

TurtleBot3 Burger Guide

官方的介紹:

TurtleBot3 是一款小型、價格實惠且可自定義的基於 ROS 的移動機器人，適用於教育、研究、愛好項目和產品原型開發。TurtleBot3 的目標是提供一個低成本、高度靈活的機器人開發平台，無需犧牲功能和質量，同時提供足夠的擴展性，適應各種複雜的機器人應用。TurtleBot3 可以通過簡單的機械組件和升級的電子元件（包括自定義計算機和感測器）進行多種方式的定制。此外，TurtleBot3 持續升級其現成的性能，並不斷提升包括經濟實惠且小型的 SBC（適用於穩定的嵌入式系統）。TurtleBot3 的核心技術包括 SLAM、導航和操作，這使它適用於各種研究和服務機器人應用。

連接至機器人:

由於 TurtleBot3 搭載 Raspberry pi 4 和 Ubuntu22.04，因此可透過 ssh 連接到機器人，在同一局域網或虛擬局域網都可以連上。

假設機器人的 IP 為 192.168.1.100，可在 cmd 執行以下指令：

```
1. ssh ubuntu@192.168.1.100
```

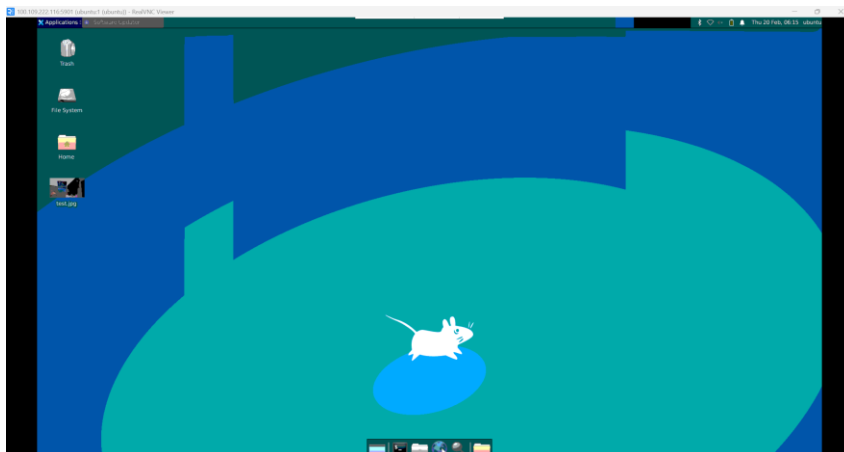
帳號：ubuntu

密碼：ubuntu

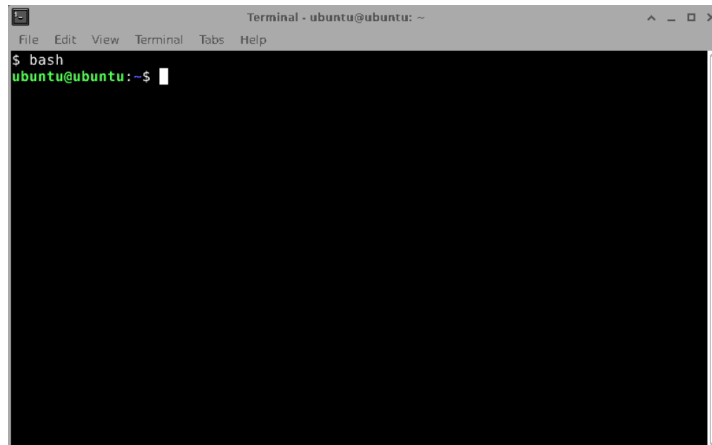
連上桌面環境需要下載 RealVNC Viewer，假設 IP 為 192.168.1.100:



帳號和密碼皆為 ubuntu，連進去應該可以看見 TurtleBot3 的桌面



Terminal 的基礎使用:

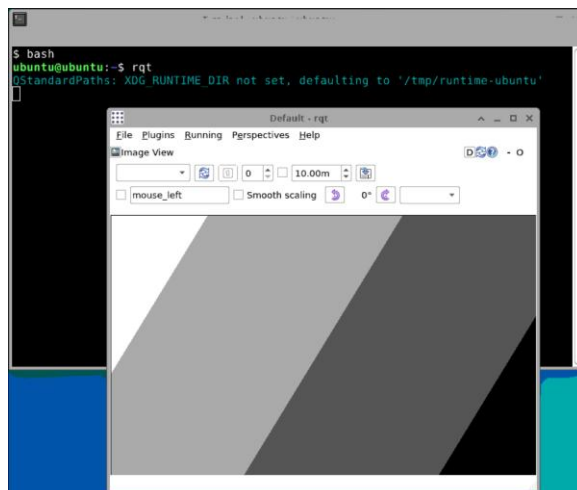


由於機器人是裝 xfce 輕量的桌面環境，預設使用 zsh 而我們比較常用 bash，因此必須先打 bash 切換成 bash 環境。

可視化工具:

rqt 是一個基於 Qt 的圖形化工具，旨在幫助開發者在使用 ROS（Robot Operating System）時進行可視化和監控。它是一個插件架構的工具集，可以擴展功能，並且支持多種不同的可視化工具。

