home/learningx/q...
* /apply_calib/calibrate_gyros: True
* /calibrate_angularSpeed: 0
* /calibrate_lineSpeed: 0
* /imu_filter_madgwick/fixed_frame: odom
* /imu_filter_madgwick/publish_tf: False
* /imu_filter_madgwick/use_mag: False
* /imu_filter_madgwick/use_magnetic_field_msg: True
* /imu_filter_madgwick/world_frame: enu
* /mcubaudrate: 115200
* /mcuserialport: /dev/stm32board
  
```

再打开另外一个终端，输入如下命令：

```
roslaunch qingzhou_nav qingzhou_move_base.launch
```

```

/home/learningx/qingzhou_ws/src/qingzhou_nav/launch/qingzhou_move_base.launch http://
learningx@learningx:~$ roslaunch qingzhou_nav qingzhou_move_base.launch
... logging to /home/learningx/.ros/log/fb7ec810-bdd9-11eb-90c4-8236f8c5b531/ros
launch-learningx-612.log
Checking log directory for disk usage. This may take a while.
Press Ctrl-C to interrupt
Done checking log file disk usage. Usage is <1GB.

WARNING: ignoring defunct <master /> tag
started roslaunch server http://learningx:42521/

SUMMARY
=====

PARAMETERS
* /amcl/gui_publish_rate: 10.0
* /amcl/kld_err: 0.05
* /amcl/kld_z: 0.99
* /amcl/laser_lambda_short: 0.1
* /amcl/laser_likelihoood_max_dist: 2.0
* /amcl/laser_max_beams: 60
* /amcl/laser_model_type: likelihood_field
* /amcl/laser_sigma_hit: 0.2
* /amcl/laser_z_hit: 0.5
* /amcl/laser_z_max: 0.05

```

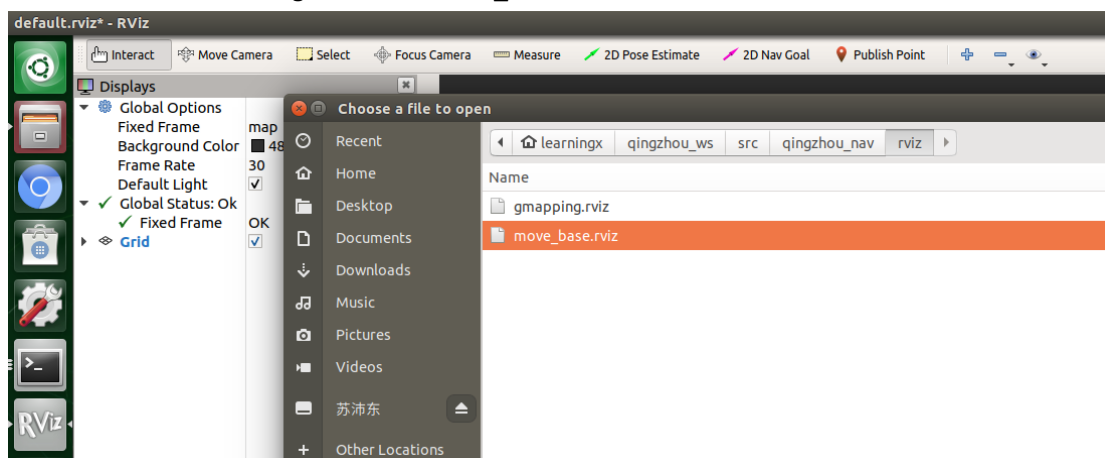
打开第三个终端，输入 `rviz` 并回车：

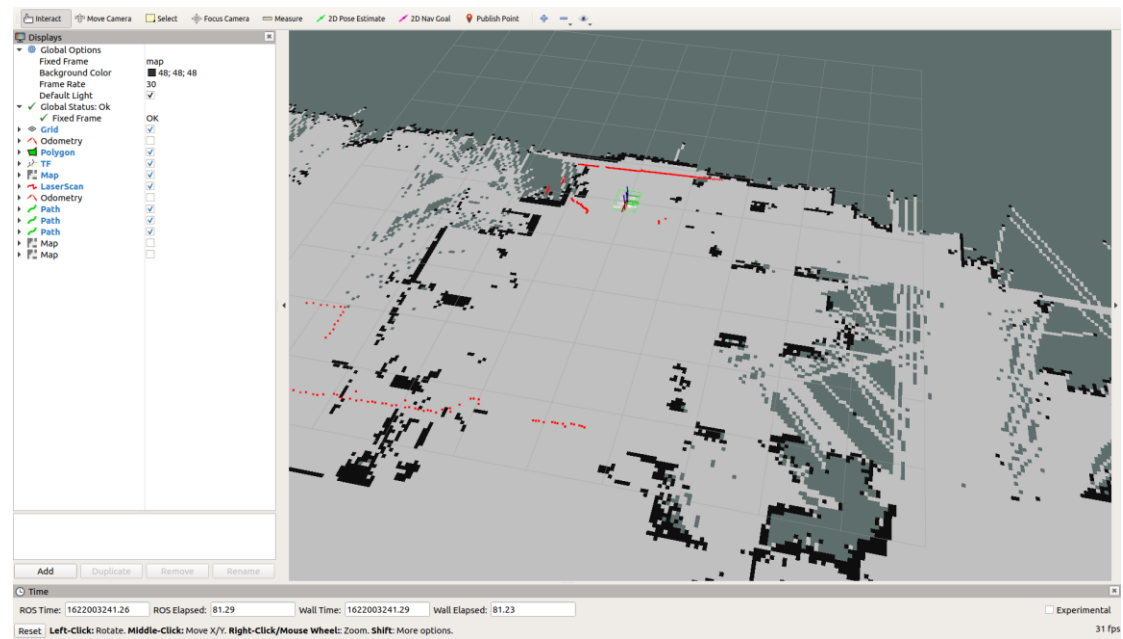
```

learningx@learningx: ~
learningx@learningx:~$ rviz
[ INFO] [1622003158.803619961]: rviz version 1.13.17
[ INFO] [1622003158.803750117]: compiled against Qt version 5.9.5
[ INFO] [1622003158.803793867]: compiled against OGRE version 1.9.0 (Ghadamon)
[ INFO] [1622003158.819641679]: Forcing OpenGL version 0.
[ INFO] [1622003159.589654492]: Stereo is NOT SUPPORTED
[ INFO] [1622003159.589862929]: OpenGL device: NVIDIA Tegra X1 (nvgpu)/integrate
d
[ INFO] [1622003159.589974700]: OpenGL version: 4.6 (GLSL 4.6).

```

窗口最大化，Config 文件选择 `move_base.rviz`：





出现以上地图界面说明程序已正常启动。

至此说明轻舟机器人的示例导航测试已经结束，程序运行都正常了，接下来配置远程启动轻舟机器人相关设置。

远程控制轻舟机器人

1. 在远程电脑中装入 Ubuntu 系统，安装 ROS，然后输入如下指令安装 SSH：

