TURTLEBOT 2
Rviz and Gazebo simulation

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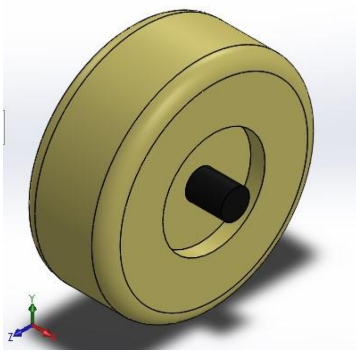
ROBOT PARTS

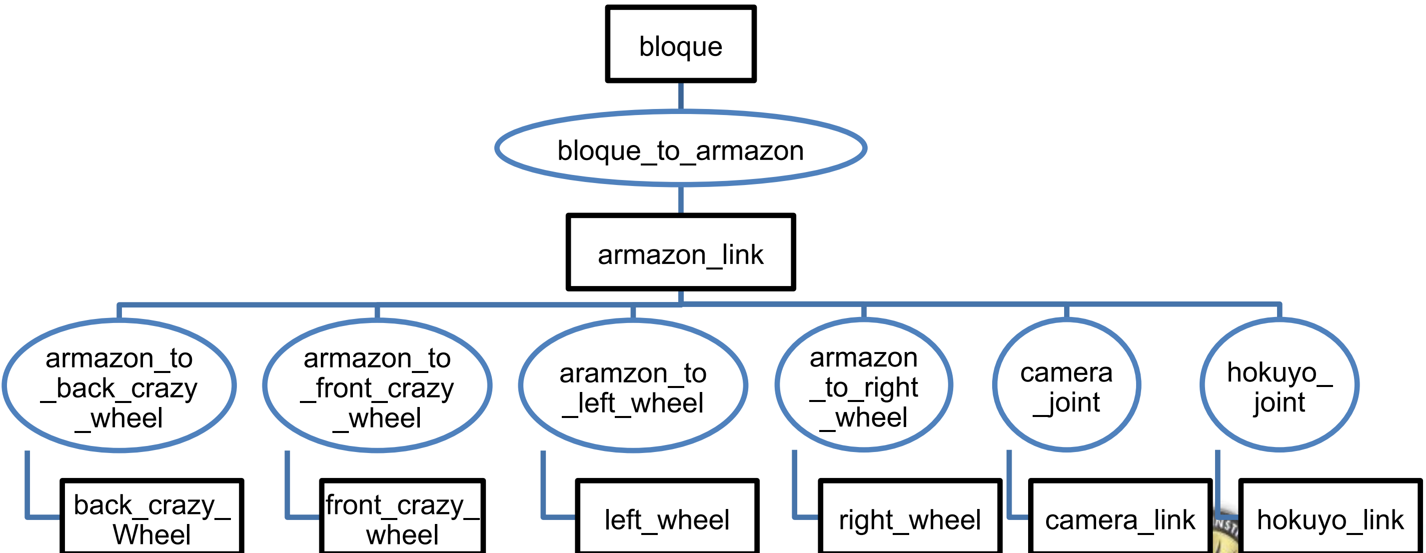
Chassis

Traction wheel



Unpowered wheel

Turtlebot’s Tree Structure



Turtlebot's URDF

```
<!-- Joint between the block and chasis-->
<joint name="bloque_to_armazon" type="fixed">
  <parent link="bloque"/>
  <child link="armazon_link"/>
  <origin xyz="0 0 0"/>
  <axis xyz="0 0 0" />
```