簡單來說可以訂閱 Node，查看推送的可視化圖片或相機數據。



操作 TurtleBot3 的部分:

必須先 bring up，載入機器人的必要驅動程式與節點。

1. `ros2 launch turtlebot3_bringup robot.launch.py`

```
Terminal - ubuntu@ubuntu: ~
$ bash
ubuntu@ubuntu:~$ ros2 launch turtlebot3_bringup robot.launch.py
[INFO] [launch]: All log files can be found below /home/ubuntu/.ros/log/2025-02-20-07-02-43-390751-ubuntu-5891
[INFO] [launch]: Default logging verbosity is set to INFO
urdf_file_name : turtlebot3_burger.urdf
[INFO] [robot_state_publisher-1]: process started with pid [5892]
[INFO] [ld08_driver-2]: process started with pid [5894]
[INFO] [turtlebot3_ros-3]: process started with pid [5896]
[INFO] [turtlebot3 node]: Init TurtleBot3 Node Main
[INFO] [turtlebot3 node]: Init DynamixelSDKWrapper
[INFO] [DynamixelSDKWrapper]: Succeeded to open the port(/dev/ttyACM0)!
[INFO] [DynamixelSDKWrapper]: Succeeded to change the baudrate!
[INFO] [robot_state_publisher-1]: [1740034964.377907730] [robot_state_publisher]: got segment base_footprint
[INFO] [robot_state_publisher-1]: [1740034964.378237323] [robot_state_publisher]: got segment base_link
[INFO] [robot_state_publisher-1]: [1740034964.378301675] [robot_state_publisher]: got segment base_scan
[INFO] [robot_state_publisher-1]: [1740034964.378335212] [robot_state_publisher]: got segment caster_back_link
[INFO] [robot_state_publisher-1]: [1740034964.378363749] [robot_state_publisher]: got segment imu_link
[INFO] [robot_state_publisher-1]: [1740034964.378390082] [robot_state_publisher]: got segment wheel_left_link
[INFO] [robot_state_publisher-1]: [1740034964.378415360] [robot_state_publisher]: got segment wheel_right_link
[INFO] [turtlebot3_ros-3]: [1740034964.381549673] [turtlebot3 node]: Start Calibration of Gyro
[ld08_driver-2] /dev/ttyUSB0 CP2102 USB to UART Bridge Controller
[ld08_driver-2] /dev/ttyACM0 OpenCR Virtual ComPort in FS Mode
[ld08_driver-2] FOUND LDS-02
[ld08_driver-2] LDS-02 started successfully
[turtlebot3_ros-3] [INFO] [1740034969.381802743] [turtlebot3 node]: Calibration End
[turtlebot3_ros-3] [INFO] [1740034969.381934733] [turtlebot3 node]: Add Motors
[turtlebot3_ros-3] [INFO] [1740034969.382418078] [turtlebot3 node]: Add Wheels
[turtlebot3_ros-3] [INFO] [1740034969.382786805] [turtlebot3 node]: Add Sensors
[turtlebot3_ros-3] [INFO] [1740034969.400095635] [turtlebot3 node]: Succeeded to create battery state publisher
[turtlebot3_ros-3] [INFO] [1740034969.403757035] [turtlebot3 node]: Succeeded to create imu publisher
[turtlebot3_ros-3] [INFO] [1740034969.419882834] [turtlebot3 node]: Succeeded to create sensor state publisher
[turtlebot3_ros-3] [INFO] [1740034969.424008276] [turtlebot3 node]: Succeeded to create joint state publisher
[turtlebot3_ros-3] [INFO] [1740034969.424157766] [turtlebot3 node]: Add Devices
[turtlebot3_ros-3] [INFO] [1740034969.424207103] [turtlebot3 node]: Succeeded to create motor power server
[turtlebot3_ros-3] [INFO] [1740034969.430588888] [turtlebot3 node]: Succeeded to create reset server
[turtlebot3_ros-3] [INFO] [1740034969.433162937] [turtlebot3 node]: Succeeded to create sound server
[turtlebot3_ros-3] [INFO] [1740034969.435240178] [turtlebot3 node]: Run!
[turtlebot3_ros-3] [INFO] [1740034969.478810073] [diff_drive_controller]: Init Odometry
[turtlebot3_ros-3] [INFO] [1740034969.502159006] [diff_drive_controller]: Run!
```

可以透過 topic list 查看馬達、光達等節點是否成功啟動

1. `ros2 topic list`

```
Terminal - ubuntu@ubuntu: ~
$ bash
ubuntu@ubuntu:~$ ros2 topic list
/battery_state
/cmd_vel
/imu
/joint_states
/magnetic_field
/odom
/parameter_events
/robot_description
/rosout
/scan
/sensor_state
/tf
/tf_static
ubuntu@ubuntu:~$
```