```
sudo apt-get install ssh
```

2. 将远程电脑与轻舟机器人连入同一个局域网。

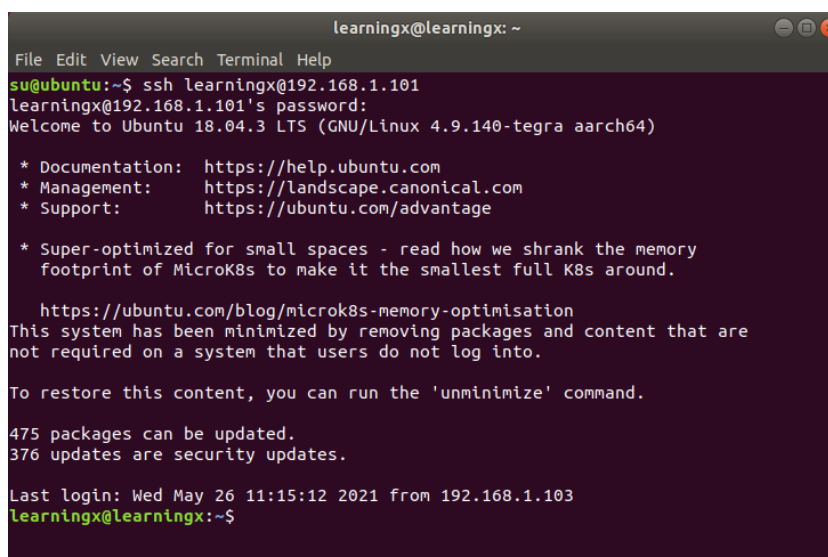
3. 测试 SSH 远程连接

在远程电脑 Ubuntu 系统的终端中输入：

```
ssh learningx@192.168.1.101
```

*learningx 替换为你的轻舟机器人用户名，IP 地址也用轻舟机器人实际地址替换

输入密码后，终端显示类似如下界面：



```
learningx@learningx: ~  
File Edit View Search Terminal Help  
su@ubuntu:~$ ssh learningx@192.168.1.101  
learningx@192.168.1.101's password:  
Welcome to Ubuntu 18.04.3 LTS (GNU/Linux 4.9.140-tegra aarch64)  
  
* Documentation:  https://help.ubuntu.com  
* Management:    https://landscape.canonical.com  
* Support:        https://ubuntu.com/advantage  
  
* Super-optimized for small spaces - read how we shrank the memory  
  footprint of MicroK8s to make it the smallest full K8s around.  
  https://ubuntu.com/blog/microk8s-memory-optimisation  
  This system has been minimized by removing packages and content that are  
  not required on a system that users do not log into.  
  To restore this content, you can run the 'unminimize' command.  
  
475 packages can be updated.  
376 updates are security updates.  
  
Last login: Wed May 26 11:15:12 2021 from 192.168.1.103  
learningx@learningx:~$
```

然后就可以在此界面远程执行建图、导航等指令了。

4. 配置远程 Rviz（可参考教程 341）

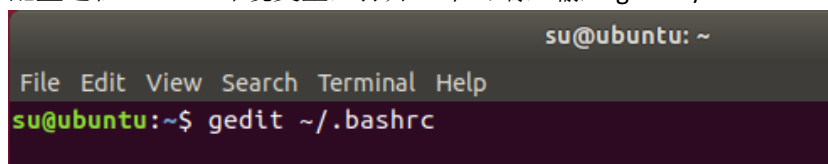
此处测试设备：

（1）轻舟机器人：ip 为 192.168.1.101，主机名为 learningx。

（2）远程 ubuntu（虚拟机）：ip 为 192.168.1.103，主机名为 ubuntu。（虚拟机需要通过桥接的形式与 PC 本地机连接，PC 机 IP 为 192.168.1.102）

配置方法：

步骤一、配置远程 ubuntu 环境变量，打开一个终端，输入 `gedit ~/.bashrc`：



```
su@ubuntu: ~  
File Edit View Search Terminal Help  
su@ubuntu:~$ gedit ~/.bashrc
```

在打开的 .bashrc 文件中加入如下图所示的两行内容。其中：ROS_MASTER_URI 对应轻舟机器人的 IP，ROS_HOSTNAME 对应远程 ubuntu 的 IP。


```

Open ▾  .bashrc
~/
. /usr/share/bash-completion/bash_completion
elif [ -f /etc/bash_completion ]; then
. /etc/bash_completion
fi
fi
source /opt/ros/melodic/setup.bash
source ~/qingzhou_ws/devel/setup.bash
export ROS_MASTER_URI=http://192.168.1.101:11311
export ROS_HOSTNAME=192.168.1.103
sh ▾ Tab Width: 8 ▾ Li

```

保存后关闭，在终端输入 `source ~/.bashrc` 刷新环境变量。

```

su@ubuntu: ~
File Edit View Search Terminal Help
su@ubuntu:~$ gedit ~/.bashrc
su@ubuntu:~$ source ~/.bashrc
su@ubuntu:~$

```

5.

步骤二、配置远端 ubuntu 的 /etc/hosts 文件，首先打开 hosts 文件：

终端输入：`sudo gedit /etc/hosts`

