



# 基于TurtleBot3的仿真slam建模与导航 (Gazebo建模)

## 一、TurtleBot3简介

TurtleBot3 是一个小型，低成本，完全可编程，基于 ROS 的移动机器人。它旨在用于教育，研究，产品原型和爱好应用的目的。TurtleBot3 的目标是大幅降低平台的尺寸和价格，而不会牺牲性能，功能和质量。由于提供了其他选项，如底盘，计算机和传感器，TurtleBot3 可以通过各种方式进行定制。TurtleBot3 应用了 SBC（单板计算机），深度传感器和 3D 打印的最新技术进步等技术。

## 二、安装ROS

- 本文使用Ubuntu18.04安装ROS Melodic

### 1. 更改ROS 源(国内源)

```
sudo sh -c '... /etc/lsb-release && echo "deb http://mirrors.ustc.edu.cn/ros/ubuntu/ $DIS...
```

### 2. 设置密钥

```
sudo apt-key adv --keyserver hkp://keyserver.ubuntu.com:80 --recv-key 421C365BD9FF1F7...
```

### 3. 更新软件包列表

```
sudo apt update
```

### 4. 安装ROS Melodic

```
sudo apt-get install ros-melodic-desktop-full
```

## 5. 初始化rosdep

```
sudo rosdep init
```

## 6. 更新rosdep

```
sudo rosdep update
```

## 7. 将ros添加到环境变量

```
echo "source /opt/ros/melodic/setup.bash" >> ~/.bashrc source ~/.bashrc
```

## 8. 运行ROS检测是否安装成功

```
roscore
```

```
...  欢迎  ROS.md  ...
roscore http://mingqi-OMEN-Laptop-15-ek0xxx:11311/
文件(F) 编辑(E) 查看(V) 搜索(S) 终端(T) 帮助(H)
Press Ctrl-C to interrupt
Done checking log file disk usage. Usage is <1GB.

started roslaunch server http://mingqi-OMEN-Laptop-15-ek0xxx:43079/
ros_comm version 1.14.13

SUMMARY
=====
PARAMETERS
* /rostdistro: melodic
* /rosversion: 1.14.13

NODES
auto-starting new master
process[master]: started with pid [6862]
ROS_MASTER_URI=http://mingqi-OMEN-Laptop-15-ek0xxx:11311/

setting /run_id to e8d9fb4e-876c-11ee-997e-e0d4e8e0a295
process[rosout-1]: started with pid [6873]
started core service [/rosout]

```

- 如图所示，这ROS Melodic安装成功

## 三、安装Turtlebot3

### 1. 安装Turtlebot3依赖库

```
sudo apt-get install ros-melodic-joy ros-melodic-teleop-twist-joy ros-melodic-teleop-
```

### 2. 下载Turtlebot3资源包

```
mkdir -p ~/turtlebot3_ws/src/
cd ~/turtlebot3_ws/src/
git clone https://github.com/ROBOTIS-GIT/turtlebot3_simulations.git
git clone https://github.com/ROBOTIS-GIT/turtlebot3_msgs.git
git clone https://github.com/ROBOTIS-GIT/turtlebot3.git
```

```
mingqi@mingqi-OMEN-Laptop-15-ek0xxx: ~/turtlebot3_ws
文件(F) 编辑(E) 查看(V) 搜索(S) 终端(T) 帮助(H)
remote: Total 3167 (delta 823), reused 775 (delta 773), pack-reused 2214
接收对象中: 100% (3167/3167), 15.40 MiB | 4.41 MiB/s, 完成.
处理 delta 中: 100% (1861/1861), 完成.
mingqi@mingqi-OMEN-Laptop-15-ek0xxx:~/turtlebot3_ws$ 
mingqi@mingqi-OMEN-Laptop-15-ek0xxx:~/turtlebot3_ws$ git clone https://github.com/ROBOTIS-GIT/turtlebot3_msgs.git
正克隆到 'turtlebot3_msgs'...
remote: Enumerating objects: 415, done.
remote: Counting objects: 100% (173/173), done.
remote: Compressing objects: 100% (58/58), done.
remote: Total 415 (delta 72), reused 156 (delta 61), pack-reused 242
接收对象中: 100% (415/415), 91.62 KiB | 613.00 KiB/s, 完成.
处理 delta 中: 100% (173/173), 完成.
mingqi@mingqi-OMEN-Laptop-15-ek0xxx:~/turtlebot3_ws$ 
mingqi@mingqi-OMEN-Laptop-15-ek0xxx:~/turtlebot3_ws$ git clone https://github.com/ROBOTIS-GIT/turtlebot3.git
正克隆到 'turtlebot3'...
remote: Enumerating objects: 6636, done.
remote: Counting objects: 100% (1328/1328), done.
remote: Compressing objects: 100% (221/221), done.
remote: Total 6636 (delta 1163), reused 1160 (delta 1107), pack-reused 5308
接收对象中: 100% (6636/6636), 119.99 MiB | 4.62 MiB/s, 完成.
处理 delta 中: 100% (4151/4151), 完成.
mingqi@mingqi-OMEN-Laptop-15-ek0xxx:~/turtlebot3_ws$ 
```

- git Turtlebot3 资源包成功

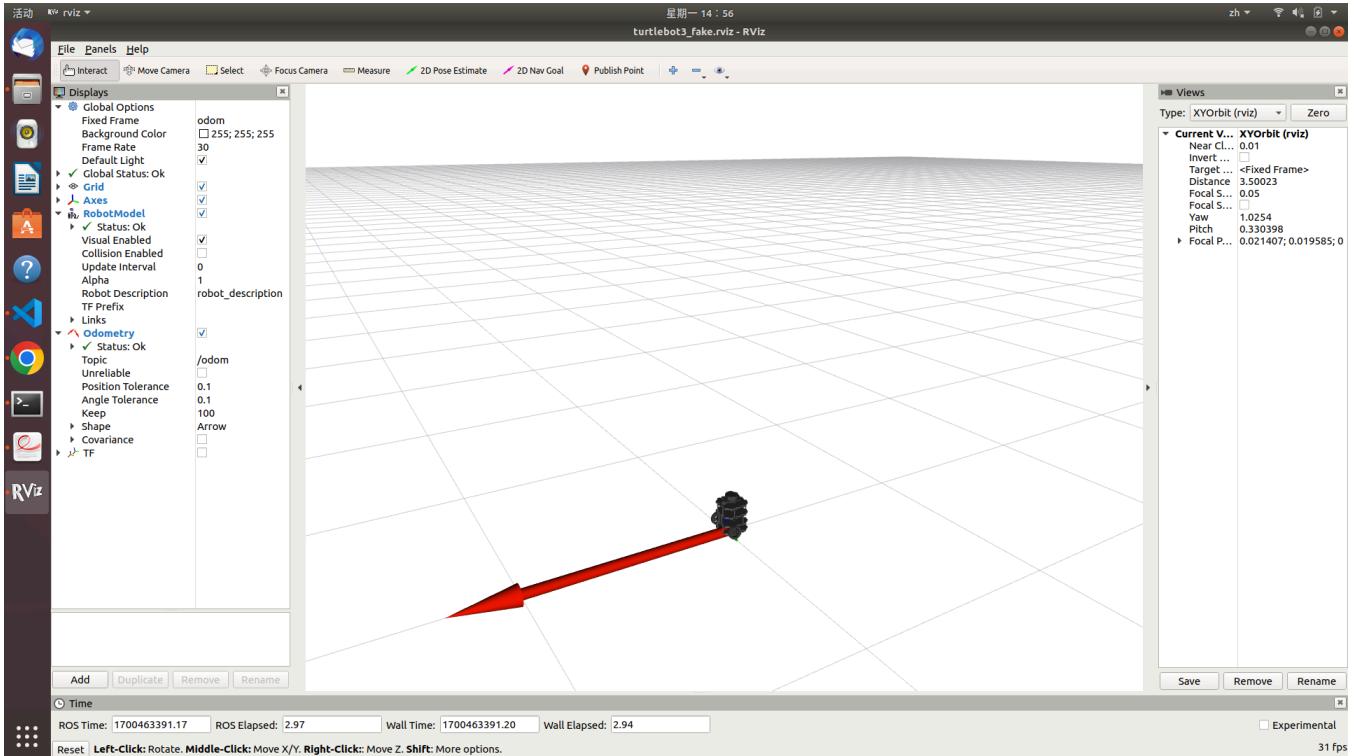
### 3. 编译Turtlebot3 资源包

```
cd ~/turtlebot3_ws
catkin_make
```

```
mingqi@mingqi-OMEN-Laptop-15-ek0xxx: ~/turtlebot3_ws
文件(F) 编辑(E) 查看(V) 搜索(S) 终端(T) 帮助(H)
[ 87%] Building CXX object turtlebot3/turtlebot3_bringup/CMakeFiles/turtlebot3_diagnostics.dir/src/turtlebot3_diagnostics.cpp.o
[ 88%] Building CXX object turtlebot3_simulations/turtlebot3_fake/CMakeFiles/turtlebot3_fake_node.dir/src/turtlebot3_fake.cpp.o
[ 90%] Generating C++ code from turtlebot3_example/Turtlebot3ActionGoal.msg
[ 91%] Generating C++ code from turtlebot3_example/Turtlebot3ActionResult.msg
[ 93%] Generating C++ code from turtlebot3_example/Turtlebot3Action.msg
[ 93%] Built target turtlebot3_example_generate_messages_eus
[ 93%] Built target turtlebot3_example_generate_messages_cpp
Scanning dependencies of target turtlebot3_example_generate_messages
[ 93%] Built target turtlebot3_example_generate_messages
[ 95%] Linking CXX executable /home/mingqi/turtlebot3_ws/devel/lib/turtlebot3_simam/flat_world_imu_node
[ 95%] Built target flat_world_imu_node
[ 96%] Linking CXX executable /home/mingqi/turtlebot3_ws/devel/lib/turtlebot3_gazebo/turtlebot3_drive
[ 96%] Built target turtlebot3_drive
[ 98%] Linking CXX executable /home/mingqi/turtlebot3_ws/devel/lib/turtlebot3_bringup/turtlebot3_diagnostics
[ 98%] Built target turtlebot3_diagnostics
[100%] Linking CXX executable /home/mingqi/turtlebot3_ws/devel/lib/turtlebot3_fake/turtlebot3_fake_node
[100%] Built target turtlebot3_fake_node
mingqi@mingqi-OMEN-Laptop-15-ek0xxx:~/turtlebot3_ws$
```