Urdf structure for bloque to chassis joint

Turtlebot's URDF

```
<!-- Chasis of the robot -->
<link name="armazon_link">
  <visual>
    <origin rpy="0 0 0" xyz="0 0 0"/>
    <geometry>
      <mesh filename="package://proyecto/
meshes/armazon.STL"/>
    </geometry>
    <material name="black_metal">
      <color rgba="0.1 0.1 0.1 1"/>
    </material>
  </visual>

  <inertial>
    <origin
      xyz="-0.00020681 -5.8482E-09 0.04814"
      rpy="0 0 0" />
    <mass
      value="9.9908" />
```

```
    <inertia
      ixx="0.18286"
      ixy="-8.1444E-09"
      ixz="-0.00095615"
      iyy="0.18195"
      iyz="-4.5751E-09"
      izz="0.14187" />
  </inertial>

  <collision>
    <origin
      xyz="0 0 0"
      rpy="0 0 0" />
    <geometry>
      <mesh
        filename="package://proyecto/meshes/
armazon.STL" />
    </geometry>
  </collision>

</link>
```

Description of robot's chassis

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Turtlebot's URDF

```xml
<!-- Gazebo reference of the left wheel -->
<gazebo reference="left_wheel">
  <mu1 value="1.0"/>
  <mu2 value="1.0"/>
  <kp value="10000000.0"/>
  <kd value="1.0"/>
  <fdir1 value="1 0 0"/>
  <material>Gazebo/Black</material>
  <turnGravityOff>false</turnGravityOff>
</gazebo>
```

Gazebo reference for traction wheel and PID controller

Turtlebot’s URDF

```
  <!-- Transmission is important to link the
joints and the controller Transmission for the
left wheel-->
  <transmission
name="armazon_to_left_wheel_trans">
    <type>transmission_interface/
SimpleTransmission</type>
    <joint name="armazon_to_left_wheel"/>
    <actuator
name="armazon_to_left_wheel_motor">
      <hardwareInterface>EffortJointInterface</
hardwareInterface>
      <mechanicalReduction>1</
mechanicalReduction>
    </actuator>
  </transmission>
```

Gazebo reference for transmission and motor of left wheel

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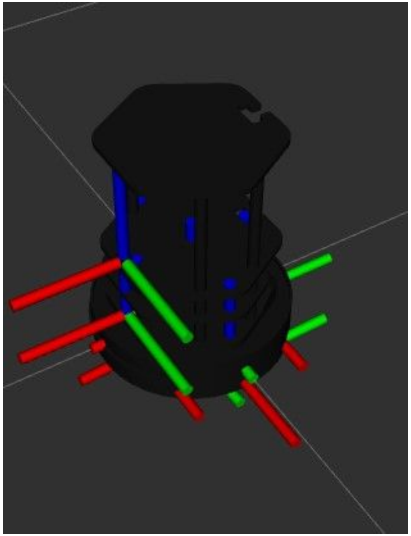
Turtlebot's Launch

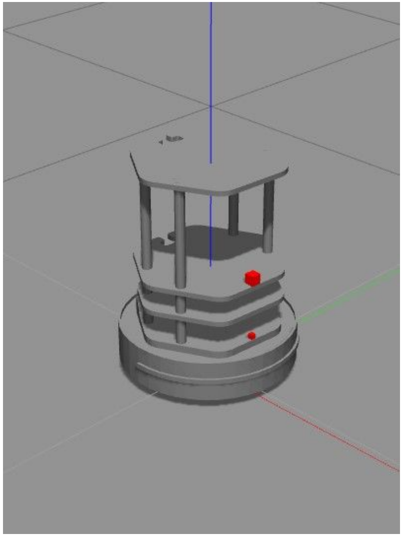
```
        <launch>
        <!-- Including Empty world files from
gazebo -->
        <include file="$(find gazebo_ros)/
launch/empty_world.launch" />
        <arg name="model" />
        <!-- Parsing xacro and setting
robot_description parameter -->
        <param name="robot_description"
textfile="$(find proyecto)/urdf/proyecto.urdf" /
>
        <!-- Setting gui parameter to true for
display joint slider -->
        <param name="use_gui" value="true"/>
        <!-- Starting Joint state publisher
node which will publish the joint values -->
        <node name="joint_state_publisher"
pkg="joint_state_publisher"
type="joint_state_publisher" />
```

```
        <!-- Starting robot state publish which
will publish tf -->
        <node name="robot_state_publisher"
pkg="robot_state_publisher"
type="robot_state_publisher"/>
        <!-- Launch visualization in Gazebo -->
        <node name="spawn_model"
pkg="gazebo_ros" type="spawn_model" args="-file
$(find proyecto)/urdf/proyecto.urdf -urdf -
model proyecto" output="screen" />
    <param name="publish_frequency"
type="double" value="50.0" />
        <!-- Launch visualization in rviz -->
        <node name="rviz" pkg="rviz"
type="rviz" args="-d $(find proyecto)/
urdf.rviz" required="true" />
</launch>
```

