

Turtlebot3 SLAM 和导航实验

笔记本电脑：

安装 Turtlebot3 及依赖包：

```
$ sudo apt-get install ros-kinetic-joy ros-kinetic-teleop-twist-joy ros-kinetic-teleop-twist-keyboard ros-kinetic-laser-proc ros-kinetic-rgbd-launch ros-kinetic-depthimage-to-laserscan ros-kinetic-rosserial-arduino ros-kinetic-rosserial-python ros-kinetic-rosserial-server ros-kinetic-rosserial-client ros-kinetic-rosserial-msgs ros-kinetic-amcl ros-kinetic-map-server ros-kinetic-move-base ros-kinetic-urdf ros-kinetic-xacro ros-kinetic-compressed-image-transport ros-kinetic-rqt-image-view ros-kinetic-gmapping ros-kinetic-navigation ros-kinetic-interactive-markers
```

从 GitHub 上下载 Turtlebot3 源码：

```
$ cd ~/catkin_ws/src/  
$ git clone https://github.com/ROBOTIS-GIT/turtlebot3_msgs.git  
$ git clone https://github.com/ROBOTIS-GIT/turtlebot3.git  
$ cd ~/catkin_ws && catkin_make  
$ source ~/catkin_ws/devel/setup.bash
```

现场网络配置：

1. 在 PC，执行如下命令获得对应的 IP 地址：
\$ ifconfig
2. 修改 .bashrc
\$ gedit ~/.bashrc
3. PC 配置如下：
\$ ROS_MASTER_URI=http://IP_OF_PC:11311
\$ ROS_HOSTNAME=IP_OF_PC
\$ export TURTLEBOT3_MODEL=waffle_pi
4. 保存
5. 让环境生效：
\$ source ~/.bashrc

TurtleBot3：

提前配置（无需进行）

1. \$ source /opt/ros/kinetic/setup.bash
2. \$ cd ~/catkin_ws && catkin_make
3. \$ source ~/catkin_ws/devel/setup.bash
4. \$ rosrn turtlebot3_bringup create_udev_rules

时间同步:

5. \$ sudo apt-get install chrony
6. \$ sudo apt-get install ntpdate
7. \$ sudo ntpdate ntp.ubuntu.com
8. \$ date

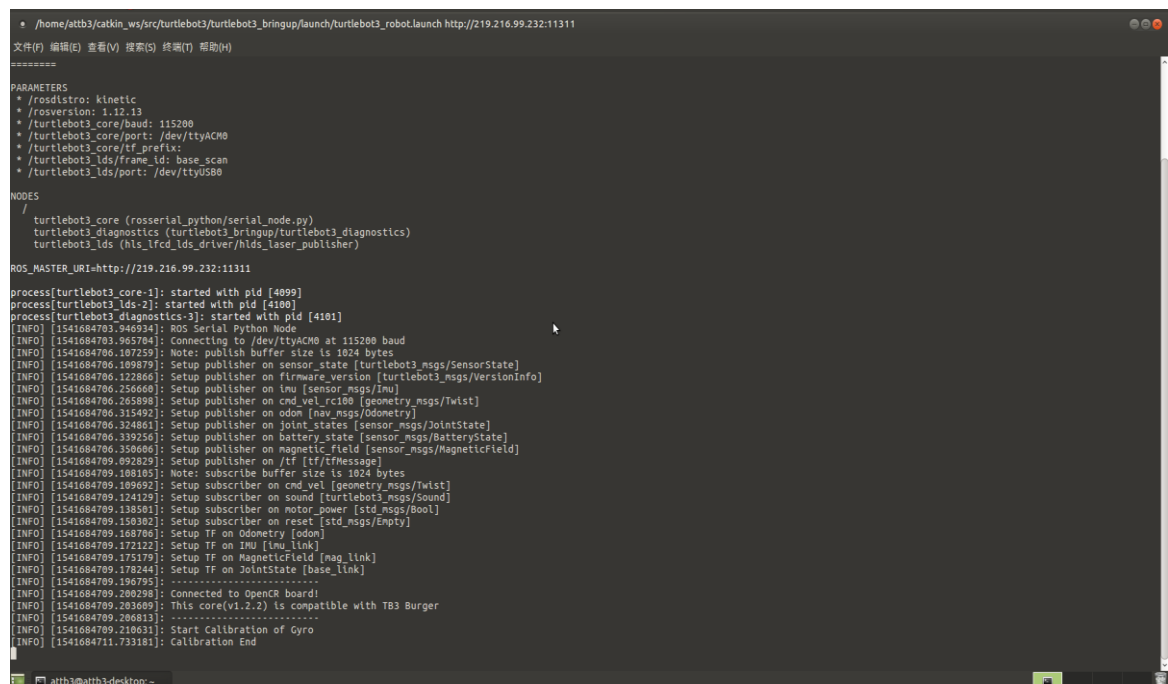
现场网络配置:

1. 在 Turtlebot3 上执行如下命令获得对应的 IP 地址:
\$ ifconfig
2. 修改 .bashrc
\$ pluma ~/.bashrc
3. PC 配置如下:
\$ ROS_MASTER_URI=http://IP_OF_PC:11311
\$ ROS_HOSTNAME=IP_OF_Turtlebot3
4. 保存
5. 让环境生效:
\$ source ~/.bashrc

实验:

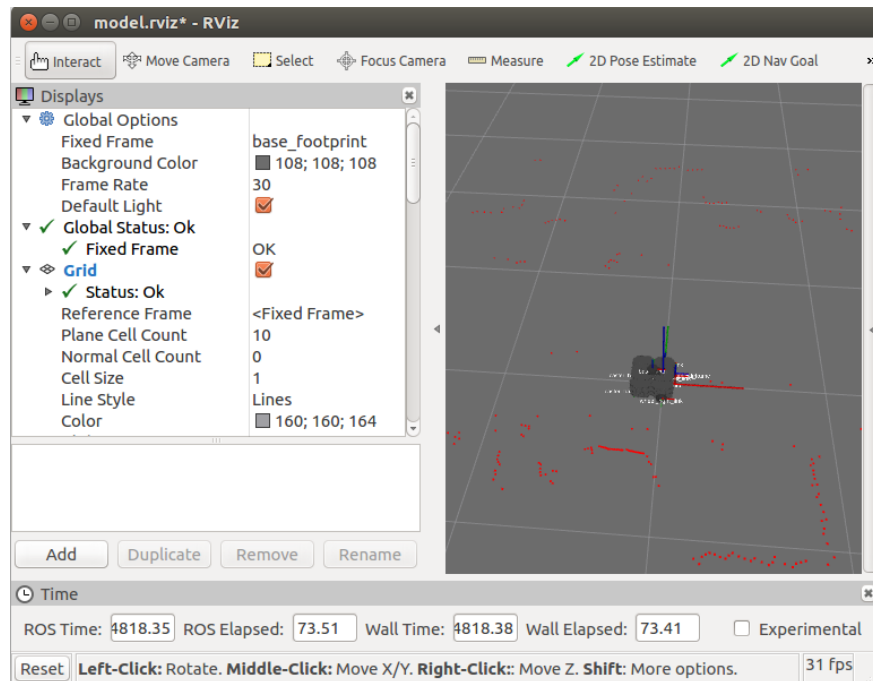
PC 和 Turtlebot3 启动测试:

1. [PC] 启动 roscore
\$ roscore
 2. [TurtleBot3] 启动 waffle_pi
\$ roslaunch turtlebot3_bringup turtlebot3_robot.launch
- 通信成功界面:



```
attb3@attb3-desktop: ~  
$ roslaunch turtlebot3_bringup turtlebot3_robot.launch http://219.216.99.232:11311  
*****  
PARAMETERS  
* /roscpp: kinetic  
* /rosversion: 1.12.13  
* /turtlebot3_core/serial_node: /dev/ttyACM0  
* /turtlebot3_core/serial_port: 115200  
* /turtlebot3_core/tf_prefix: base_scan  
* /turtlebot3_lds/frame_id: base_scan  
* /turtlebot3_lds/port: /dev/ttyUSB0  
NODES  
/ turtlebot3_core (roscpp/serial_node.py)  
/ turtlebot3_diagnostics (turtlebot3_bringup/turtlebot3_diagnostics)  
/ turtlebot3_lds (hls_lfcd_lds_driver/hlds_laser_publisher)  
ROS_MASTER_URI=http://219.216.99.232:11311  
process[turtlebot3_core-1]: started with pid [4099]  
process[turtlebot3_lds-2]: started with pid [4100]  
process[turtlebot3_diagnostics-3]: started with pid [4101]  
[INFO] [1541684703.946934]: ROS Serial Python Node  
[INFO] [1541684703.965704]: Connecting to /dev/ttyACM0 at 115200 baud  
[INFO] [1541684706.107259]: Note: publish buffer size is 1024 bytes  
[INFO] [1541684706.109879]: Setup publisher on sensor_state [turtlebot3_msgs/SensorState]  
[INFO] [1541684706.122866]: Setup publisher on firmware_version [turtlebot3_msgs/VersionInfo]  
[INFO] [1541684706.256668]: Setup publisher on imu [sensor_msgs/Imu]  
[INFO] [1541684706.265898]: Setup publisher on cmd_vel [geometry_msgs/Twist]  
[INFO] [1541684706.315492]: Setup publisher on odom [nav_msgs/Odometry]  
[INFO] [1541684706.324861]: Setup publisher on joint_states [sensor_msgs/JointState]  
[INFO] [1541684706.339256]: Setup publisher on battery_state [sensor_msgs/BatteryState]  
[INFO] [1541684706.350606]: Setup publisher on magnetic_field [sensor_msgs/MagneticField]  
[INFO] [1541684709.092829]: Setup publisher on /tf [tf/tfMessage]  
[INFO] [1541684709.108105]: Note: subscribe buffer size is 1024 bytes  
[INFO] [1541684709.109692]: Setup subscriber on cmd_vel [geometry_msgs/Twist]  
[INFO] [1541684709.124129]: Setup subscriber on sound [turtlebot3_msgs/Sound]  
[INFO] [1541684709.138581]: Setup subscriber on motor_power [std_msgs/Bool]  
[INFO] [1541684709.159302]: Setup subscriber on reset [std_msgs/Empty]  
[INFO] [1541684709.168706]: Setup TF on Odometry [odom]  
[INFO] [1541684709.172122]: Setup TF on imu [imu_link]  
[INFO] [1541684709.175179]: Setup TF on MagneticField [mag_link]  
[INFO] [1541684709.178244]: Setup TF on JointState [base_link]  
[INFO] [1541684709.196795]: .....  
[INFO] [1541684709.200298]: Connected to OpenCR board!  
[INFO] [1541684709.203689]: This core(v1.2.2) is compatible with TB3 Burger  
[INFO] [1541684709.206813]: .....  
[INFO] [1541684709.210631]: Start Calibration of Gyro  
[INFO] [1541684711.733181]: Calibration End
```

3. [PC] 启动 rviz
`$ export TURTLEBOT3_MODEL=waffle_pi`
`$ roslaunch turtlebot3_bringup turtlebot3_model.launch`
 模型加载成功界面：



注意：

时间不同步会导致模型加载不成功和激光传感器数据错误。

PC 和 Turtlebot3 键盘控制

1. [PC] 启动 roscore
`$ roscore`
2. [TurtleBot3] 启动 waffle_pi
`$ roslaunch turtlebot3_bringup turtlebot3_robot.launch`
3. [PC] 启动进行简单远程操作测试
`$ roslaunch turtlebot3_teleop turtlebot3_teleop_key.launch`
 成功启动：

```
Checking log directory for disk usage. This may take awhile.
Press Ctrl-C to interrupt
Done checking log file disk usage. Usage is <1GB.

started roslaunch server http://192.168.1.103:38701/

SUMMARY
=====
PARAMETERS
* /model: waffle_pi
* /rostdistro: kinetic
* /rosversion: 1.12.14

NODES
/
  turtlebot3_teleop_keyboard (turtlebot3_teleop/turtlebot3_teleop_key)

ROS_MASTER_URI=http://192.168.1.103:11311

process[turtlebot3_teleop_keyboard-1]: started with pid [3492]

Control Your TurtleBot3!
-----
Moving around:
    w    d
    a    s
    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
```

实验一：同时定位和构图（SLAM）

1. [PC] 启动 roscore
\$ roscore
2. [TurtleBot3] 启动 waffle_pi
\$ roslaunch turtlebot3_bringup turtlebot3_robot.launch
3. [PC] 打开终端，然后运行 SLAM 启动文件和 rviz
\$ export TURTLEBOT3_MODEL=waffle_pi
4. \$ roslaunch turtlebot3_slam turtlebot3_slam.launch slam_methods:=gmapping
5. [PC] 启动键盘操作
\$ roslaunch turtlebot3_teleop turtlebot3_teleop_key.launch
6. 通过键盘控制 Turtlebot3 移动进行建图
7. [PC] 打开终端，然后运行地图保存节点
\$ rosrun map_server map_saver -f filename

实验二：导航

1. [PC] 启动 roscore
\$ roscore
2. [TurtleBot3] 启动 waffle_pi
\$ roslaunch turtlebot3_bringup turtlebot3_robot.launch
3. [PC] 启动导航
4. \$ roslaunch turtlebot3_navigation turtlebot3_navigation.launch
map_file:=\$HOME/map.yaml
5. 点击 2D Nav Goal 按钮