## 4. 测试Turtlebot3是否安装成功

```
export TURTLEBOT3_MODEL=burger
source ~/turtlebot3_ws/devel/setup.bash
roslaunch turtlebot3_fake turtlebot3_fake.launch
```



## 5. 把Turtlebot3加入环境变量

- 打开.bashrc文件

```
gedit ~/.bashrc
```

将下面两行**Shell**命令拷贝到文件最后

```
export TURTLEBOT3_MODEL=burger
source ~/turtlebot3_ws/devel/setup.bash
```

## 四、安装Cartographer

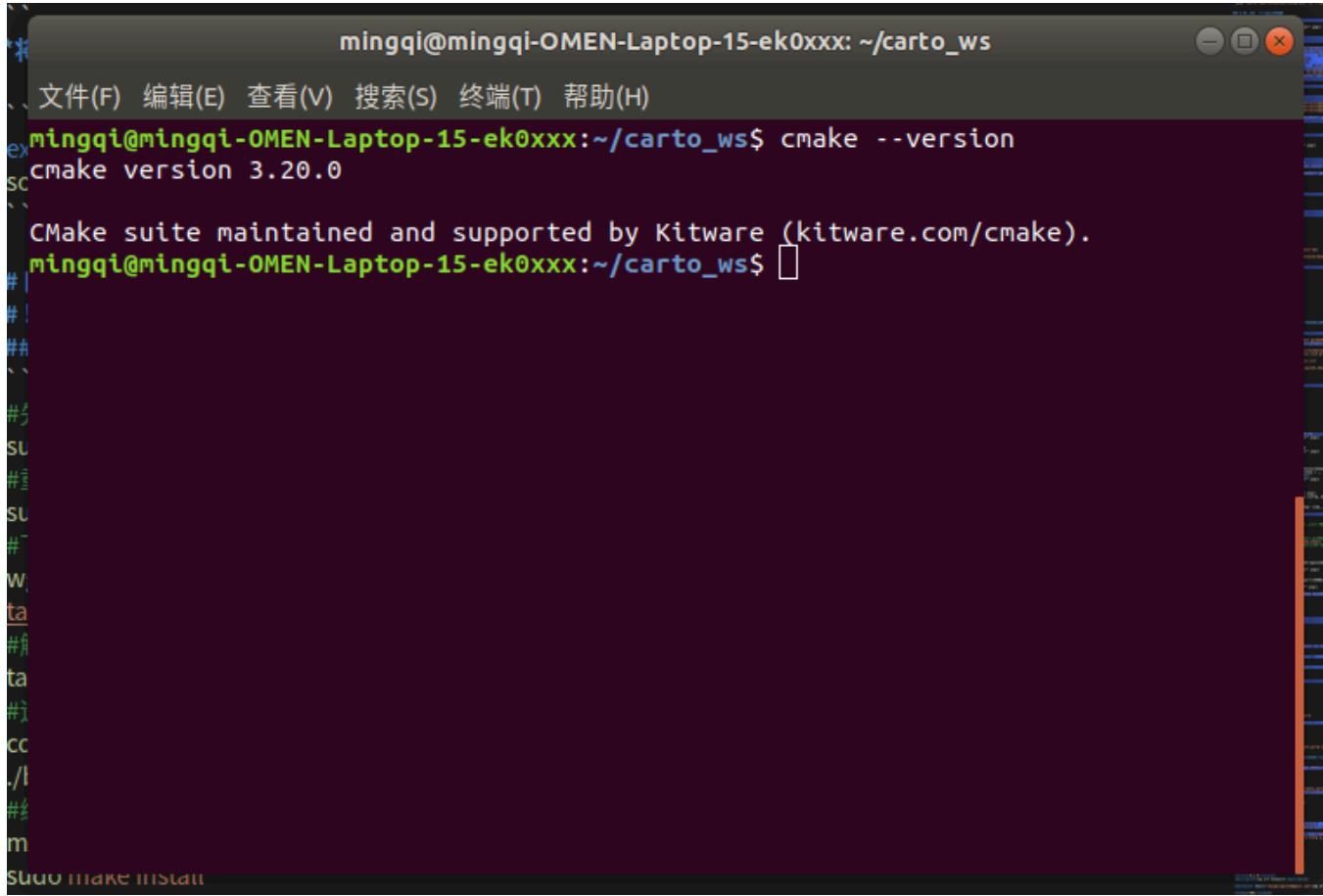
！！安装Cartographer，需要先升级Cmake

## 1、升级Cmake到3.2.0

```
#先卸载3.10的CMake
sudo apt remove cmake
#重新安装依赖
sudo apt-get install build-essential libssl-dev
#下载Cmake3.2.0
wget https://github.com/Kitware/CMake/releases/download/v3.20.0/cmake-3.20.0.tar.gz
#解压缩
tar -zxvf cmake-3.20.0.tar.gz
#运行bootstrap脚本
cd cmake-3.20.0
./bootstrap
#编译安装
make
sudo make install
```

- 检测Cmake安装是否成功

```
cmake --version
```



```
mingqi@mingqi-OMEN-Laptop-15-ek0xxx: ~/carto_ws
文件(F) 编辑(E) 查看(V) 搜索(S) 终端(T) 帮助(H)
mingqi@mingqi-OMEN-Laptop-15-ek0xxx:~/carto_ws$ cmake --version
cmake version 3.20.0
CMake suite maintained and supported by Kitware (kitware.com/cmake).
mingqi@mingqi-OMEN-Laptop-15-ek0xxx:~/carto_ws$
```

