TESR_iron-X Tutorial
(Basic)

Ubuntu and ROS Noetic Installation

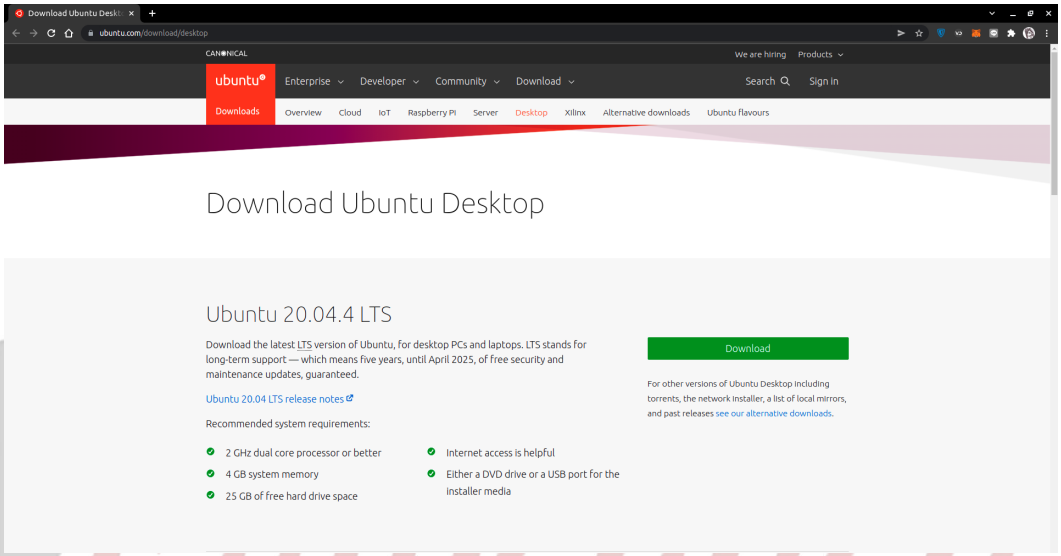
*You can skip this Installation if you already have Ubuntu 20.04 LTS and ROS Noetic on your own PC/Laptop. Go to the Main Topic by **"Click Here"**

Install Ubuntu using VMware player

1. Download Ubuntu Image

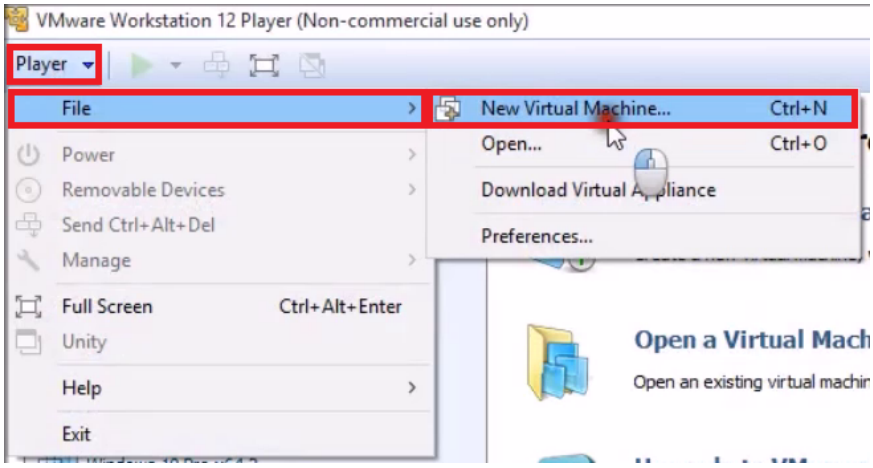
You can download an Ubuntu image at link: https://ubuntu.com/download/desktop

Make sure to save it to a memorable location on your PC! For this tutorial, we will use the Ubuntu 20.04 LTS release.

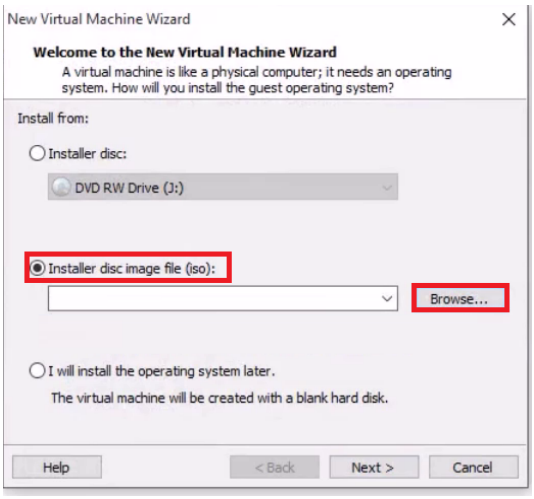


2. Setting up a VM

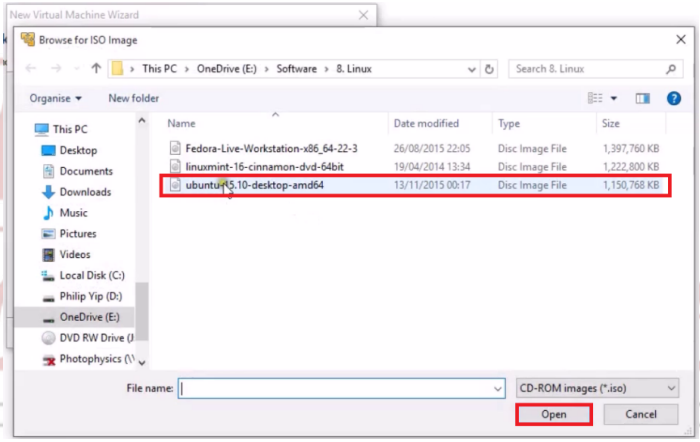
Left click player → Left Click File → Left Click New Virtual Machine:



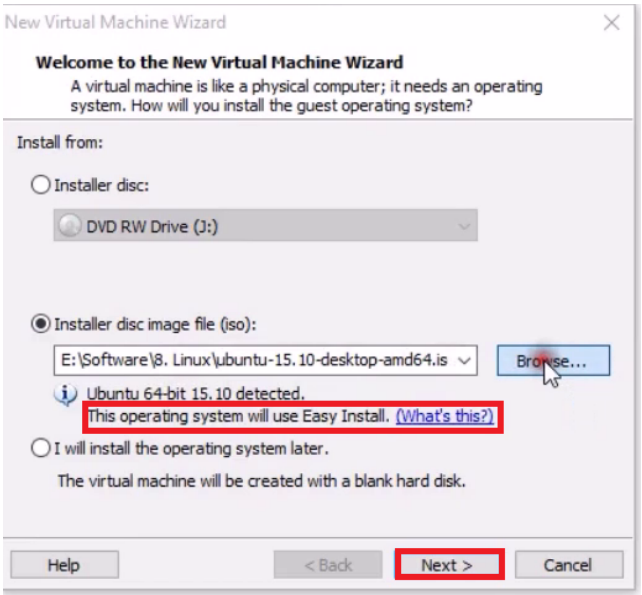
Select Installer Disk Image File (.iso):



Select browse…. and left click the Ubuntu .iso you downloaded:\



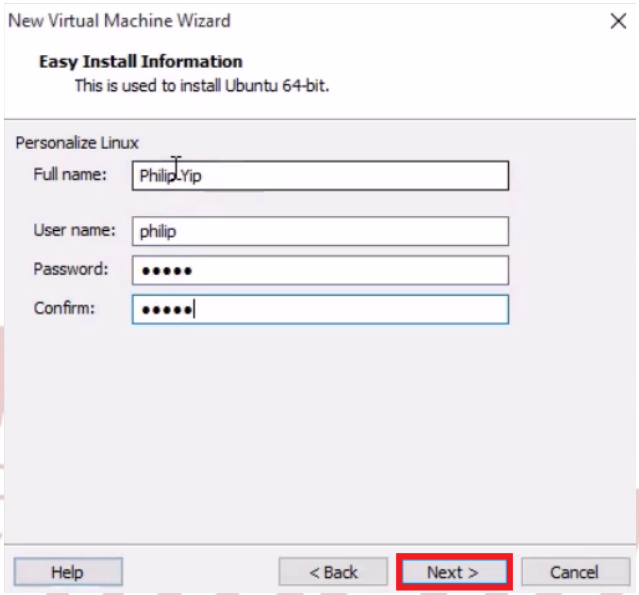
Select Open



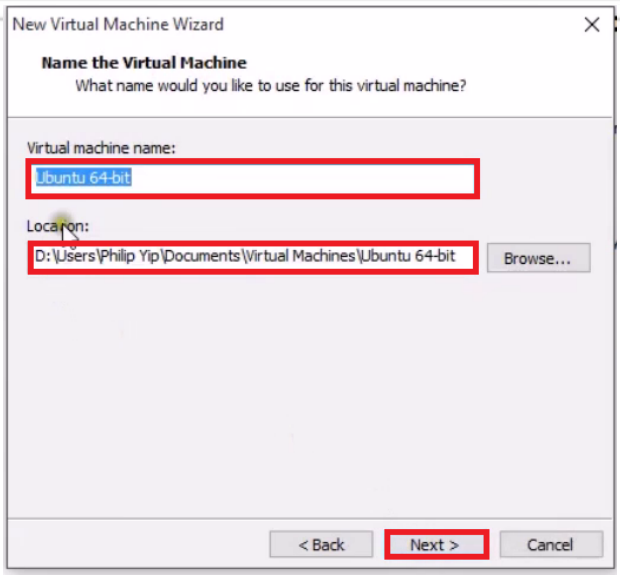
Ensure "This Operating System will use Easy Install" is shown.

With Easy Install VMWare Player will automatically install Ubuntu and VMWare tools without the need for user input. If easy_install is not selected one may have difficulty installing VMWare tools manually. The only disadvantage of easy install is there is no option to select language options using VMWare player and it defaults to English US language and keyboard :(. The language settings for both can easily be changed after installation and I will demonstrate the change of English US to proper English UK.

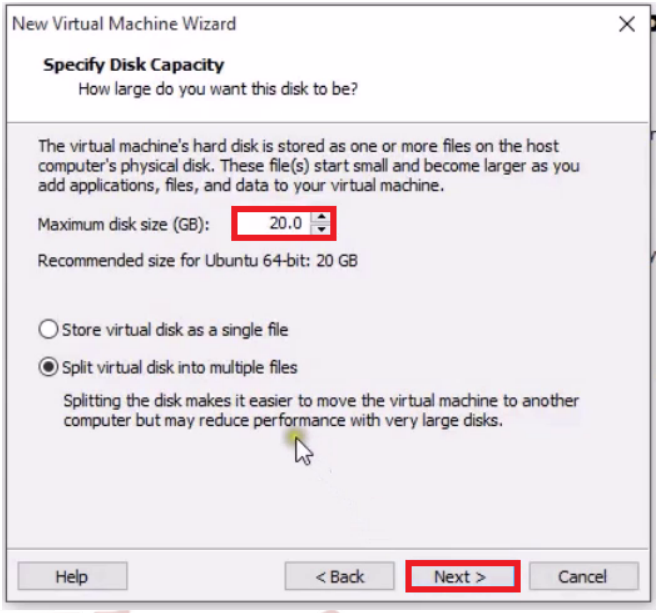
Type in your full name and username. The username has to all be lower case with no spaces. Then type in your password, Ubuntu won't let you install without a password:



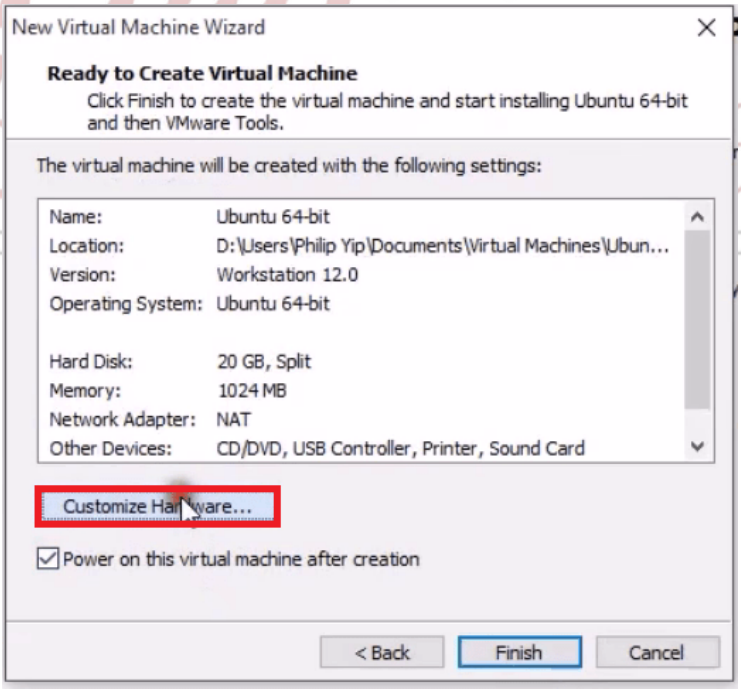
Here you can name your VM and you can also opt to change the location of the VM e.g. to a different HDD/SSD depending what suits.