Launch file of the turtlebot

Robot models





Rviz and Gazebo Simulation

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Mapping using SLAM

```
<launch>
  <arg name="scan_topic" default="scan" />

  <node pkg="gmapping" type="slam_gmapping" name="slam_gmapping"
output="screen">
    <param name="base_frame" value="bloque"/>
    <param name="odom_frame" value="odom"/>
    <param name="map_update_interval" value="5.0"/>
    <param name="maxUrange" value="6.0"/>
    <param name="maxRange" value="8.0"/>
    <param name="sigma" value="0.05"/>
    <param name="kernelSize" value="1"/>
    <param name="lstep" value="0.05"/>
    <param name="astep" value="0.05"/>
```

gmapping.launch parameters

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Mapping using SLAM

```
  <node pkg="move_base" type="move_base" respawn="false"
name="move_base" output="screen">
    <rosparam file="$(find proyecto)/param/costmap_common_params.yaml"
command="load" ns="global_costmap" />
    <rosparam file="$(find proyecto)/param/costmap_common_params.yaml"
command="load" ns="local_costmap" />
    <rosparam file="$(find proyecto)/param/local_costmap_params.yaml"
command="load" />
    <rosparam file="$(find proyecto)/param/global_costmap_params.yaml"
command="load" />
    <rosparam file="$(find proyecto)/param/
base_local_planner_params.yaml" command="load" />
    <rosparam file="$(find proyecto)/param/
dwa_local_planner_params.yaml" command="load" />
    <rosparam file="$(find proyecto)/param/move_base_params.yaml"
command="load" />
```

Local and global costmap

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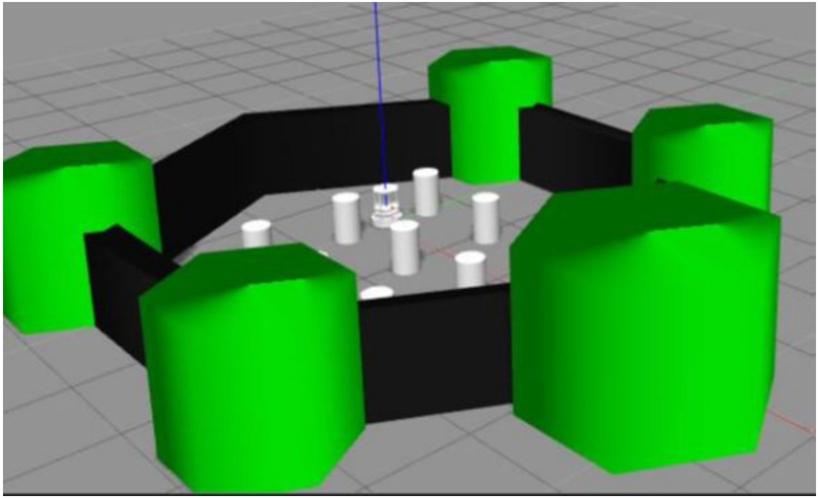
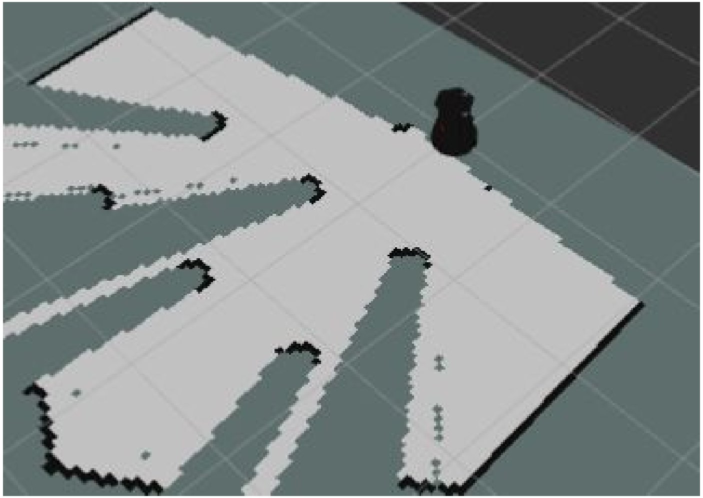
Turtlebot's environment