- 安装成功

## 2、安装Cartographer

！！按照[Cartographer官网](#)教程安装

- 安装一些工具：wstool, rosdep和Ninja

```
sudo apt-get update
sudo apt-get install -y python-wstool python-rosdep ninja-build stow
```

- 安装好这些工具后,创建一个cartographer\_ros工作区

```
#创建文件夹  
mkdir carto_ws  
cd carto_ws  
#下载源码  
wstool init src  
wstool merge -t src https://raw.githubusercontent.com/cartographer-project/cartographer/master/cartographer/cartographer.rosinstall  
wstool update -t src
```

- 更改代码，防止后面报错  
打开**cartographer/package.xml**将第46行 `<depend>libabsl-dev</depend>` 进行注释
- 安装依赖项

```
sudo rosdep init  
rosdep update  
rosdep install --from-paths src --ignore-src --rosdistro=${ROS_DISTRO} -y
```

- 安装abseil-cpp 库

```
src/cartographer/scripts/install_abseil.sh
```

```
//由于版本冲突，您可能需要卸载ROS abseil-cpp  
sudo apt-get remove ros-${ROS_DISTRO}-abseil-cpp
```

- 编译

```
catkin_make_isolated --install --use-ninja
```

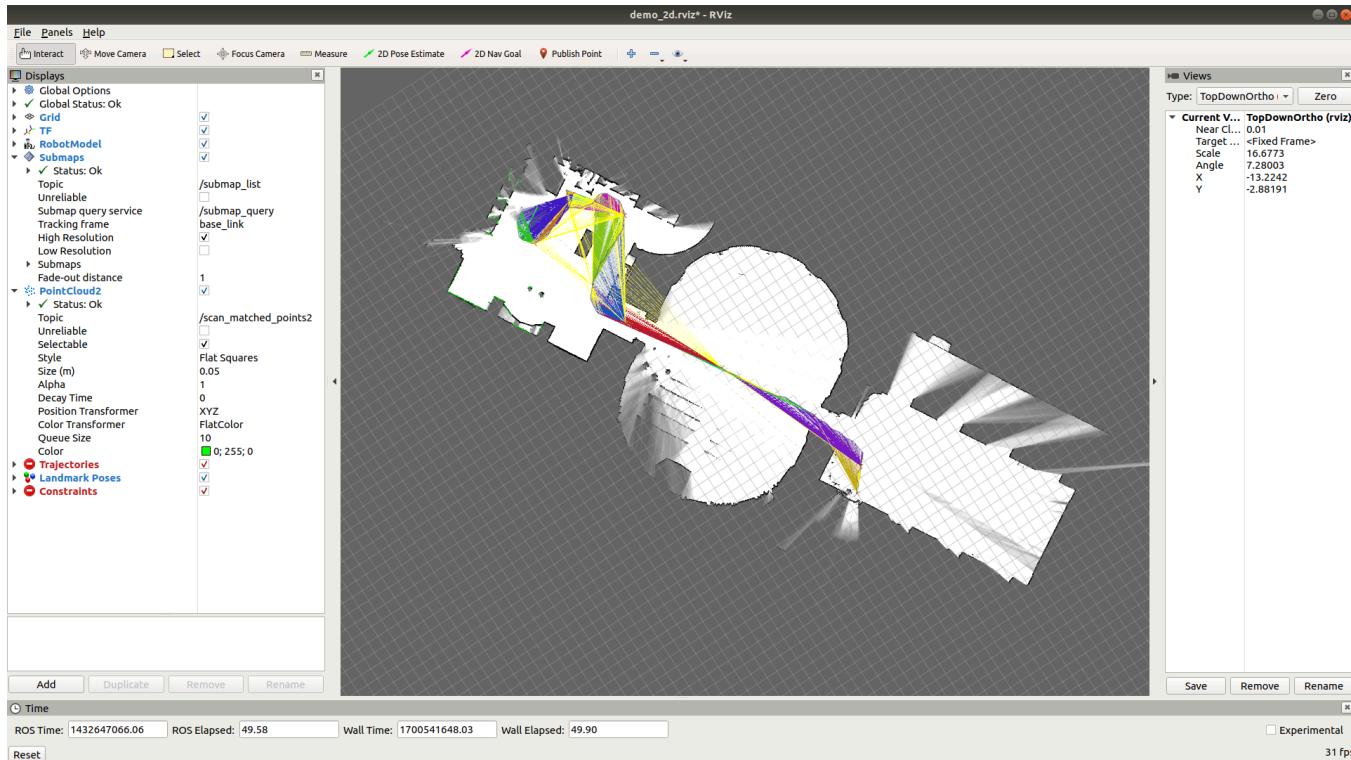
- 将 `cartographer_ws` 添加到环境变量中

```
echo 'source ~/carto_ws/install_isolated/setup.bash' >> ~/.bashrc  
source ~/.bashrc
```

### 3.官方**demo**验证

- 2D-Demo与结果

```
#下载demo包
wget -P ~/Downloads https://storage.googleapis.com/cartographer-public-data/bags/backpack_2d.bag
#测试
roslaunch cartographer_ros demo_backpack_2d.launch bag_filename:=${HOME}/Downloads/cartographer-ros-demos/backpack_2d.bag
```



## 五、Gazebo仿真环境搭建

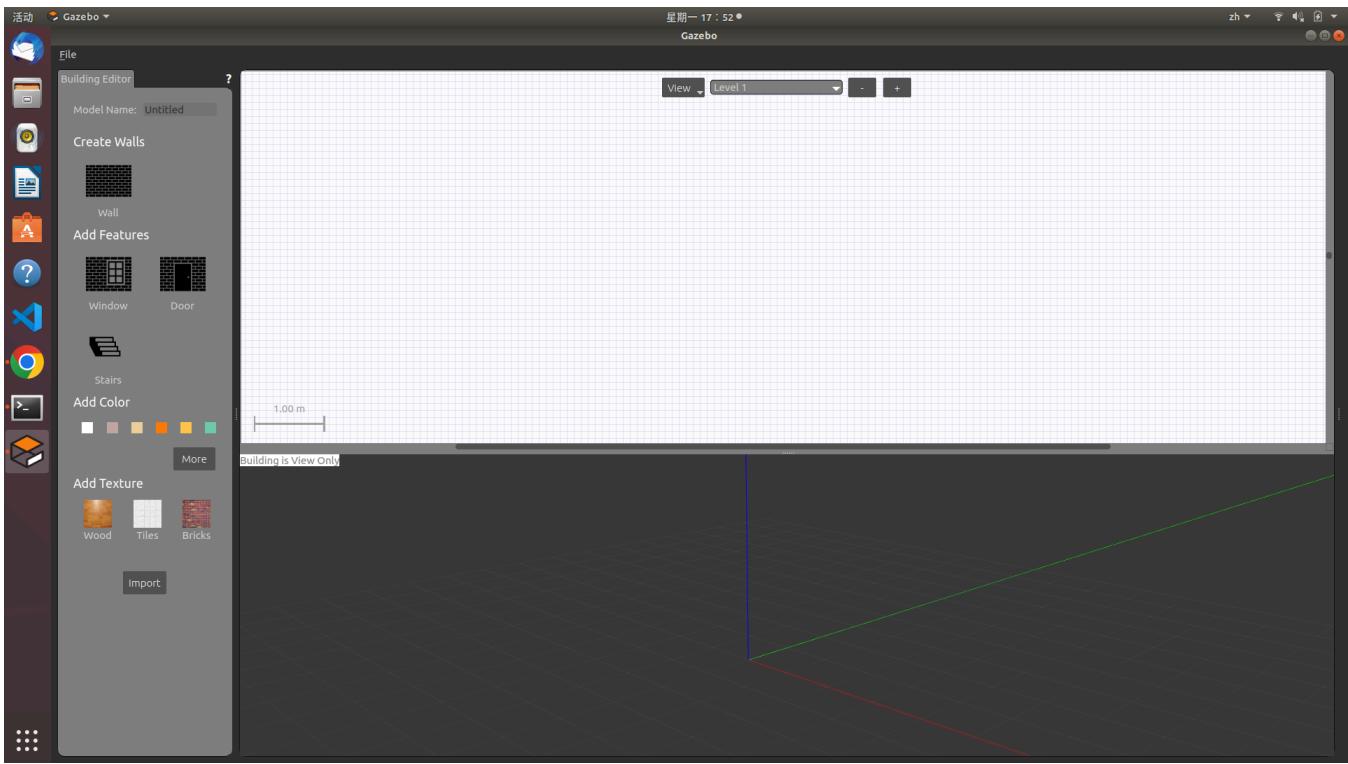
！！经过测试默认安装的**Gazebo9**在建立模型放置窗户与门时，会闪退，所以更新为**Gazebo11**