```

su@ubuntu: ~
File Edit View Search Terminal Help
su@ubuntu:~$ sudo gedit /etc/hosts

```

在 hosts 中加入轻舟机器人的 IP 和主机名如下所示：（注意是主机名而不是用户名！），

```

Open ▾  hosts
/etc
127.0.0.1    localhost
127.0.1.1    ubuntu
192.168.1.101 learningx

# The following lines are desirable for IPv6 capable hosts
::1          ip6-localhost ip6-loopback
fe00::0      ip6-localnet
ff00::0      ip6-mcastprefix
ff02::1      ip6-allnodes
ff02::2      ip6-allrouters

```

以上配置完成，可以将轻舟机器人断开显示器，放在地上准备建图了！

- 5 远程查看建图，首先将 `qingzhou_ws/src/qingzhou_nav/` 目录下的 `rviz` 文件夹复制到远程电脑 home 下，用于执行远程 `rviz` 时调用。

（1）打开一个终端，执行以下指令**连接 SSH**：`ssh learningx@192.168.1.101`
 然后输入如下指令启动底盘：`roslaunch qingzhou_nav qingzhou_bringup.launch`
 以上两步如下图所示：


```

/home/learningx/qingzhou_ws/src/qingzhou_nav/launch/qingzhou_bringup.launch http://loc...
File Edit View Search Terminal Help
su@ubuntu:~$ ssh learningx@192.168.1.101
learningx@192.168.1.101's password:
Welcome to Ubuntu 18.04.3 LTS (GNU/Linux 4.9.140-tegra aarch64)

 * Documentation:  https://help.ubuntu.com
 * Management:    https://landscape.canonical.com
 * Support:       https://ubuntu.com/advantage

 * Super-optimized for small spaces - read how we shrank the memory
   footprint of MicroK8s to make it the smallest full K8s around.

   https://ubuntu.com/blog/microk8s-memory-optimisation
This system has been minimized by removing packages and content that are
not required on a system that users do not log into.

To restore this content, you can run the 'unminimize' command.

475 packages can be updated.
376 updates are security updates.

Last login: Wed May 26 11:15:12 2021 from 192.168.1.103
learningx@learningx:~$ roslaunch qingzhou_nav qingzhou_bringup.launch
... logging to /home/learningx/.ros/log/81988040-bdc5-11eb-b5c1-8236f8c5b531/ros
launch-learningx-7883.log
Checking log directory for disk usage. This may take a while.
Press Ctrl-C to interrupt
Done checking log file disk usage. Usage is <1GB.

started roslaunch server http://learningx:42293/

SUMMARY
=====

PARAMETERS
 * /apply_calib/calib_file: /home/learningx/q...
 * /apply_calib/calibrate_gyros: True

```

(2) 再打开另一个终端，执行以下指令**连接 SSH**：`ssh learningx@192.168.1.101`
 输入如下指令启动建图：`roslaunch qingzhou_nav qingzhou_hdmap.launch`

```

/home/learningx/qingzhou_ws/src/qingzhou_nav/launch/qingzhou_hdmap.launch http://loc...
File Edit View Search Terminal Help
su@ubuntu:~$ ssh learningx@192.168.1.101
learningx@192.168.1.101's password:
Welcome to Ubuntu 18.04.3 LTS (GNU/Linux 4.9.140-tegra aarch64)

 * Documentation:  https://help.ubuntu.com
 * Management:    https://landscape.canonical.com
 * Support:       https://ubuntu.com/advantage

 * Super-optimized for small spaces - read how we shrank the memory
   footprint of MicroK8s to make it the smallest full K8s around.

   https://ubuntu.com/blog/microk8s-memory-optimisation
This system has been minimized by removing packages and content that are
not required on a system that users do not log into.

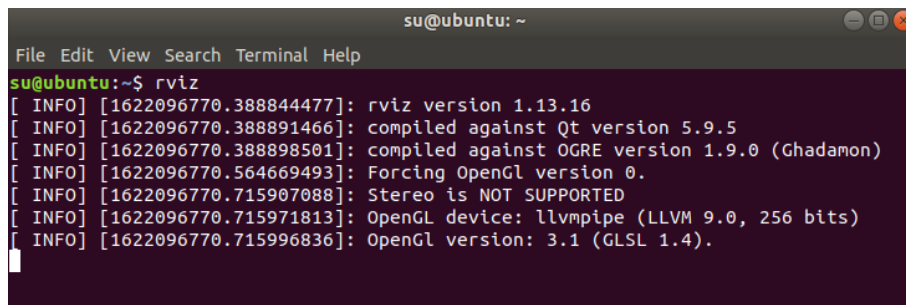
To restore this content, you can run the 'unminimize' command.

475 packages can be updated.
376 updates are security updates.

Last login: Wed May 26 09:52:33 2021 from 192.168.1.103
learningx@learningx:~$ roslaunch qingzhou_nav qingzhou_hdmap.launch
... logging to /home/learningx/.ros/log/81988040-bdc5-11eb-b5c1-8236f8c5b531/ros
launch-learningx-8363.log

```

(3) 打开第三个终端，**不要连接 ssh**，直接输入 `rviz` 并回车，如下图：

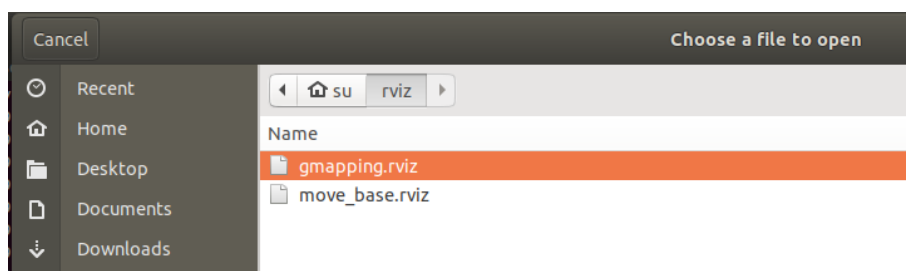