Environment to map.

Mapping using SLAM



Mapping process

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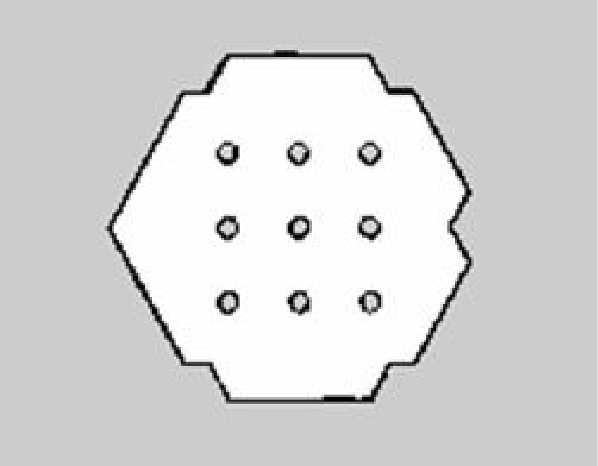
Mapping using SLAM



Saved map

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Autonomous Localization using AMCL

```
  <!-- Map server -->
  <arg name="map_file" default="$(find proyecto)/maps/test.yaml"/>
  <node name="map_server" pkg="map_server" type="map_server"
rgs="$(arg map_file)" />

  <arg name="initial_pose_x" default="0.0"/> <!-- Use 17.0 for
illow's map in simulation -->
  <arg name="initial_pose_y" default="0.0"/> <!-- Use 17.0 for
illow's map in simulation -->
  <arg name="initial_pose_a" default="0.0"/>

  <include file="$(find proyecto)/launch/includes/amcl.launch.xml">

    <arg name="initial_pose_x" value="0"/>
    <arg name="initial_pose_y" value="0"/>
    <arg name="initial_pose_a" value="0"/>

!--
    <arg name="initial_pose_x" value="$(arg initial_pose_x)"/>
    <arg name="initial_pose_y" value="$(arg initial_pose_y)"/>
    <arg name="initial_pose_a" value="$(arg initial_pose_a)"/>
-->
  </include>

  <include file="$(find proyecto)/launch/includes/
ove_base.launch.xml"/>
```

```
<arg name="use_map_topic"  default="false"/>
<arg name="scan_topic"     default="scan"/>
<arg name="initial_pose_x" default="0.0"/>
<arg name="initial_pose_y" default="0.0"/>
<arg name="initial_pose_a" default="0.0"/>

<node pkg="amcl" type="amcl" name="amcl">
  <param name="use_map_topic"                value="$(arg
e_map_topic)"/>
  <!-- Publish scans from best pose at a max of 10 Hz -->
  <param name="odom_model_type"              value="diff"/>
  <param name="odom_alpha5"                  value="0.1"/>
  <param name="gui_publish_rate"             value="10.0"/>
  <param name="laser_max_beams"                value="60"/>
  <param name="laser_max_range"              value="12.0"/>
  <param name="min_particles"                value="500"/>
  <param name="max_particles"                value="2000"/>
  <param name="kld_err"                      value="0.05"/>
  <param name="kld_z"                        value="0.99"/>
  <param name="odom_alpha1"                  value="0.2"/>
  <param name="odom_alpha2"                  value="0.2"/>
  <!-- translation std dev, m -->
  <param name="odom_alpha3"                  value="0.2"/>
  <param name="odom_alpha4"                  value="0.2"/>
  <param name="laser_z_hit"                  value="0.5"/>
```