## 1. 打开Gazebo

gazebo

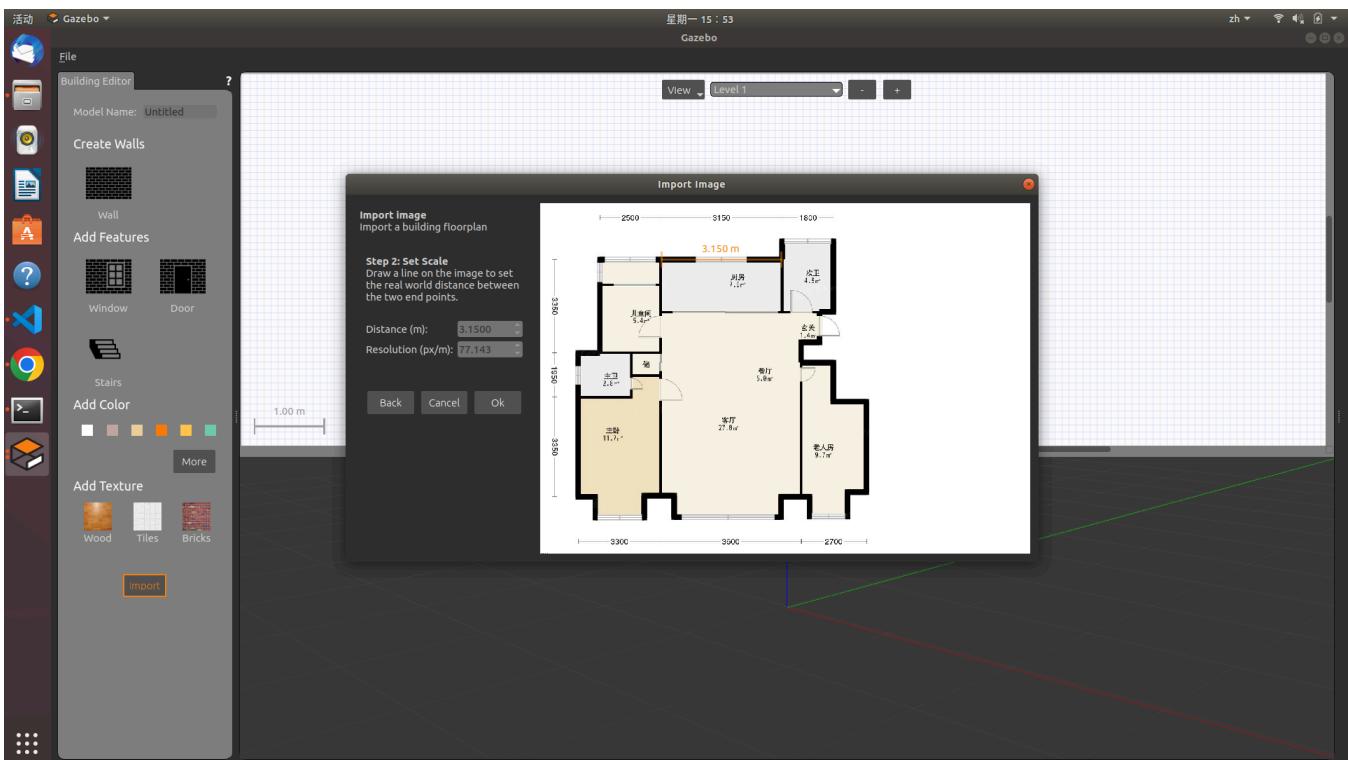
## 2. 打开建筑编辑器

点击上方“Edit”中“Building Edit”进入建筑编辑器。



### 3. 用户型图作为参考

点击左下角“import” ，选择一张户型照片导入。



户型图如下



#### 4. 创建模型

- 点击左边“Wall”，对着房屋轮廓和内部墙壁描边，下方的3D视图会同步显示墙壁信息。
- 再按照户型图进行门窗的设置，点击左边的“Window”和“Door”，在相应墙壁位置选择即可。
- 可以双击2D视图里的墙壁进行详细参数设置。



## 5. 保存模型

如图，完成模型绘制。



点击左上角“File”→“Save”保存，保存为model.config和model.sdf文件。

## 6.生成.world文件

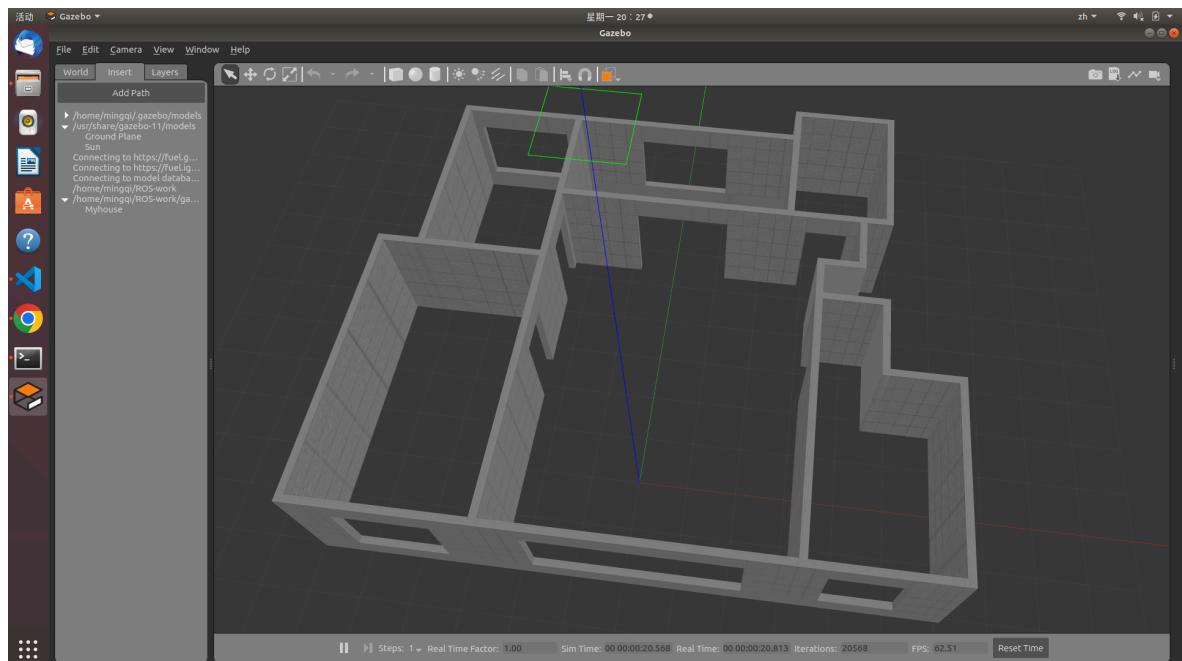
在gazebo\_mode文件中有三个模型，但因为我的电脑性能不行，导入就卡顿，所以用了gazebo的库。

- ganebo库安装

```
# 进入.gazebo文件夹，用于存放Gazebo模型和相关配置文件
cd ~/.gazebo/
# 安装Git工具
sudo apt install git
# 从https://gitee.com/dva7777/gazebo_models.git克隆Gazebo模型
git clone https://gitee.com/dva7777/gazebo_models.git
# 将克隆的gazebo_models文件夹重命名为models，并放到.gazebo文件夹下
mv gazebo_models/ ./models
```