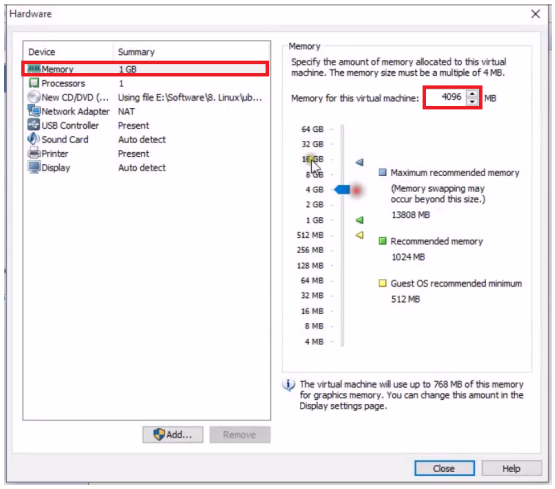
Select next. The default storage is 20 GB but you may increase it. I recommend leaving Split virtual disk into multiple files.



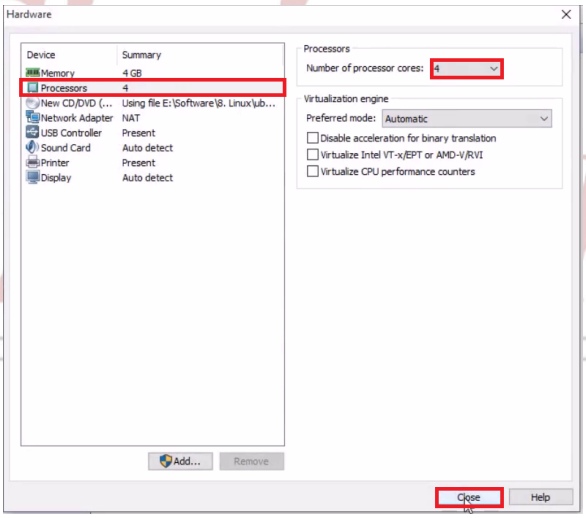
Before installing Ubuntu select Customize Hardware because the default hardware settings are pretty weak:



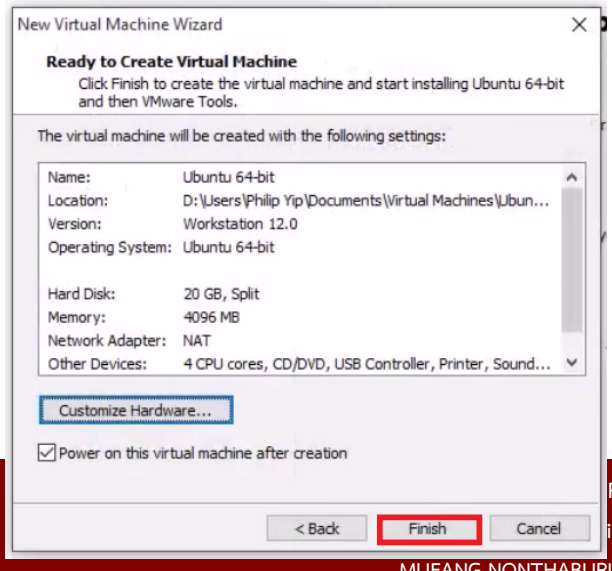
If you computer is capable (has at least 8 GB of RAM) up the RAM to 4 GB:



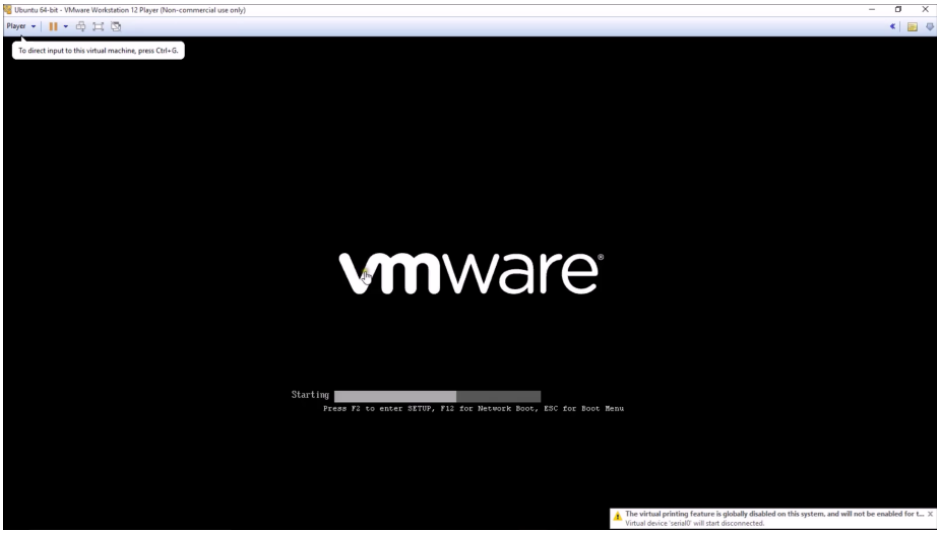
If your computer is capable of at least 8 threads, change the Number of processor cores to 4. If your processor has 4 threads change the Number of processor cores to 2. This will substantially increase the Ubuntu VMs system performance.