amcl.launch file

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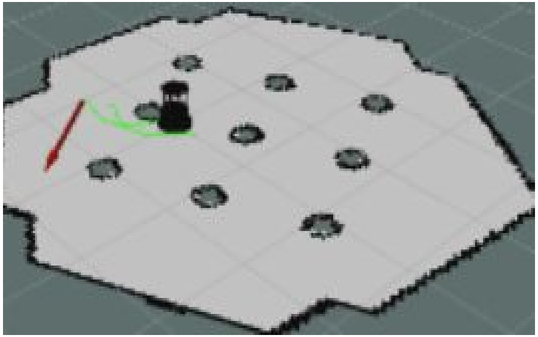
Autonomous Localization using AMCL

```
# Trajectory Scoring Parameters
  path_distance_bias: 0.8     # 32.0   -
  goal_distance_bias: 0.6      # 24.0
  occdist_scale: 0.5          # 0.01   -
  forward_point_distance: 0.325 # 0.325
  stop_time_buffer: 0.2         # 0.2
  scaling_speed: 0.25           # 0.25
  max_scaling_factor: 0.2       # 0.2
```

Trajectory parameters

Autonomous Localization using AMCL



Plugins added in Rviz & Autonomous navigation in Rviz

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Jetson TK1

The Jetson TK1 nvidia's board is used as the cpu of the turtlebot.

Jetson’s requirements for the turtlebot

1. L4T (Linux for Tegra) 21.3
2. GRINCH KERNEL 21.3.4
3. ROS Indigo
4. Turtlebot and kobuki ROS dependencies

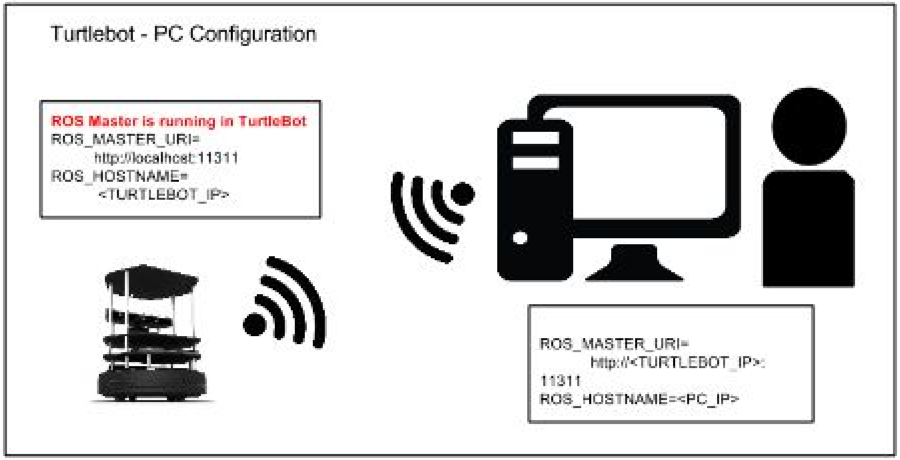
Jetson's configuration

1. Download and install the las version of Jetpack TK1 (21.3).
2. Reinstall the system with Ubuntu 14.04.
3. Update repositories
   $ sudo apt-get update y *$sudo apt-get upgrade*.
4. Install the custom kernel, in this case the *grinch kernel*
   $ sudo apt-get install git
   $ git clone https://github.com/jetsonhacks/installGrinch.git