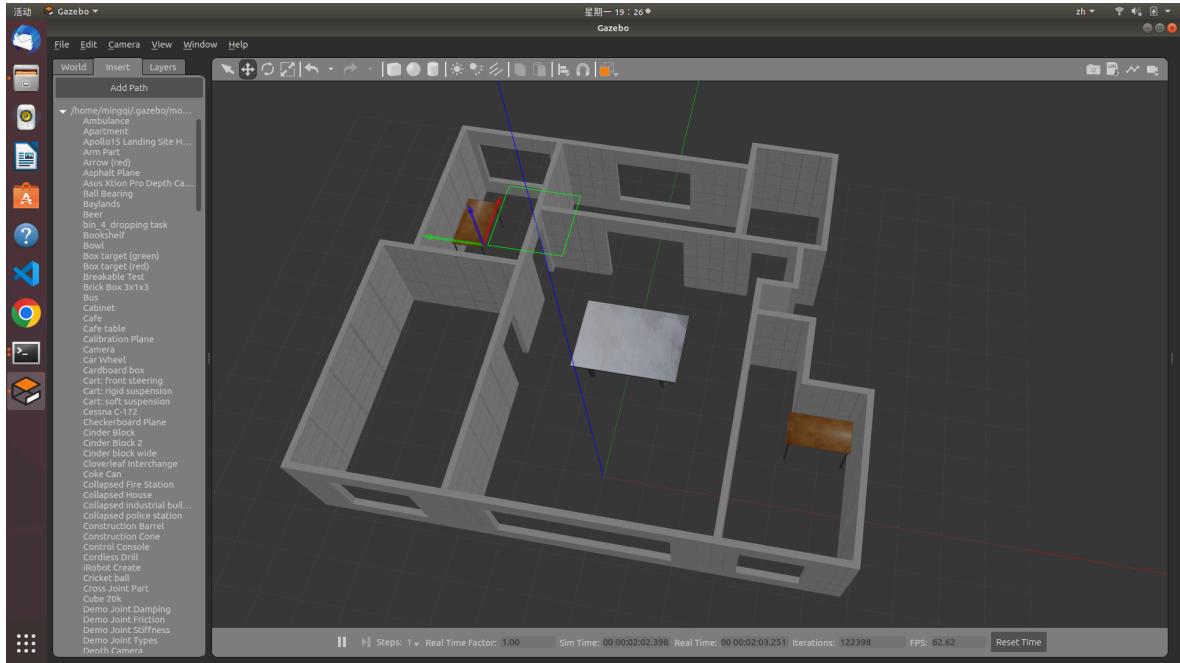
- 放置房间模型

再次打开gazebo，左上角insert选项卡里就会找到自己的模型，找到并选择自己刚才建好的模型放置到右边窗口。



- 放置部分家具

在insert选项下，选择添加自己想要的家具等模型，来丰富自己的world。可以通过上方按钮，来平移、旋转模型选择合适的摆放位置。



- 点击“File”中“Save world”，保存到 .world 文件下，并命名为 Myhouse.world。

## 六、配置ROS工作空间

### 1. 创建ROS工作空间

```
#创建文件夹
mkdir -p ~/roshomework/src
cd roshomework/src
# ROS的工作空间初始化命令
catkin_init_workspace
cd ..
# 编译整个工作空间
catkin_make
#配置文件中加入环境变量
echo "source ~/roshomework/devel/setup.bash" >> ~/.bashrc
```

可以将**ros-w**的压缩包解压，把所有文件放入**roshomework/src**中。省略以下部分至下一章节

在**roshomework/src**建立三个文件夹，分别为**launch**、**src**和**worlds**。再创建一个包清单的**package.xml**文件

```
touch ~/roshomework/src/package.xml  
mkdir ~/roshomework/src/launch  
mkdir ~/roshomework/src/src  
mkdir ~/roshomework/src/words
```

## 2. 导入.world文件

- 创建gazebo\_world文件夹

```
mkdir ~/roshomework/src/worlds/gazebo_world
```

- 将第四章-6中生成的**Myhouse.world**放入**gazebo\_world**文件夹中

## 3. 编写launch文件

- 参考turtlebot3\_world.launch文件编写
- 新建.launch文件

```
touch ~/roshomework/src/launch/ turtlebot3_world.launch
```

- 将下面程序复制到**turtlebot3\_world.launch**文件中

```
<launch>
  <arg name="model" default="$(env TURTLEBOT3_MODEL)" doc="model type [burger, waffle, wa...
  <arg name="x_pos" default="0.0"/>
  <arg name="y_pos" default="0.0"/>
  <arg name="z_pos" default="0.0"/>

  <include file="$(find gazebo_ros)/launch/empty_world.launch">
    <arg name="world_name" value="$(find ros-w)/worlds/gazebo_world/Myhouse.world"/>
    <arg name="paused" value="false"/>
    <arg name="use_sim_time" value="true"/>
    <arg name="gui" value="true"/>
    <arg name="headless" value="false"/>
    <arg name="debug" value="false"/>
  </include>

  <param name="robot_description" command="$(find xacro)/xacro --inorder $(find turtlebot...
  <node pkg="gazebo_ros" type="spawn_model" name="spawn_urdf" args="-urdf -model turtlebo...
</launch>
```

#### 4. 编写**package.xml**文件

- 将下列程序复制到**package.xml**中

```
<?xml version="1.0"?>
<package format="2">
  <name>ros-w</name>
  <version>0.1.0</version>
  <description>zmq wrh homework</description>

  <maintainer email="zhangmingqi318@gmail.com">zmq wrh</maintainer>

  <license>GPL</license>

  <buildtool_depend>catkin</buildtool_depend>
  <build_depend>rospy</build_depend>
  <build_export_depend>rospy</build_export_depend>
  <exec_depend>rospy</exec_depend>
  <exec_depend>gazebo_ros</exec_depend>

  <export>
    <gazebo_ros gazebo_media_path="${prefix}/worlds"/>
  </export>
</package>
```