```

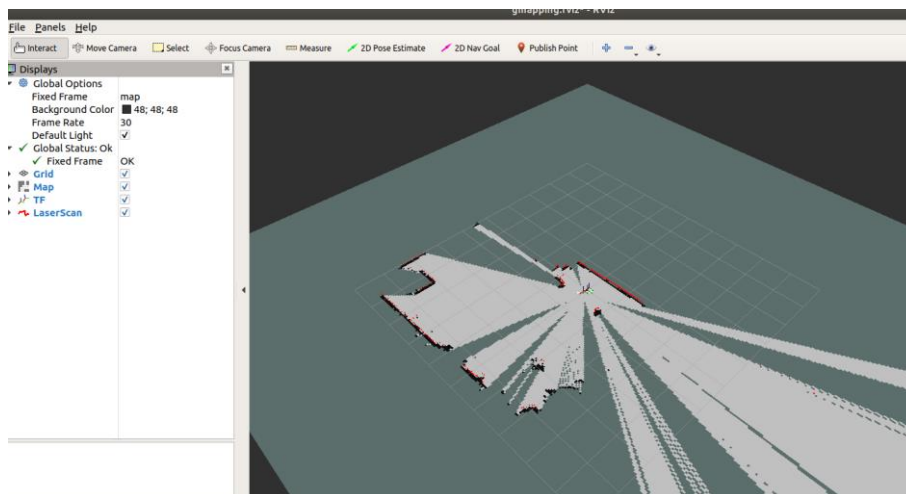
su@ubuntu: ~
File Edit View Search Terminal Help
su@ubuntu:~$ rviz
[ INFO] [1622096770.388844477]: rviz version 1.13.16
[ INFO] [1622096770.388891466]: compiled against Qt version 5.9.5
[ INFO] [1622096770.388898501]: compiled against OGRE version 1.9.0 (Ghadamon)
[ INFO] [1622096770.564669493]: Forcing OpenGL version 0.
[ INFO] [1622096770.715907088]: Stereo is NOT SUPPORTED
[ INFO] [1622096770.715971813]: OpenGL device: llvmpipe (LLVM 9.0, 256 bits)
[ INFO] [1622096770.715996836]: OpenGL version: 3.1 (GLSL 1.4).

```

会出现 `rviz` 的界面，选择左上角 `file -> Open Config`，找到拷贝到远程电脑用的 `rviz` 文件夹，选中 `gmapping.rviz`：



此时 `Rviz` 中将出现地图信息，接下来可通过遥控器控制小车移动完成建图：



6. 保存地图（**注意：地图是保存在车上而非远程电脑上**）

首先连接 ssh，然后输入如下指令定位到地图存放文件夹：

```
cd qingzhou_ws/src/qingzhou_nav/maps/
```

```

learningx@learningx: ~/qingzhou_ws/src/qingzhou_nav/maps
File Edit View Search Terminal Help
su@ubuntu:~$ ssh learningx@192.168.1.101
learningx@192.168.1.101's password:
Welcome to Ubuntu 18.04.3 LTS (GNU/Linux 4.9.140-tegra aarch64)

 * Documentation:  https://help.ubuntu.com
 * Management:    https://landscape.canonical.com
 * Support:       https://ubuntu.com/advantage

 * Super-optimized for small spaces - read how we shrank the memory
   footprint of MicroK8s to make it the smallest full K8s around.

   https://ubuntu.com/blog/microk8s-memory-optimisation
This system has been minimized by removing packages and content that are
not required on a system that users do not log into.

To restore this content, you can run the 'unminimize' command.

475 packages can be updated.
376 updates are security updates.

Last login: Wed May 26 10:01:56 2021 from 192.168.1.103
learningx@learningx:~$ cd qingzhou_ws/src/qingzhou_nav/maps/
learningx@learningx:~/qingzhou_ws/src/qingzhou_nav/maps$

```

输入保存地图命令：roslaunch map_server map_saver -f 地图名

```

learningx@learningx: ~/qingzhou_ws/src/qingzhou_nav/maps
File Edit View Search Terminal Help
su@ubuntu:~$ ssh learningx@192.168.1.101
learningx@192.168.1.101's password:
Welcome to Ubuntu 18.04.3 LTS (GNU/Linux 4.9.140-tegra aarch64)

 * Documentation:  https://help.ubuntu.com
 * Management:    https://landscape.canonical.com
 * Support:       https://ubuntu.com/advantage

 * Super-optimized for small spaces - read how we shrank the memory
   footprint of MicroK8s to make it the smallest full K8s around.

   https://ubuntu.com/blog/microk8s-memory-optimisation
This system has been minimized by removing packages and content that are
not required on a system that users do not log into.

To restore this content, you can run the 'unminimize' command.

475 packages can be updated.
376 updates are security updates.

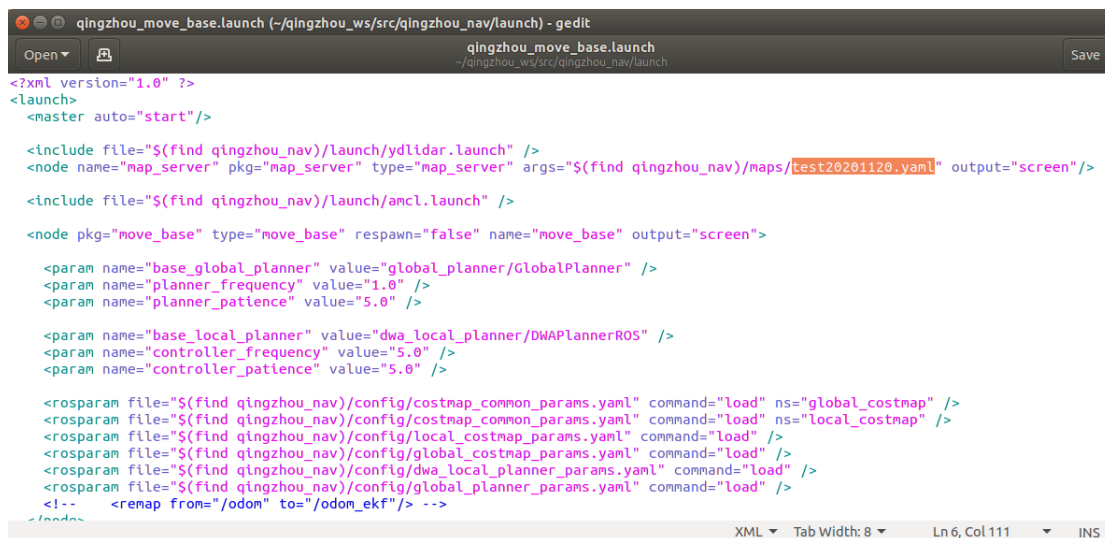
Last login: Wed May 26 10:09:52 2021 from 192.168.1.103
learningx@learningx:~/qingzhou_ws/src/qingzhou_nav/maps$ roslaunch map_server map_saver -f 20210527
[ INFO] [1621995163.557748115]: Waiting for the map
[ INFO] [1621995163.835111552]: Received a 384 X 608 map @ 0.050 m/pix
[ INFO] [1621995163.835216240]: Writing map occupancy data to 20210527.pgm
[ INFO] [1621995163.865470615]: Writing map occupancy data to 20210527.yaml
[ INFO] [1621995163.865810406]: Done
learningx@learningx:~/qingzhou_ws/src/qingzhou_nav/maps$

```

7. 结合地图与导航程序

方法 1:

将轻舟机器人连接电脑显示器，找到 `qingzhou_ws/src/qingzhou_nav/launch` 目录下的 `qingzhou_move_base.launch`，打开后修改对应位置为新地图名即可。