Jetson's configuration

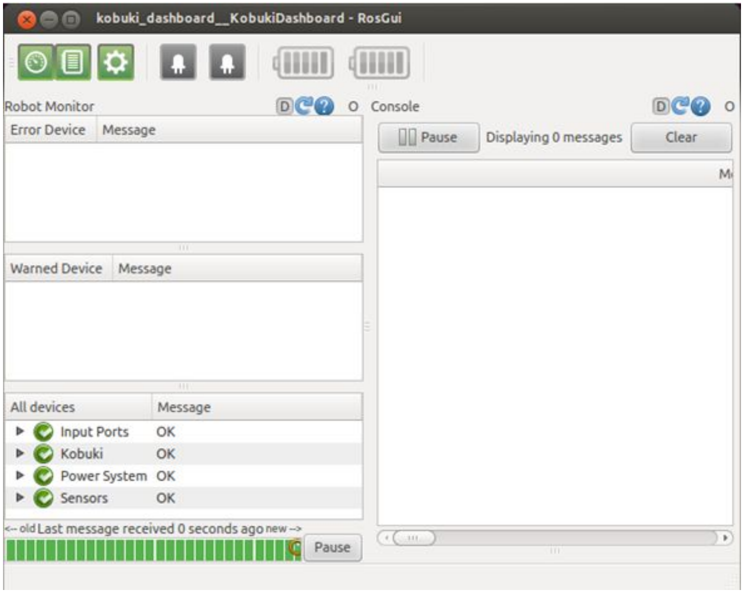
5. Follow the tutorial on https://github.com/jetsonhacks/postFlash to improve the efficiency of the card
6. Install ROS Indigo
   $ git clone https://github.com/jetsonhacks/installROS.git
7. Install essentials
   $ sudo apt-get install build-essential
8. Install g++
   $ sudo apt-get install g++

Network configuration



Network configuration between the Host PC and the turtlebot, after this, it is necessary to do the deb installation and the source installation respectively

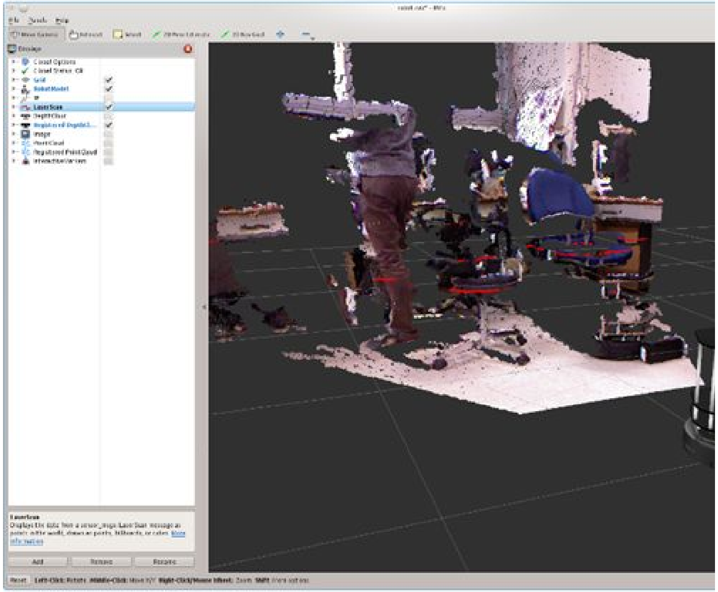
Configuration of turtlebot's bringup



This step is necessary to bring up or start the turtlebot software and get connected to the turtlebot from the host PC