## 5. 更改Turtlebot3类型

- 打开.bashrc文件

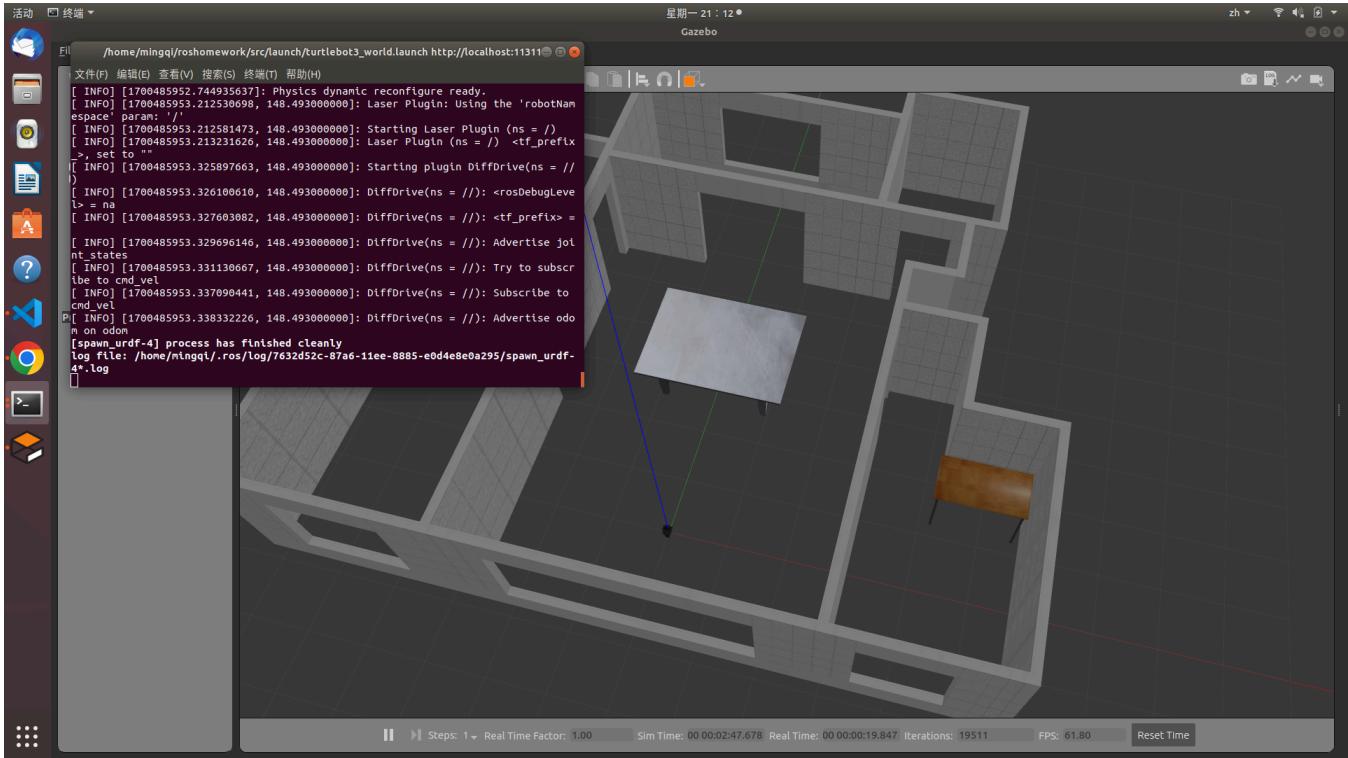
```
gedit ~/.bashrc
```

将下TURTLEBOT3\_MODEL=burger改为export TURTLEBOT3\_MODEL=waffle

```
#原为burger
export TURTLEBOT3_MODEL=burger
#改为waffle
export TURTLEBOT3_MODEL=waffle
```

## 6. 测试工作空间是否建立

```
roslaunch ros-w turtlebot3_world.launch
```



## 七、程序编写

### 1、编写键盘控制程序

- 在 ~/roshomework/src/src 中创建控制小车的 Python 的程序（参考 turtlebot3\_teleop\_key 程序）

```
touch ~/roshomework/src/src/rosw_teleop_key.py
```

- 下列代码复制进入.py文件中

```
#!/usr/bin/env python

import rospy
from geometry_msgs.msg import Twist
import sys, select, os
if os.name == 'nt':
    import msvcrt, time
else:
    import tty, termios
```

```
BURGER_MAX_LIN_VEL = 0.22
BURGER_MAX_ANG_VEL = 2.84
```

```
WAFFLE_MAX_LIN_VEL = 0.26
WAFFLE_MAX_ANG_VEL = 1.82
```

```
LIN_VEL_STEP_SIZE = 0.01
ANG_VEL_STEP_SIZE = 0.1
```

```
msg = """
Control Your TurtleBot3!
-----
```

```
Moving around:
```

```
     w
a     s     d
     x
```

```
w/x : increase/decrease linear velocity (Burger : ~ 0.22, Waffle and Waffle Pi : ~ 0.26)
a/d : increase/decrease angular velocity (Burger : ~ 2.84, Waffle and Waffle Pi : ~ 1.82)
```

```
space key, s : force stop
```

```
CTRL-C to quit
***
```

```
e = """
Communications Failed
***
```

```
def getKey():
    if os.name == 'nt':
        timeout = 0.1
        startTime = time.time()
    while(1):
        if msvcrt.kbhit():
            if sys.version_info[0] >= 3:
                return msvcrt.getch().decode()
            else:
                return msvcrt.getch()
        elif time.time() - startTime > timeout:
            return ''

    tty.setraw(sys.stdin.fileno())
    rlist, _, _ = select.select([sys.stdin], [], [], 0.1)
    if rlist:
        key = sys.stdin.read(1)
    else:
        key = ''

    termios.tcsetattr(sys.stdin, termios.TCSADRAIN, settings)
    return key

def vels(target_linear_vel, target_angular_vel):
    return "currently:\tlinear vel %s\t angular vel %s " % (target_linear_vel,target_angular_vel)

def makeSimpleProfile(output, input, slop):
    if input > output:
        output = min( input, output + slop )
    elif input < output:
        output = max( input, output - slop )
    else:
        output = input

    return output

def constrain(input, low, high):
    if input < low:
        input = low
```

```

    elif input > high:
        input = high
    else:
        input = input

    return input

def checkLinearLimitVelocity(vel):
    if turtlebot3_model == "burger":
        vel = constrain(vel, -BURGER_MAX_LIN_VEL, BURGER_MAX_LIN_VEL)
    elif turtlebot3_model == "waffle" or turtlebot3_model == "waffle_pi":
        vel = constrain(vel, -WAFFLE_MAX_LIN_VEL, WAFFLE_MAX_LIN_VEL)
    else:
        vel = constrain(vel, -BURGER_MAX_LIN_VEL, BURGER_MAX_LIN_VEL)

    return vel

def checkAngularLimitVelocity(vel):
    if turtlebot3_model == "burger":
        vel = constrain(vel, -BURGER_MAX_ANG_VEL, BURGER_MAX_ANG_VEL)
    elif turtlebot3_model == "waffle" or turtlebot3_model == "waffle_pi":
        vel = constrain(vel, -WAFFLE_MAX_ANG_VEL, WAFFLE_MAX_ANG_VEL)
    else:
        vel = constrain(vel, -BURGER_MAX_ANG_VEL, BURGER_MAX_ANG_VEL)

    return vel

if __name__=="__main__":
    if os.name != 'nt':
        settings = termios.tcgetattr(sys.stdin)

    rospy.init_node('turtlebot3_teleop')
    pub = rospy.Publisher('cmd_vel', Twist, queue_size=10)

    turtlebot3_model = rospy.get_param("model", "burger")

    status = 0
    target_linear_vel = 0.0
    target_angular_vel = 0.0

```

```

control_linear_vel = 0.0
control_angular_vel = 0.0

try:
    print(msg)
    while not rospy.is_shutdown():
        key = getKey()
        if key == 'w' :
            target_linear_vel = checkLinearLimitVelocity(target_linear_vel + LIN_VEL_STEPPING)
            status = status + 1
            print(vels(target_linear_vel,target_angular_vel))
        elif key == 'x' :
            target_linear_vel = checkLinearLimitVelocity(target_linear_vel - LIN_VEL_STEPPING)
            status = status + 1
            print(vels(target_linear_vel,target_angular_vel))
        elif key == 'a' :
            target_angular_vel = checkAngularLimitVelocity(target_angular_vel + ANG_VEL_STEPPING)
            status = status + 1
            print(vels(target_linear_vel,target_angular_vel))
        elif key == 'd' :
            target_angular_vel = checkAngularLimitVelocity(target_angular_vel - ANG_VEL_STEPPING)
            status = status + 1
            print(vels(target_linear_vel,target_angular_vel))
        elif key == ' ' or key == 's' :
            target_linear_vel = 0.0
            control_linear_vel = 0.0
            target_angular_vel = 0.0
            control_angular_vel = 0.0
            print(vels(target_linear_vel, target_angular_vel))
        else:
            if (key == '\x03'):
                break

        if status == 20 :
            print(msg)
            status = 0

twist = Twist()

```

```

control_linear_vel = makeSimpleProfile(control_linear_vel, target_linear_vel,
twist.linear.x = control_linear_vel; twist.linear.y = 0.0; twist.linear.z = 0.0

control_angular_vel = makeSimpleProfile(control_angular_vel, target_angular_vel)
twist.angular.x = 0.0; twist.angular.y = 0.0; twist.angular.z = control_angular

pub.publish(twist)

except:
    print(e)

finally:
    twist = Twist()
    twist.linear.x = 0.0; twist.linear.y = 0.0; twist.linear.z = 0.0
    twist.angular.x = 0.0; twist.angular.y = 0.0; twist.angular.z = 0.0
    pub.publish(twist)

if os.name != 'nt':
    termios.tcsetattr(sys.stdin, termios.TCSADRAIN, settings)