```
<?xml version="1.0" ?>
<launch>
  <master auto="start"/>

  <include file="$(find qingzhou_nav)/launch/ydlidar.launch" />
  <node name="map_server" pkg="map_server" type="map_server" args="$(find qingzhou_nav)/maps/test20201120.yaml" output="screen"/>

  <include file="$(find qingzhou_nav)/launch/amcl.launch" />

  <node pkg="move_base" type="move_base" respawn="false" name="move_base" output="screen">

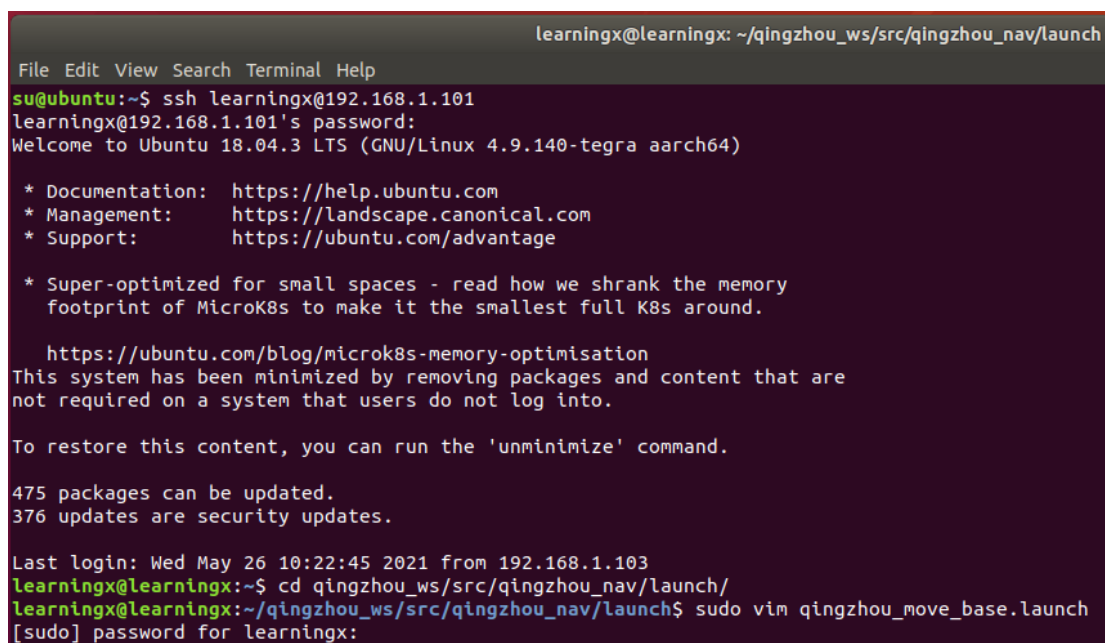
    <param name="base_global_planner" value="global_planner/GlobalPlanner" />
    <param name="planner_frequency" value="1.0" />
    <param name="planner_patience" value="5.0" />

    <param name="base_local_planner" value="dwa_local_planner/DWAPlanerROS" />
    <param name="controller_frequency" value="5.0" />
    <param name="controller_patience" value="5.0" />

    <roscppparam file="$(find qingzhou_nav)/config/costmap_common_params.yaml" command="load" ns="global_costmap" />
    <roscppparam file="$(find qingzhou_nav)/config/costmap_common_params.yaml" command="load" ns="local_costmap" />
    <roscppparam file="$(find qingzhou_nav)/config/local_costmap_params.yaml" command="load" />
    <roscppparam file="$(find qingzhou_nav)/config/global_costmap_params.yaml" command="load" />
    <roscppparam file="$(find qingzhou_nav)/config/dwa_local_planner_params.yaml" command="load" />
    <roscppparam file="$(find qingzhou_nav)/config/global_planner_params.yaml" command="load" />
  </node>
  <remap from="/odom" to="/odom_ekf"/> -->
</launch>
```

方法 2:

远程电脑连接 ssh，定位到 qingzhou_ws/src/qingzhou_nav/launch，使用 vim 打开 qingzhou_move_base.launch（涉及 vim 编辑器的使用，新手建议方法 1）



```
learningx@learningx: ~/qingzhou_ws/src/qingzhou_nav/launch
File Edit View Search Terminal Help
su@ubuntu:~$ ssh learningx@192.168.1.101
learningx@192.168.1.101's password:
Welcome to Ubuntu 18.04.3 LTS (GNU/Linux 4.9.140-tegra aarch64)

 * Documentation:  https://help.ubuntu.com
 * Management:    https://landscape.canonical.com
 * Support:       https://ubuntu.com/advantage