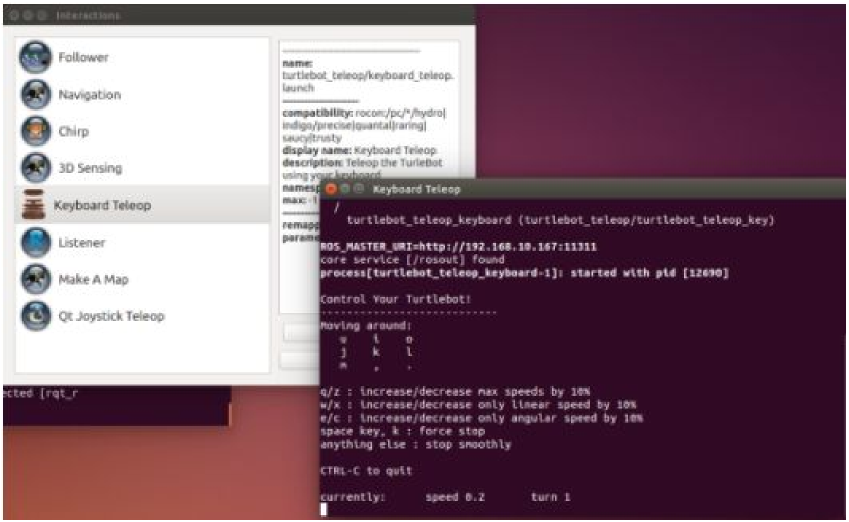
Enable 3D visualization

```
roslaunch turtlebot_bringup 3dsensor.launch
```



Most of the visualization launchers can be found in the *turtlebot_rviz_launchers* package. This is useful to allow the call of launchers to visualize the turtle and its data streams.

Keyboard_Teleop




```
roslaunch turtlebot_teleop keyboard_teleop.launch --screen
```

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Gmapping

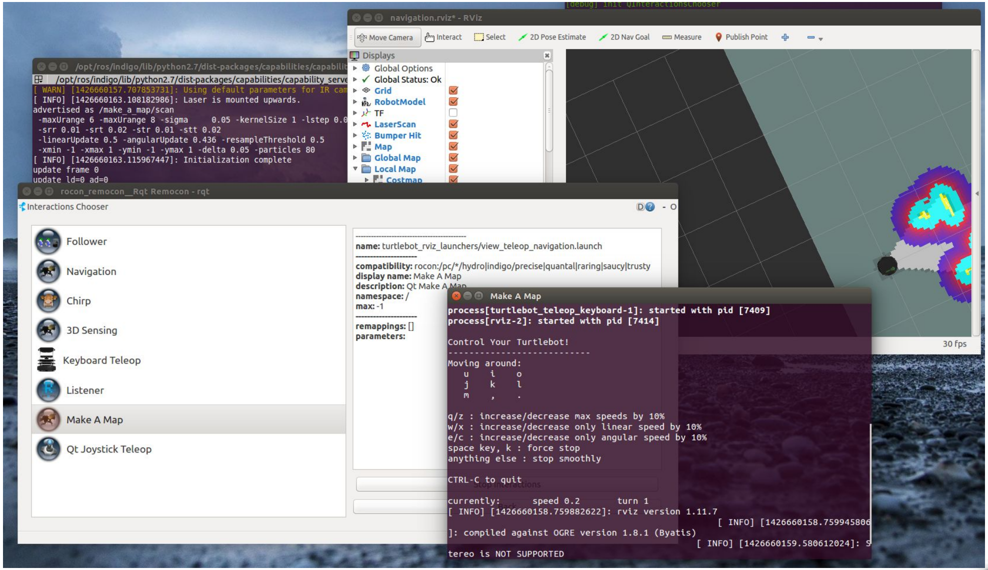
- Bring up the robot

```
roslaunch turtlebot_bringup minimal.launch
```