另外可以使用 echo 即時的觀察節點回傳的情況

```
ubuntu@ubuntu:~$ ros2 topic echo /scan
header:
  stamp:
    sec: 1740035277
    nanosec: 836271188
  frame_id: base_scan
angle_min: 0.012190211564302444
angle_max: 6.2736968994140625
angle_increment: 0.02164965309202671
time_increment: 0.0004362875479273498
scan_time: 0.12618295848369598
range_min: 0.0
range_max: 100.0
ranges:
- 1.4989999532699585
- 1.4630000591278076
- .nan
- 1.4320000410079956
- 1.3899999856948853
- 1.4149999618530273
- 1.4839999675750732
- 1.5269999504089355
- .nan
- 0.8349999785423279
- 0.8109999895095825
```

啟動相機節點&查看鏡頭輸出:

1. ros2 run v4l2_camera v4l2_camera_node

```
ubuntu@ubuntu:~$ ros2 run v4l2_camera v4l2_camera_node
[INFO] [1740035411.609252208] [v4l2_camera]: Driver: bcm2835 mmal
[INFO] [1740035411.609257184] [v4l2_camera]: Version: 331688
[INFO] [1740035411.609369940] [v4l2_camera]: Device: mmal service 16.1
[INFO] [1740035411.609419716] [v4l2_camera]: Location: platform:bcm2835-v4l2-0
[INFO] [1740035411.609461234] [v4l2_camera]: Capabilities:
[INFO] [1740035411.609501825] [v4l2_camera]: Read/write: YES
[INFO] [1740035411.609539379] [v4l2_camera]: Streaming: YES
[INFO] [1740035411.609600026] [v4l2_camera]: Current pixel format: JPEG @ 1024x768
[INFO] [1740035411.610525461] [v4l2_camera]: Available pixel formats:
[INFO] [1740035411.610637902] [v4l2_camera]: YU12 - Planar YUV 4:2:0
[INFO] [1740035411.610681122] [v4l2_camera]: YUYV - YUYV 4:2:2
[INFO] [1740035411.610718788] [v4l2_camera]: RGB3 - 24-bit RGB 8-8-8
[INFO] [1740035411.610755750] [v4l2_camera]: JPEG - JFIF JPEG
[INFO] [1740035411.610793915] [v4l2_camera]: H264 - H.264
[INFO] [1740035411.610831581] [v4l2_camera]: MJPG - Motion-JPEG
[INFO] [1740035411.610867709] [v4l2_camera]: YVYU - YVYU 4:2:2
[INFO] [1740035411.610903856] [v4l2_camera]: VYUY - VYUY 4:2:2
[INFO] [1740035411.610940337] [v4l2_camera]: UYVY - UYVY 4:2:2
[INFO] [1740035411.610975688] [v4l2_camera]: NV12 - Y/CbCr 4:2:0
[INFO] [1740035411.611012131] [v4l2_camera]: BGR3 - 24-bit BGR 8-8-8
[INFO] [1740035411.611048222] [v4l2_camera]: YV12 - Planar YVU 4:2:0
[INFO] [1740035411.611084740] [v4l2_camera]: NV21 - Y/CrCb 4:2:0
[INFO] [1740035411.611120990] [v4l2_camera]: Rx24 - 32-bit XRGB 8-8-8-8
[INFO] [1740035411.611157664] [v4l2_camera]: Available controls:
[INFO] [1740035411.611215958] [v4l2_camera]: Brightness (1) = 50
[INFO] [1740035411.611265864] [v4l2_camera]: Contrast (1) = 0
[INFO] [1740035411.611312326] [v4l2_camera]: Saturation (1) = 0
[INFO] [1740035411.611359177] [v4l2_camera]: Red Balance (1) = 1000
[INFO] [1740035411.611407582] [v4l2_camera]: Blue Balance (1) = 1000
[INFO] [1740035411.611453266] [v4l2_camera]: Horizontal Flip (2) = 0
[INFO] [1740035411.611498172] [v4l2_camera]: Vertical Flip (2) = 0
[INFO] [1740035411.611544485] [v4l2_camera]: Power Line Frequency (3) = 1
[INFO] [1740035411.611590928] [v4l2_camera]: Sharpness (1) = 0
[INFO] [1740035411.611636538] [v4l2_camera]: Color Effects (3) = 0
[INFO] [1740035411.611682796] [v4l2_camera]: Rotate (1) = 0
[INFO] [1740035411.611730572] [v4l2_camera]: Color Effects, CbCr (1) = 32896
[ERROR] [1740035411.611789915] [v4l2_camera]: Failed getting value for control 10027000: Permission denied (13); returning 0
[INFO] [1740035411.611876420] [v4l2_camera]: Codec Controls (6) = 0
[INFO] [1740035411.611929669] [v4l2_camera]: Video Bitrate Mode (3) = 0
[INFO] [1740035411.611978805] [v4l2_camera]: Video Bitrate (1) = 10000000
```

1. rqt