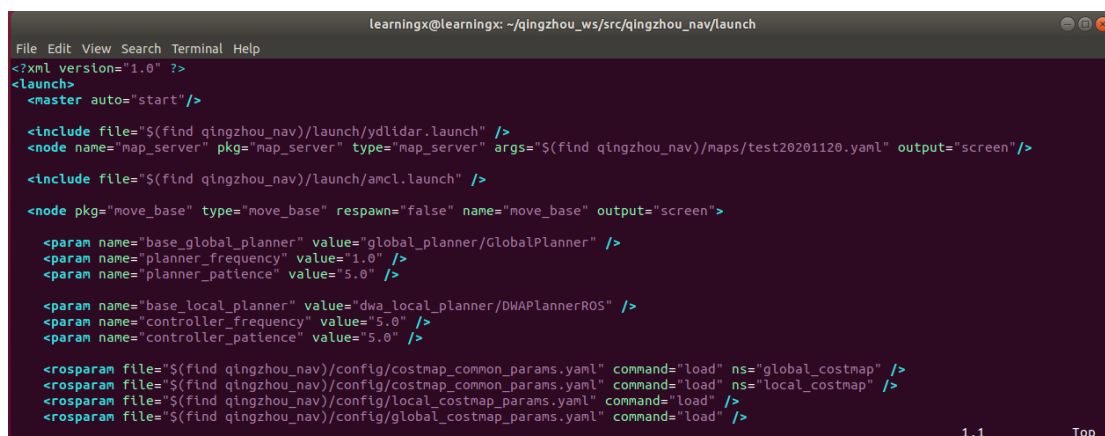
 * Super-optimized for small spaces - read how we shrank the memory
   footprint of MicroK8s to make it the smallest full K8s around.

https://ubuntu.com/blog/microk8s-memory-optimisation
This system has been minimized by removing packages and content that are
not required on a system that users do not log into.

To restore this content, you can run the 'unminimize' command.

475 packages can be updated.
376 updates are security updates.

Last login: Wed May 26 10:22:45 2021 from 192.168.1.103
learningx@learningx:~$ cd qingzhou_ws/src/qingzhou_nav/launch/
learningx@learningx:~/qingzhou_ws/src/qingzhou_nav/launch$ sudo vim qingzhou_move_base.launch
[sudo] password for learningx:
```



```
learningx@learningx: ~/qingzhou_ws/src/qingzhou_nav/launch
File Edit View Search Terminal Help
<?xml version="1.0" ?>
<launch>
  <master auto="start"/>

  <include file="$(find qingzhou_nav)/launch/ydlidar.launch" />
  <node name="map_server" pkg="map_server" type="map_server" args="$(find qingzhou_nav)/maps/test20201120.yaml" output="screen"/>

  <include file="$(find qingzhou_nav)/launch/amcl.launch" />

  <node pkg="move_base" type="move_base" respawn="false" name="move_base" output="screen">

    <param name="base_global_planner" value="global_planner/GlobalPlanner" />
    <param name="planner_frequency" value="1.0" />
    <param name="planner_patience" value="5.0" />

    <param name="base_local_planner" value="dwa_local_planner/DWAPlanerROS" />
    <param name="controller_frequency" value="5.0" />
    <param name="controller_patience" value="5.0" />

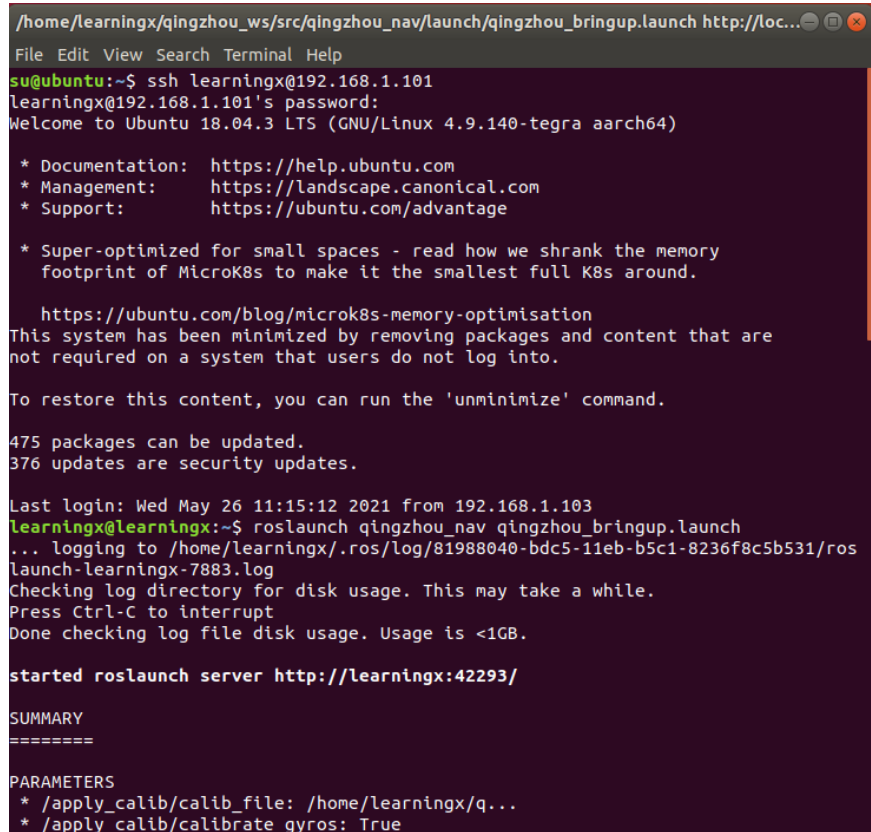
    <roscppparam file="$(find qingzhou_nav)/config/costmap_common_params.yaml" command="load" ns="global_costmap" />
    <roscppparam file="$(find qingzhou_nav)/config/costmap_common_params.yaml" command="load" ns="local_costmap" />
    <roscppparam file="$(find qingzhou_nav)/config/local_costmap_params.yaml" command="load" />
    <roscppparam file="$(find qingzhou_nav)/config/global_costmap_params.yaml" command="load" />
  </node>
  <remap from="/odom" to="/odom_ekf"/> -->
</launch>
```

9. 远程运行导航程序

(1) 打开一个终端，执行以下指令**连接 SSH**: `ssh learningx@192.168.1.101`

然后输入如下指令启动底盘: `roslaunch qingzhou_nav qingzhou_bringup.launch`

以上两步如下图所示:



```

/home/learningx/qingzhou_ws/src/qingzhou_nav/launch/qingzhou_bringup.launch http://loc...
File Edit View Search Terminal Help
su@ubuntu:~$ ssh learningx@192.168.1.101
learningx@192.168.1.101's password:
Welcome to Ubuntu 18.04.3 LTS (GNU/Linux 4.9.140-tegra aarch64)

 * Documentation:  https://help.ubuntu.com
 * Management:    https://landscape.canonical.com
 * Support:       https://ubuntu.com/advantage

 * Super-optimized for small spaces - read how we shrank the memory
   footprint of MicroK8s to make it the smallest full K8s around.

   https://ubuntu.com/blog/microk8s-memory-optimisation
This system has been minimized by removing packages and content that are
not required on a system that users do not log into.

To restore this content, you can run the 'unminimize' command.

475 packages can be updated.
376 updates are security updates.

Last login: Wed May 26 11:15:12 2021 from 192.168.1.103
learningx@learningx:~$ roslaunch qingzhou_nav qingzhou_bringup.launch
... logging to /home/learningx/.ros/log/81988040-bdc5-11eb-b5c1-8236f8c5b531/ros
launch-learningx-7883.log
Checking log directory for disk usage. This may take a while.
Press Ctrl-C to interrupt
Done checking log file disk usage. Usage is <1GB.

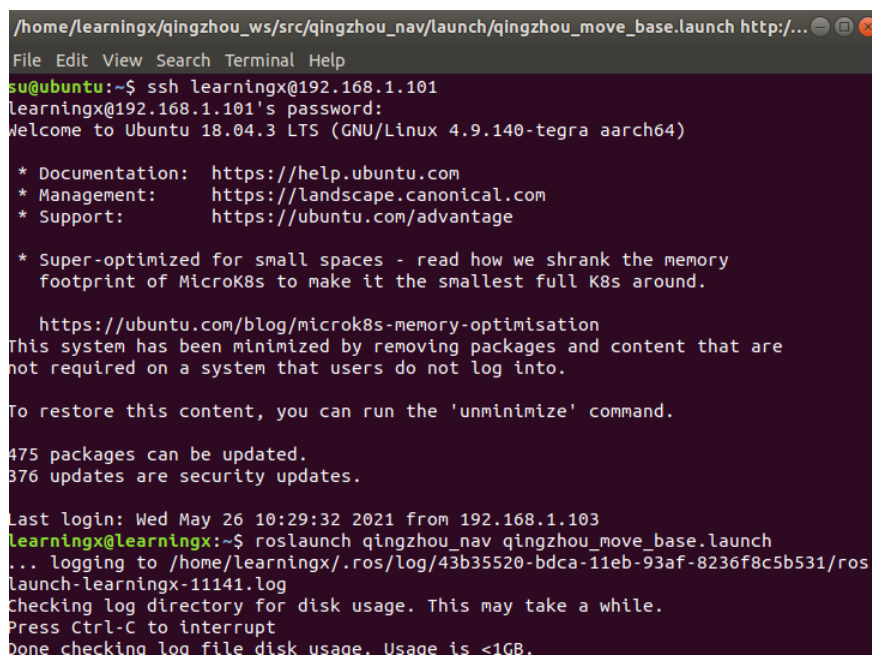
started roslaunch server http://learningx:42293/

SUMMARY
=====
PARAMETERS
 * /apply_calib/calib_file: /home/learningx/q...
 * /apply_calib/calibrate_gyros: True

```

(2) 再打开另一个终端，执行以下指令**连接 ssh**: `ssh learningx@192.168.1.101`

输入如下指令启动 `move_base`: `roslaunch qingzhou_nav qingzhou_move_base.launch`



```

/home/learningx/qingzhou_ws/src/qingzhou_nav/launch/qingzhou_move_base.launch http://...
File Edit View Search Terminal Help
su@ubuntu:~$ ssh learningx@192.168.1.101
learningx@192.168.1.101's password:
Welcome to Ubuntu 18.04.3 LTS (GNU/Linux 4.9.140-tegra aarch64)

 * Documentation:  https://help.ubuntu.com
 * Management:    https://landscape.canonical.com
 * Support:       https://ubuntu.com/advantage

 * Super-optimized for small spaces - read how we shrank the memory
   footprint of MicroK8s to make it the smallest full K8s around.

   https://ubuntu.com/blog/microk8s-memory-optimisation
This system has been minimized by removing packages and content that are
not required on a system that users do not log into.

To restore this content, you can run the 'unminimize' command.

475 packages can be updated.
376 updates are security updates.