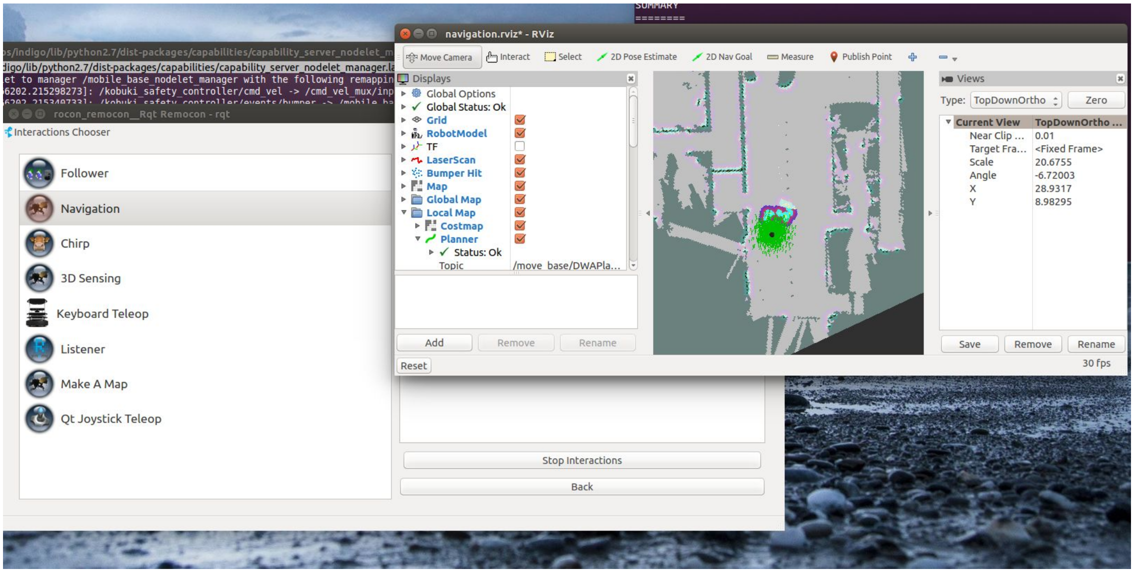
- Run the gmapping demo app

```
roslaunch turtlebot_navigation gmapping_demo.launch
```

“Make a map”


navigation.rviz* - RViz
Move Camera
Interact
Select
2D Pose Estimate
2D Nav Goal
Measure
Publish Point
Displays
Global Options
Global Status: Ok
Grid
RobotModel
TF
LaserScan
Bumper Hit
Map
Global Map
Local Map
Costmap
30 fps
/opt/ros/indigo/lib/python2.7/dist-packages/capabilities/capability_serve
[INFO] [1426660163.108182986]: Laser is mounted upwards.
advertised as /make_a_map/scan
-maxUrange 6 -maxUrange 8 -sigma 0.05 -kernelSize 1 -lstep 0.0
-srr 0.01 -srt 0.02 -str 0.01 -stt 0.02
-linearUpdate 0.5 -angularUpdate 0.436 -resampleThreshold 0.5
-xmin -1 -xmax 1 -ymin -1 -ymax 1 -delta 0.05 -particles 80
[INFO] [1426660163.115967447]: Initialization complete
update frame 0
update ld=0 ad=0
rocon_remocon__Rqt Remocon - rqt
Interactions Chooser
Follower
Navigation
Chirp
3D Sensing
Keyboard Teleop
Listener
Make A Map
Qt Joystick Teleop
name: turtlebot_rviz_launchers/view_teleop_navigation.launch
compatibility: rocon:/pc/*/hydro|indigo/precise|quantal|raring|saucy|trusty
display name: Make A Map
description: Qt Make A Map
namespace: /
max: -1
remappings: []
parameters:
Make A Map
process[turtlebot_teleop_keyboard-1]: started with pid [7409]
process[rviz-2]: started with pid [7414]
Control Your Turtlebot!
Moving around:
u i o
j k l
m , .
q/z : increase/decrease max speeds by 10%
w/x : increase/decrease only linear speed by 10%
e/c : increase/decrease only angular speed by 10%
space key, k : force stop
anything else : stop smoothly
CTRL-C to quit
currently: speed 0.2 turn 1
[INFO] [1426660158.759882622]: rviz version 1.11.7
]: compiled against OGRE version 1.8.1 (Byatis)
tereo is NOT SUPPORTED

Autonomous navigation



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TurtleBot 2 Autonomous Navigation and Obstacle-avoidance

https://www.youtube.com/watch?v=0eDFSXPnh2I

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