```

## 2、slam建模

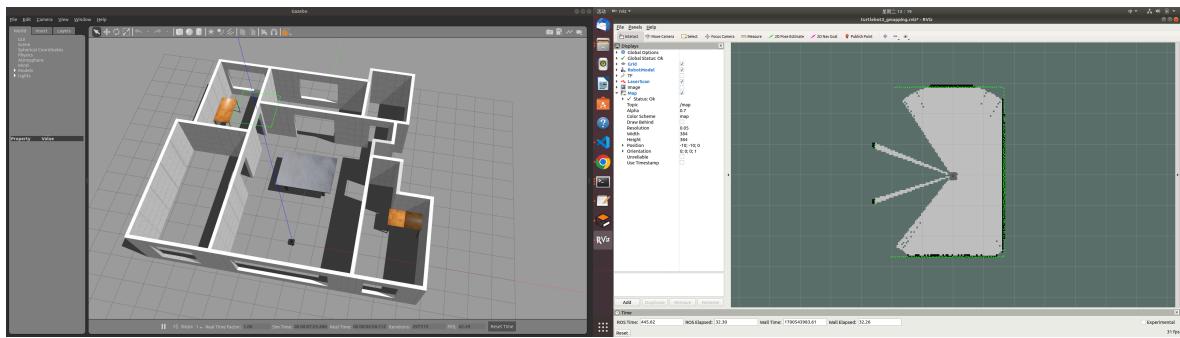
借用**turtlebot3\_slam**程序

```

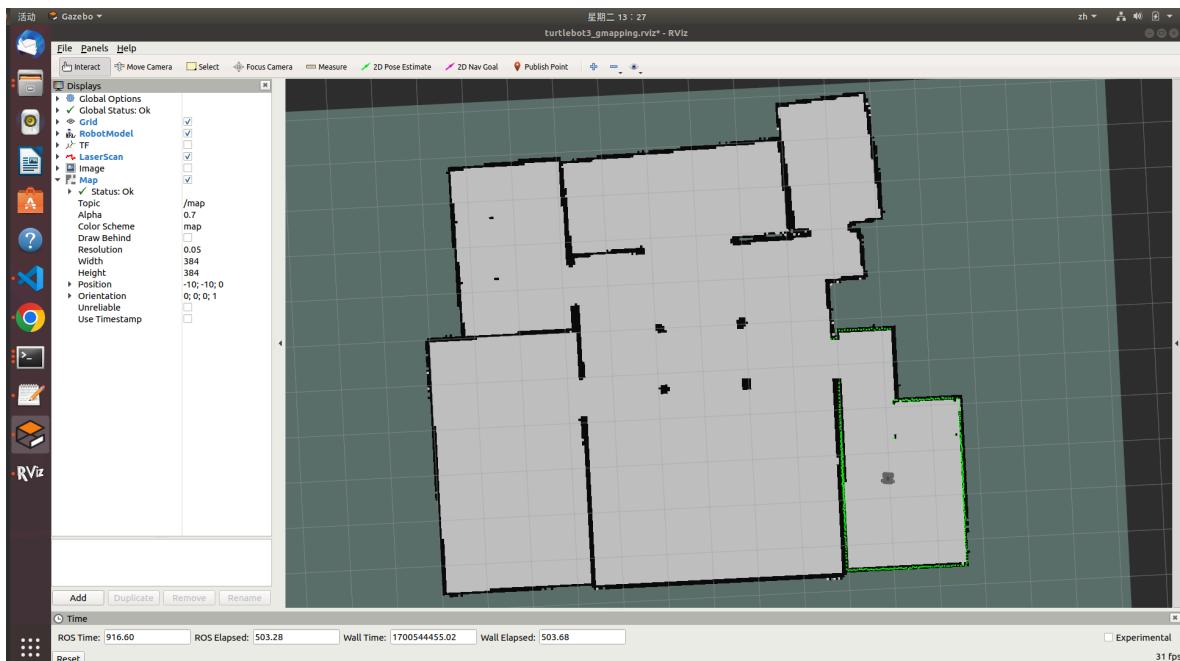
#打开模型
roslaunch ros-w turtlebot3_world.launch
#新建终端 运行键盘控制程序
rosrun ros-w ros_w_teleop_key.py
#新建终端 运行turtlebot3_slam.launch来slam建模
roslaunch turtlebot3_slam turtlebot3_slam.launch

```

- 通过键盘操控小车构建地图，如下图



- 构建完地图



- 启动map\_server，保存地图（pgm和yaml）

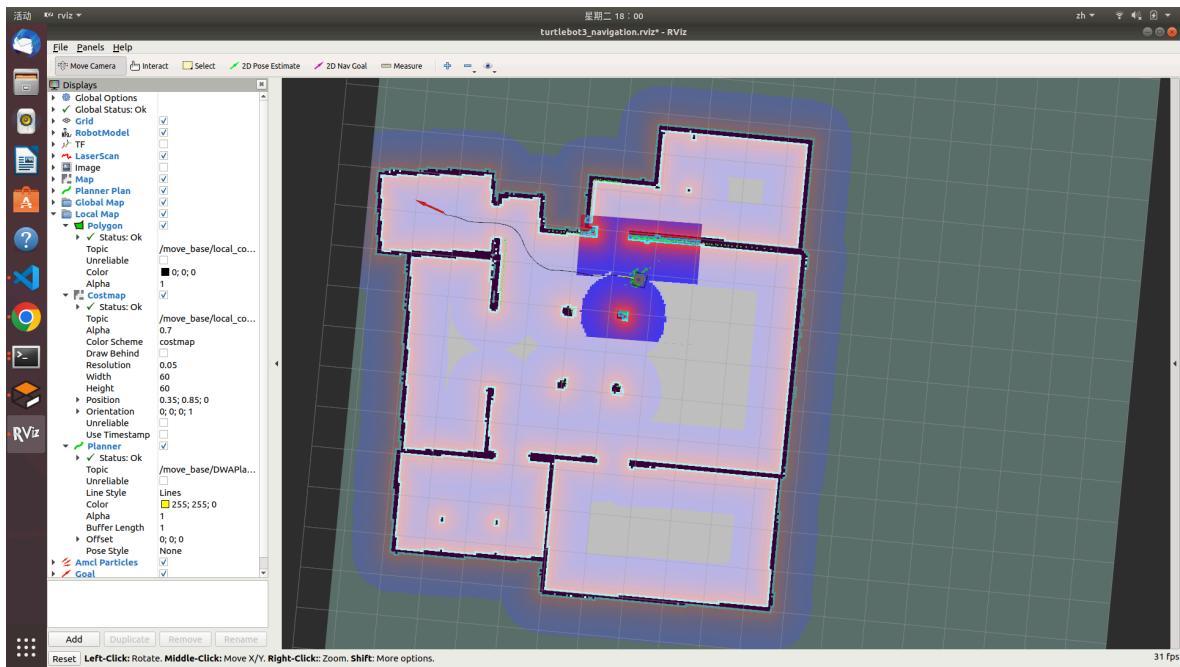
```
rosrun map_server map_saver -f /home/mingqi/roshomework/src/map/map
```

### 3、slam自主导航

借用turtlebot3\_slam程序

```
#加载仿真环境
roslaunch ros-w turtlebot3_world.launch
#加载导航节点
roslaunch turtlebot3_navigation turtlebot3_navigation.launch map_file:=/home/mingqi/roshomework/src/map/map
```

- 配置好rviz, 使用2D Pose Estimate设定好小车起始地点，再使用2D Nav Goal设定小车目标地点，小车会规划好路径，自动运行到目标位置，实现自主导航功能。



## 4、整合launch文件

整合launch文件，一共分为五个：

1. 仿真环境 (turtlebot3\_world.launch)
2. 仿真环境+键盘控制 (turtlebot3\_control.launch)
3. 仿真环境+键盘控制+激光rviz (turtlebot3\_control\_laser.launch)
4. 仿真环境+slam建模 (turtlebot3\_slam.launch)
4. 仿真环境+slam导航 (turtlebot3\_guidance.launch)

- 1. 仿真环境 (**turtlebot3\_world.launch**)

上文已经配置好

`turtlebot3_world.launch`

节点图如下：



- 2. 仿真环境+键盘控制 (**turtlebot3\_control.launch**)