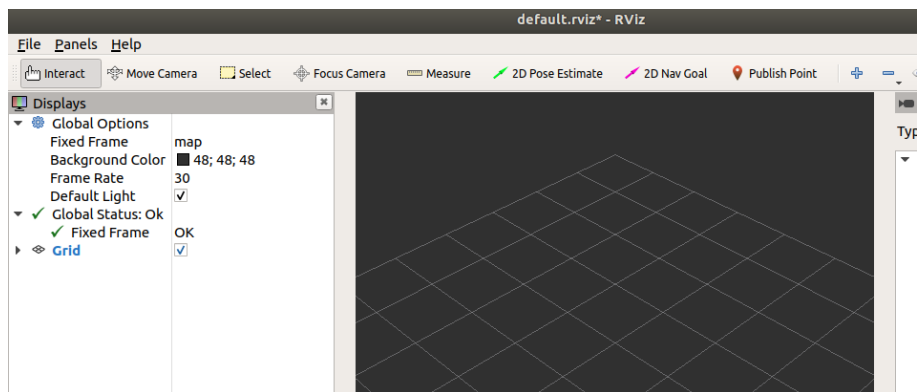
Last login: Wed May 26 10:29:32 2021 from 192.168.1.103
learningx@learningx:~$ roslaunch qingzhou_nav qingzhou_move_base.launch
... logging to /home/learningx/.ros/log/43b35520-bdca-11eb-93af-8236f8c5b531/ros
launch-learningx-11141.log
Checking log directory for disk usage. This may take a while.
Press Ctrl-C to interrupt
Done checking log file disk usage. Usage is <1GB.

```

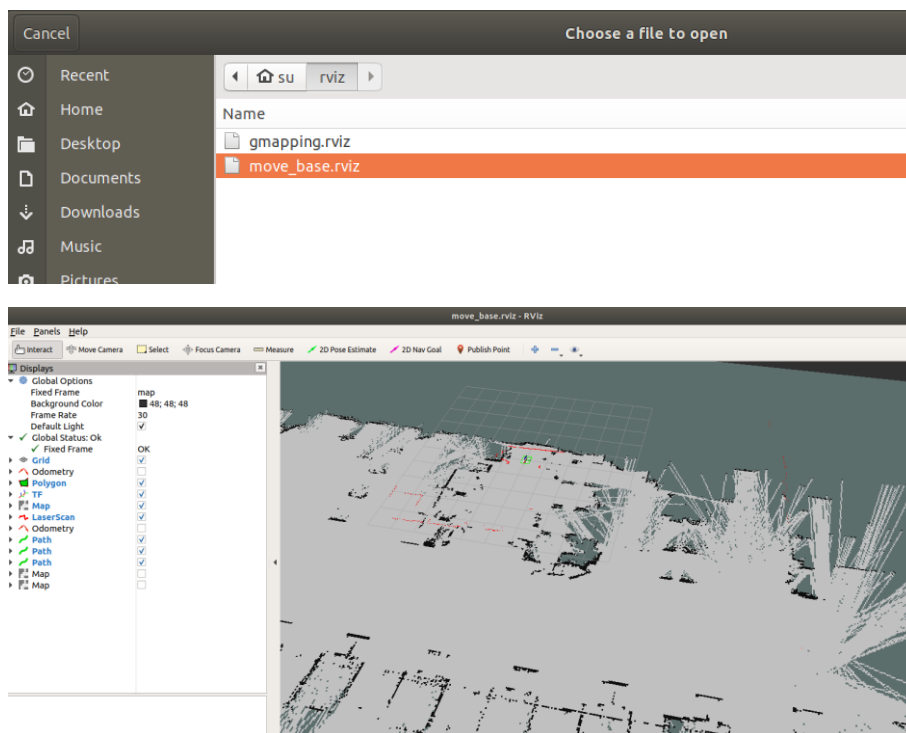
打开第三个终端，不连接 ssh，输入 rviz:

```
su@ubuntu: ~  
File Edit View Search Terminal Help  
su@ubuntu:~$ rviz  
[ INFO] [1622098831.877736502]: rviz version 1.13.16  
[ INFO] [1622098831.87775302]: compiled against Qt version 5.9.5  
[ INFO] [1622098831.877781997]: compiled against OGRE version 1.9.0 (Ghadamon)  
[ INFO] [1622098832.004797396]: Forcing OpenGL version 0.  
[ INFO] [1622098832.126358431]: Stereo is NOT SUPPORTED  
[ INFO] [1622098832.126475031]: OpenGL device: llvmpipe (LLVM 9.0, 256 bits)  
[ INFO] [1622098832.126525872]: OpenGL version: 3.1 (GLSL 1.4).
```

之后会启动 rviz 界面，如下图所示:



点击左上角 file->open config, 找到拷贝到远程电脑用的 rviz 文件夹, 选中 move_base.rviz:



出现地图后，可通过 2D Nav Goal 发送目标点，轻舟机器人将去往相应位置。

如果发送目标点，车无法去往相应的位置，终端输出找不到路径：

```

/home/learningx/qingzhou_ws/src/qingzhou_nav/launch/qingzhou_move_base.launch http://...
File Edit View Search Terminal Help
INFO [1621996224.249660783]: local_costmap: Using plugin "obstacle_layer"
INFO [1621996224.264569168]: Subscribed to Topics: scan
INFO [1621996224.331595731]: local_costmap: Using plugin "inflation_layer"
INFO [1621996224.557483595]: Created local_planner dwa_local_planner/DWAPlann
rROS
INFO [1621996224.574842502]: Sim period is set to 0.20
INFO [1621996225.165835574]: Recovery behavior will clear layer 'obstacles'
INFO [1621996225.195721616]: Recovery behavior will clear layer 'obstacles'
INFO [1621996225.324219793]: odom received!
ERROR [1621997126.263899085]: Failed to get a plan.
ERROR [1621997127.724606272]: Failed to get a plan.
ERROR [1621997129.180607417]: Failed to get a plan.
ERROR [1621997130.635894604]: Failed to get a plan.
WARN [1621997130.650994969]: Map update loop missed its desired rate of 1.000
Hz... the loop actually took 5.5526 seconds
WARN [1621997130.674421323]: Clearing both costmaps to unstuck robot (3.00m).
ERROR [1621997132.332746582]: Failed to get a plan.
ERROR [1621997133.788242571]: Failed to get a plan.
ERROR [1621997135.244701113]: Failed to get a plan.
ERROR [1621997136.700378820]: Failed to get a plan.
WARN [1621997136.728726425]: Map update loop missed its desired rate of 1.000
Hz... the loop actually took 5.0777 seconds
WARN [1621997136.874591685]: Rotate recovery behavior started.
WARN [1621997138.977774705]: Costmap2DROS transform timeout. Current time: 16

```

- (1) 观察 oled 显示屏，确保轻舟机器人切换到 AUT 模式，而不是 PS2 模式；
- (2) 根据激光点云信息，确保车的实际位置和在地图中的位置是一致的。（每次开启自动导航程序时，轻舟机器人的实际位置和开始建图时轻舟机器人的重合，可以免去位置校准）；
- (3) 先在车的正前方发送目标点进行测试直行；
- (4) 只有在场宽大于 2 米以上，才可以进行转弯的测试。

1. 同学们在使用过程中，如果发现内容有疏漏或者不严谨的地方，请与我们联系，将会有轻舟积分送上！QQ: 270220858

2. 内容如有雷同，侵权！

2021 年 1 月