加入键盘控制节点

```
#新建launch文件
touch ~/roshomework/src/launch/turtlebot3_control.launch
#文本编辑器打开
gedit ~/roshomework/src/launch/turtlebot3_control.launch
```

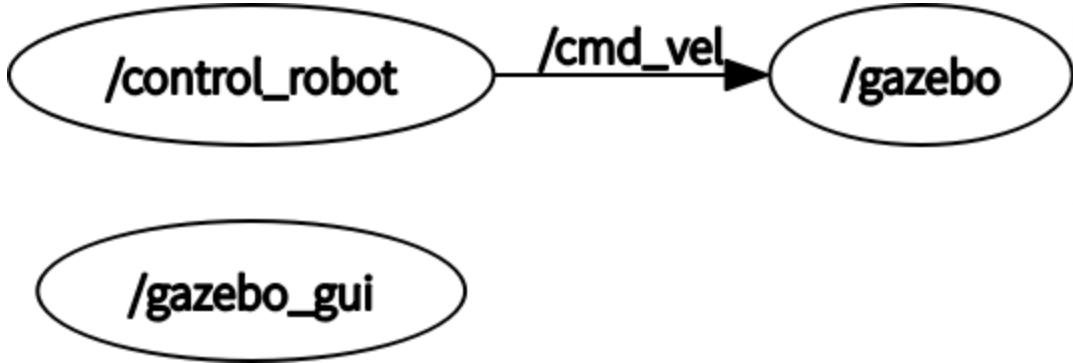
将下面程序复制到**turtlebot3\_control.launch**文件中

```
<launch>
  <arg name="model" default="$(env TURTLEBOT3_MODEL)" doc="model type [burger, waffle, wa...
  <arg name="x_pos" default="0.0"/>
  <arg name="y_pos" default="0.0"/>
  <arg name="z_pos" default="0.0"/>

  <include file="$(find gazebo_ros)/launch/empty_world.launch">
    <arg name="world_name" value="$(find ros-w)/worlds/gazebo_world/Myhouse.world"/>
    <arg name="paused" value="false"/>
    <arg name="use_sim_time" value="true"/>
    <arg name="gui" value="true"/>
    <arg name="headless" value="false"/>
    <arg name="debug" value="false"/>
  </include>

  <param name="robot_description" command="$(find xacro)/xacro --inorder $(find turtlebot3...
  <node pkg="gazebo_ros" type="spawn_model" name="spawn_urdf" args="-urdf -model turtlebot3...
  <node pkg="ros-w" type="rosw_teleop_key.py" name="control_robot" output="screen" />
</launch>
```

节点图如下：



- 3. 仿真环境+键盘控制+激光rviz (**turtlebot3\_control\_laser.launch**)  
加入键盘控制节点

```
#新建launch文件  
touch ~/roshomework/src/launch/turtlebot3_control_laser.launch  
#文本编辑器打开  
gedit ~/roshomework/src/launch/turtlebot3_control_laser.launch
```

将下面程序复制到**turtlebot3\_control\_laser.launch**文件中

```

<launch>

<arg name="model" default="$(env TURTLEBOT3_MODEL)" doc="model type [burger, waffle, wa
<arg name="x_pos" default="0.0"/>
<arg name="y_pos" default="0.0"/>
<arg name="z_pos" default="0.0"/>

<include file="$(find gazebo_ros)/launch/empty_world.launch">
<arg name="world_name" value="$(find ros-w)/worlds/gazebo_world/Myhouse.world"/>
<arg name="paused" value="false"/>
<arg name="use_sim_time" value="true"/>
<arg name="gui" value="true"/>
<arg name="headless" value="false"/>
<arg name="debug" value="false"/>
</include>

<include file="$(find turtlebot3_gazebo)/launch/turtlebot3_gazebo_rviz.launch">
</include>

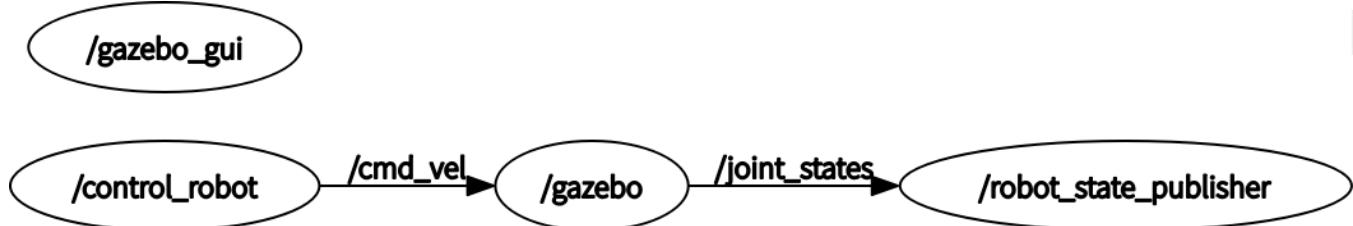
<param name="robot_description" command="$(find xacro)/xacro --inorder $(find turtlebot3_gazebo)/urdf/turtlebot3.urdf">
```

<node pkg="gazebo\_ros" type="spawn\_model" name="spawn\_urdf" args="-urdf -model turtlebot3" />

<node pkg="ros-w" type="rosws\_node" name="control\_robot" output="screen" />

</launch>

节点图如下：



- 4. 仿真环境+slam建模 (**turtlebot3\_slam.launch**)

加入键盘控制节点

```

#新建launch文件
touch ~/roshomework/src/launch/turtlebot3_slam.launch
#文本编辑器打开
gedit ~/roshomework/src/launch/turtlebot3_slam.launch

```

将下面程序复制到**turtlebot3\_slam.launch**文件中

```
<launch>

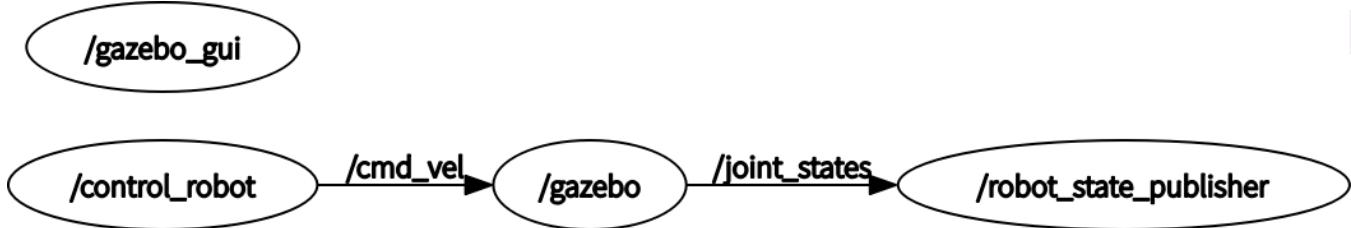
<arg name="model" default="$(env TURTLEBOT3_MODEL)" doc="model type [burger, waffle, wa
<arg name="x_pos" default="0.0"/>
<arg name="y_pos" default="0.0"/>
<arg name="z_pos" default="0.0"/>

<include file="$(find gazebo_ros)/launch/empty_world.launch">
  <arg name="world_name" value="$(find ros-w)/worlds/gazebo_world/Myhouse.world"/>
  <arg name="paused" value="false"/>
  <arg name="use_sim_time" value="true"/>
  <arg name="gui" value="true"/>
  <arg name="headless" value="false"/>
  <arg name="debug" value="false"/>
</include>

<include file="$(find turtlebot3_gazebo)/launch/turtlebot3_gazebo_rviz.launch">
</include>

<param name="robot_description" command="$(find xacro)/xacro --inorder $(find turtlebot3_gazebo)/urdf/turtlebot3_descriptions.urdf">
<node pkg="gazebo_ros" type="spawn_model" name="spawn_urdf" args="-urdf -model turtlebot3_waffle -x 0 -y 0 -z 0.5" />
<node pkg="ros-w" type="rosw_teleop_key.py" name="control_robot" output="screen" />
</param>
</launch>
```

节点图如下：



## 参考连接

- Ubuntu18.04安装ROS Melodic（详细，亲测安装完成，有清晰的截图步骤）