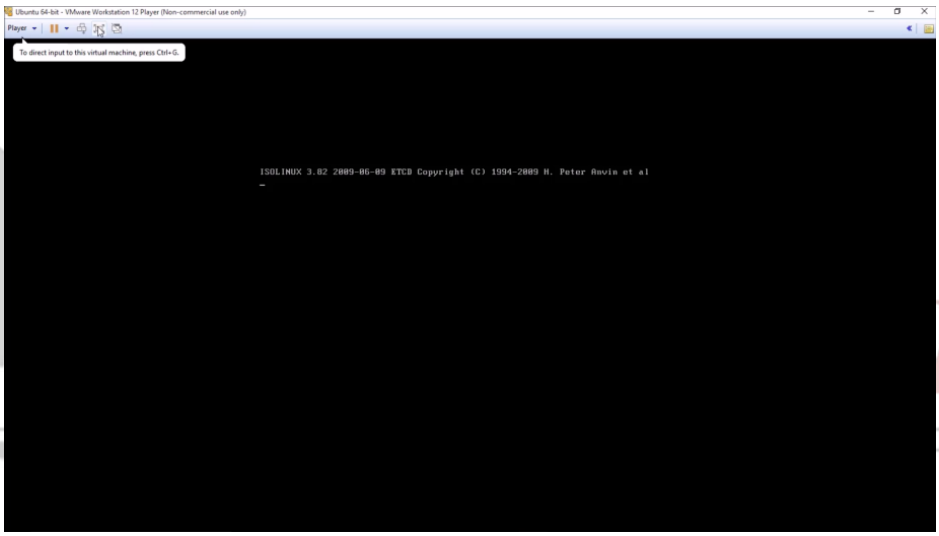


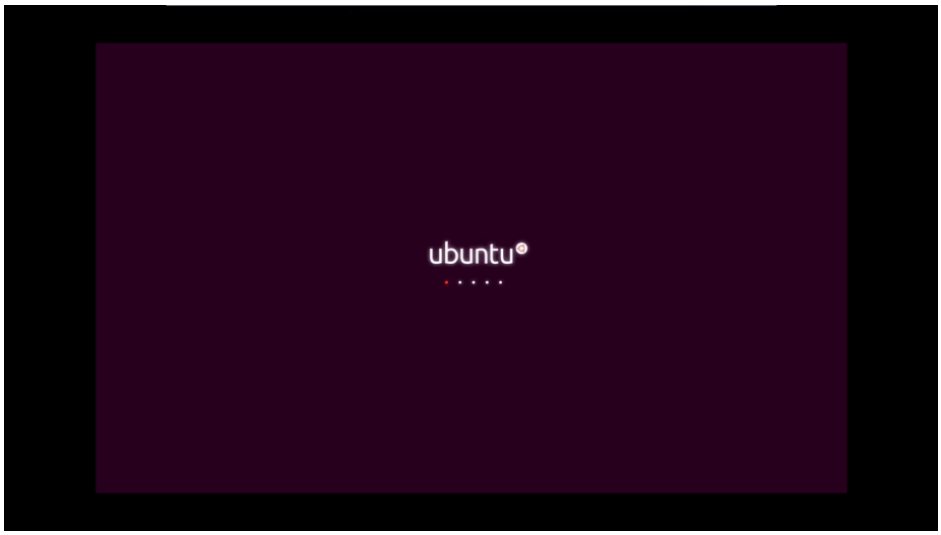
Select close and then Finish

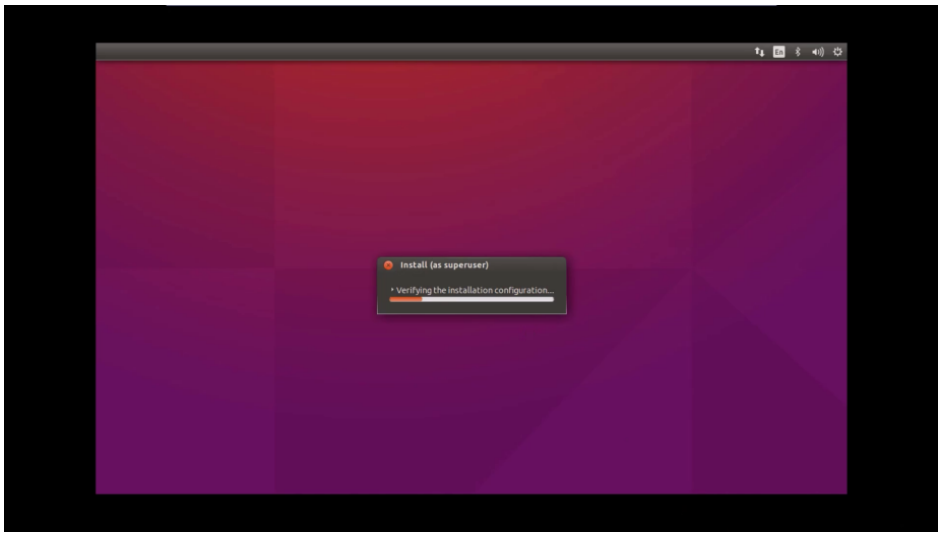


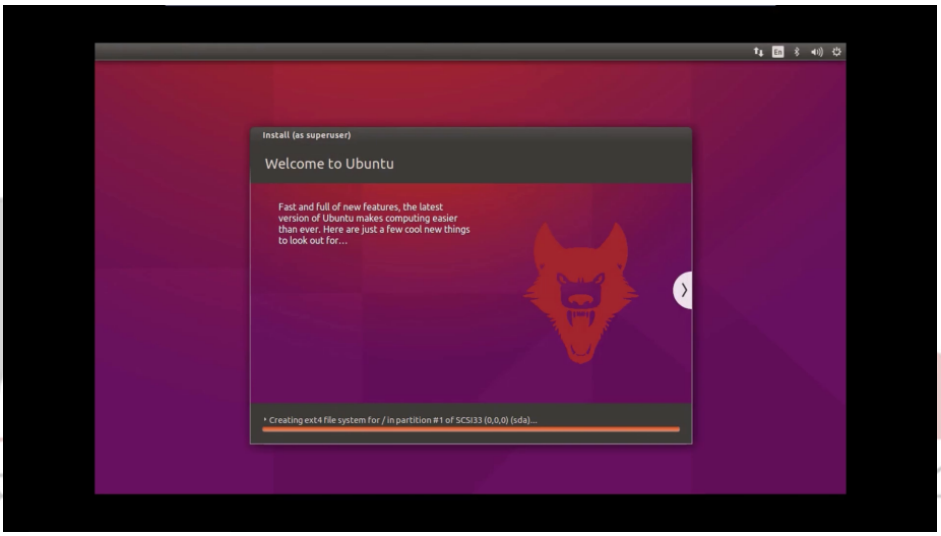
As mentioned the rest of the install will be automated. Make yourself a cup of tea and come back in 5-10 minutes:





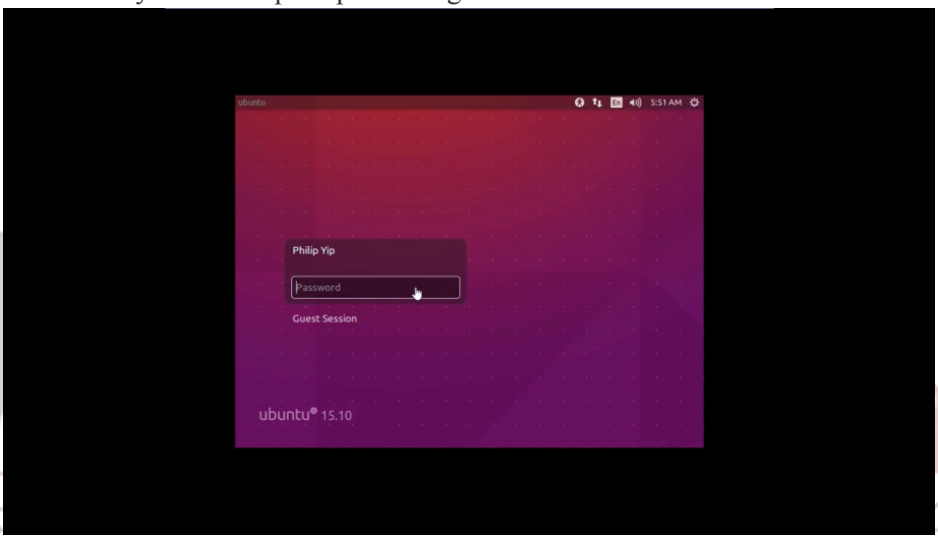



Install (as superuser)
* Verifying the installation configuration...


Install (as superuser)
Welcome to Ubuntu
Fast and full of new features, the latest version of Ubuntu makes computing easier than ever. Here are just a few cool new things to look out for...
* Creating ext4 file system for / in partition #1 of SCSI33 (0,0,0) (sda)...

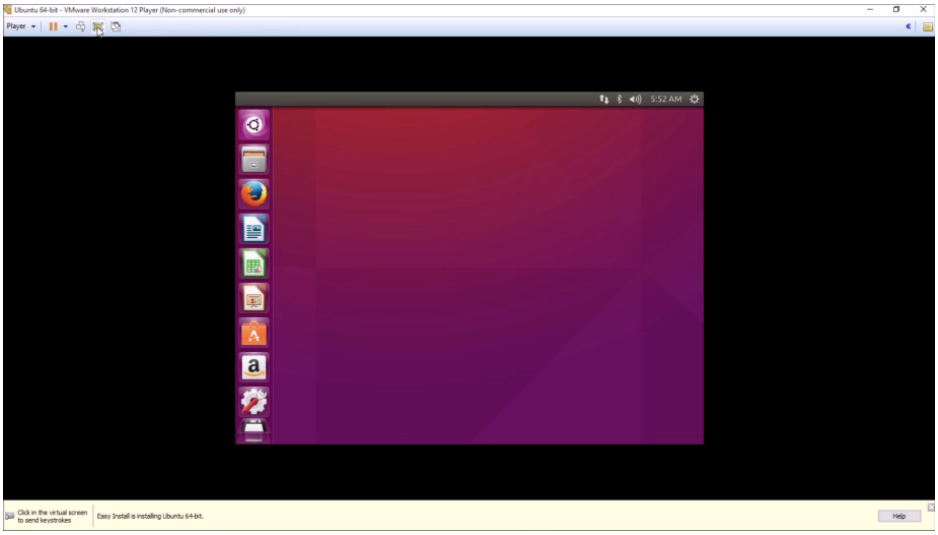

vmware
Starting
Press F2 to enter SETUP, F12 for Network Boot, ESC for Boot Menu

When the install is done you will be prompted to login:

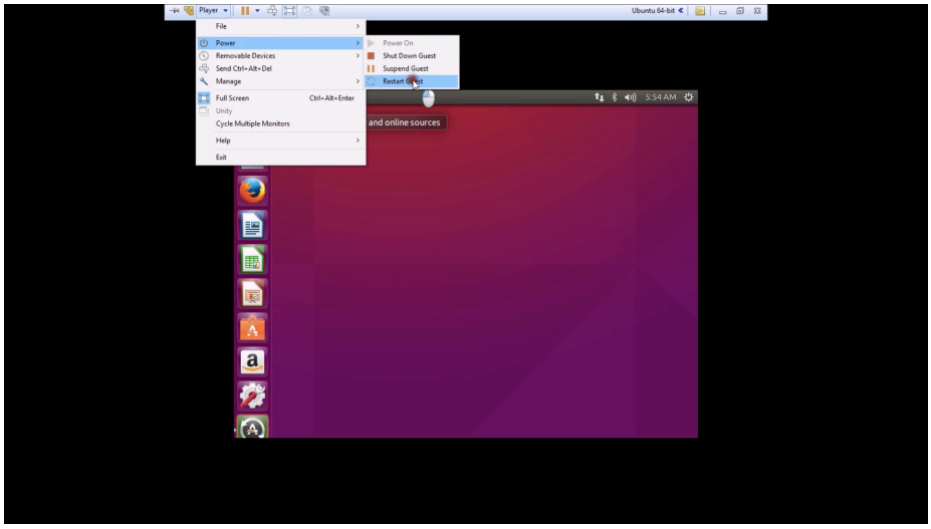


Making Sure VMWare Tools are Installed

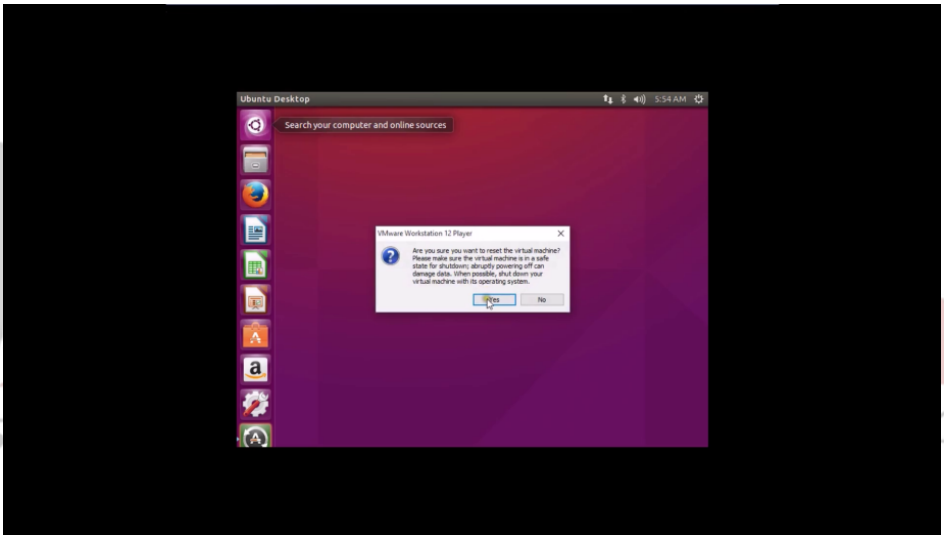
During the first launch the user experience may be terrible because VMWare tools are not installed therefore I recommend signing in waiting 5-10 minutes and then restarting:

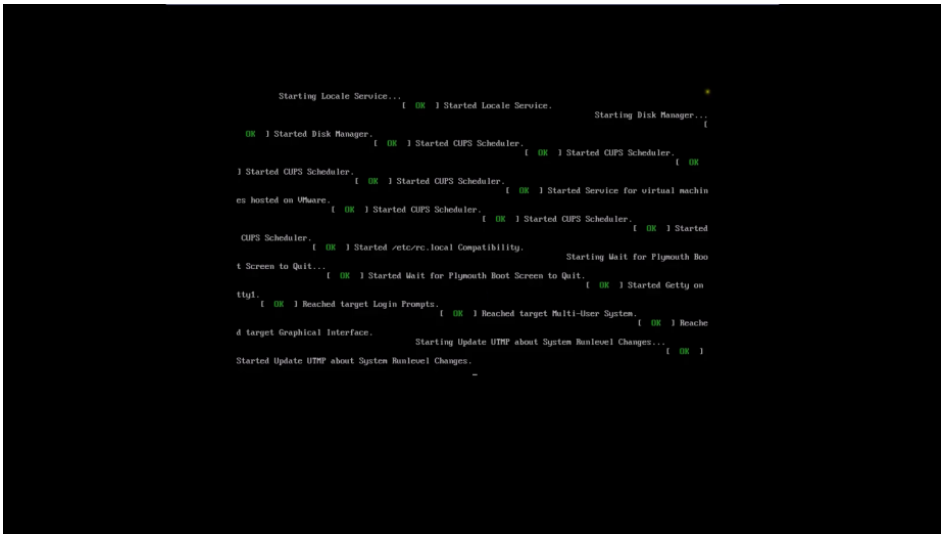


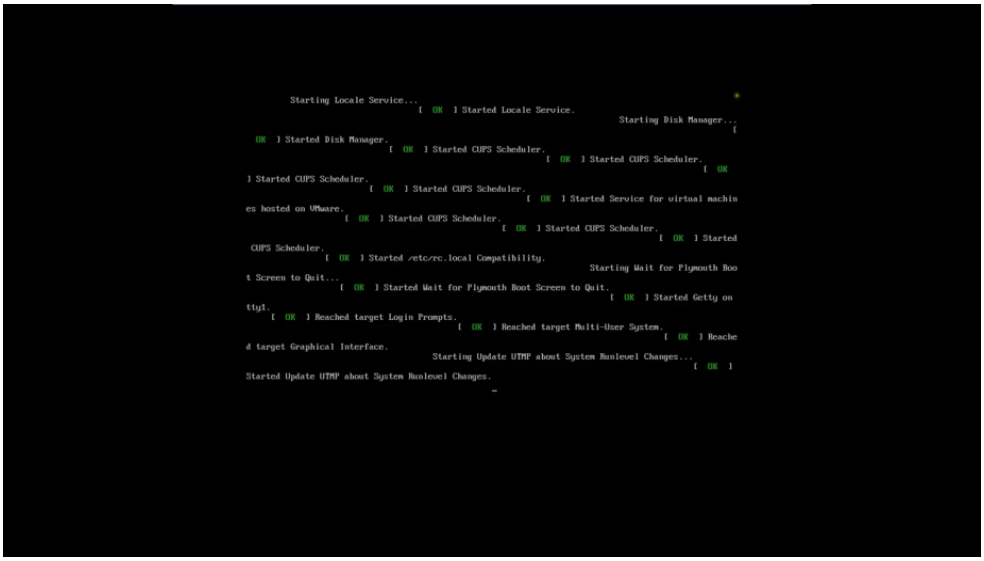
Select the player button at the top left and then power and then restart guest:



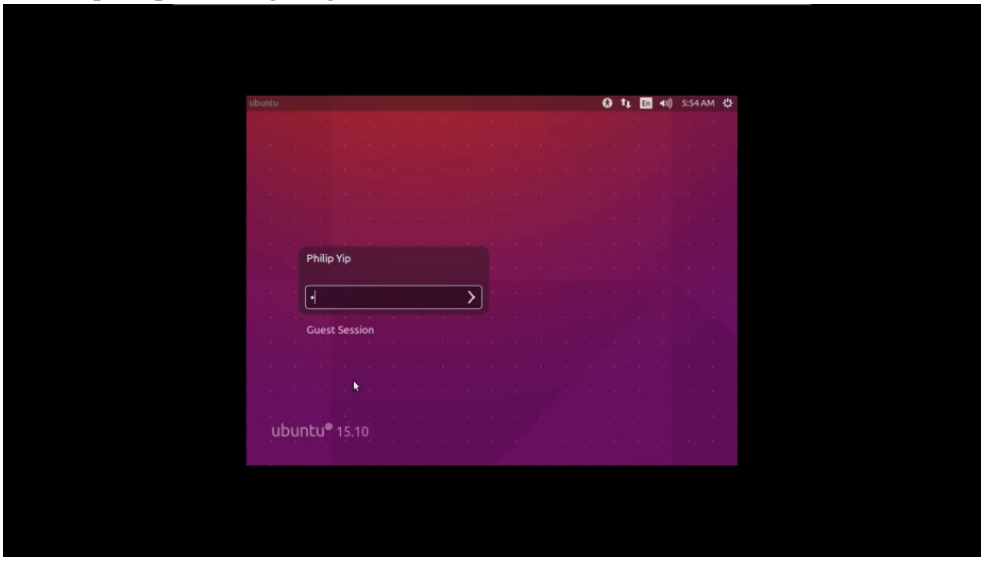
Select yes:



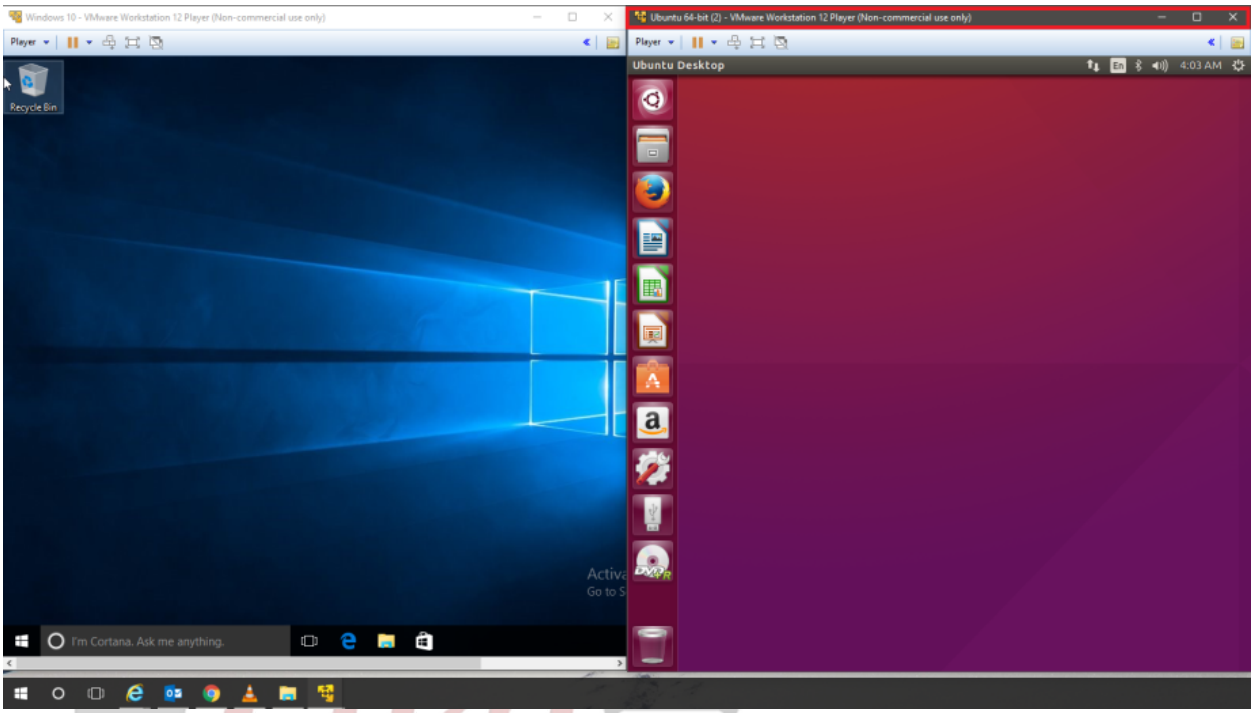




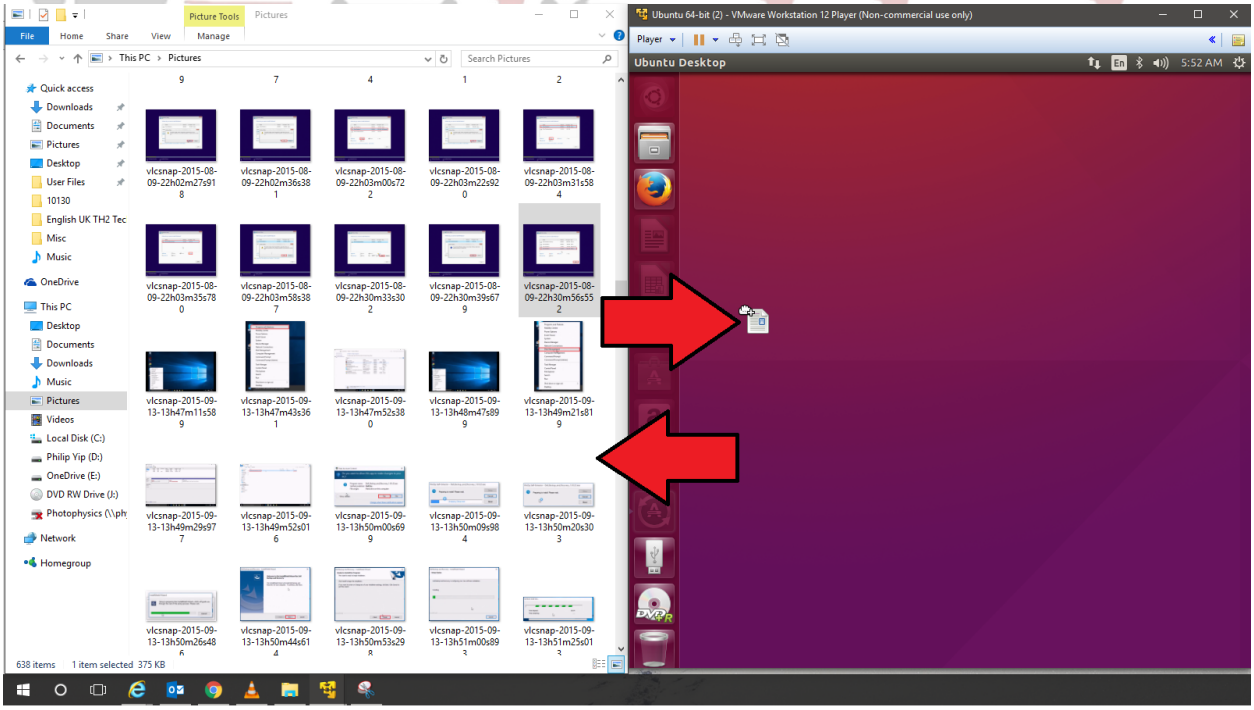
You will be prompted to login again and now it should be full screen:



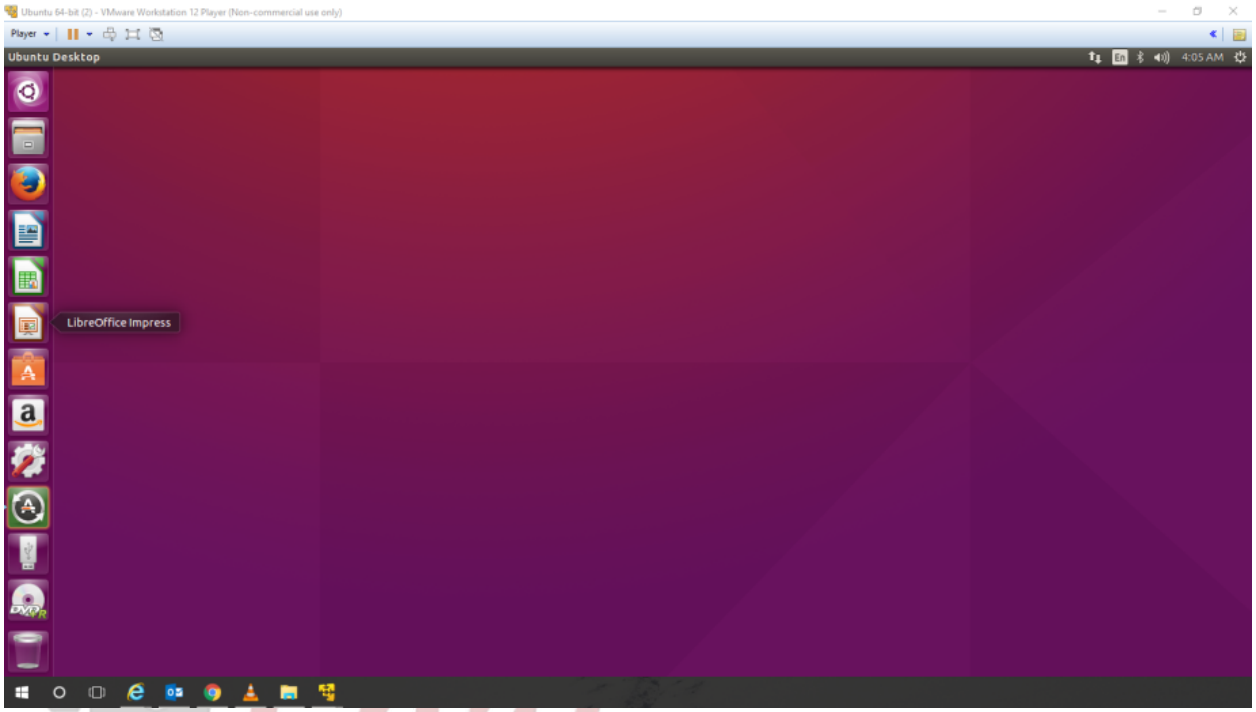
The VM is now full screen if it does not drag and drop the VMWare player Window to the left or right to aero snap half the screen. The VM should automatically resize to fill the Window:



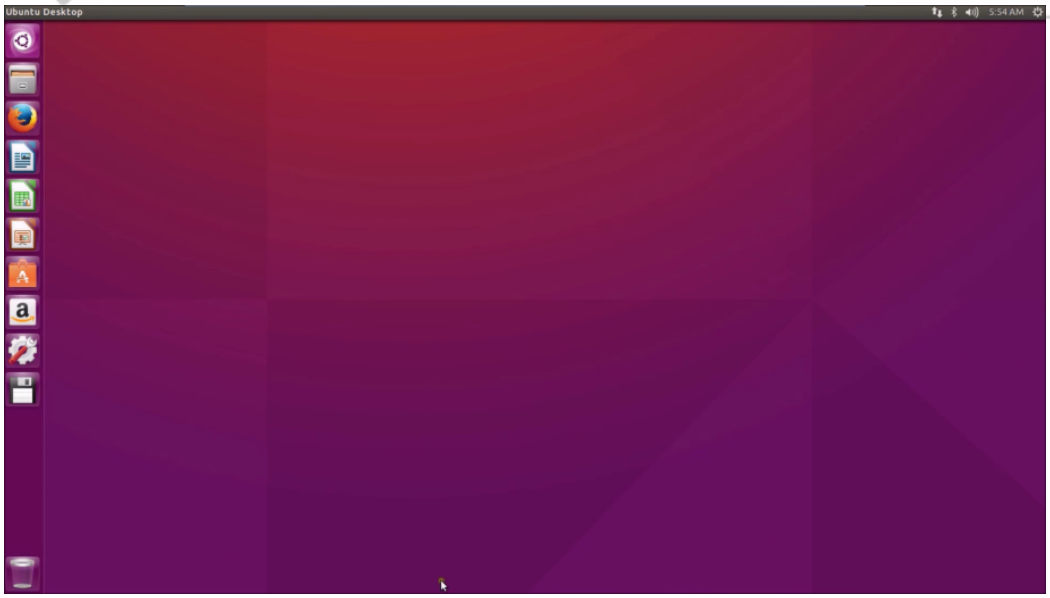
This also allows 2 way drag and drop from the host to the VM:



You can also aero snap it to the top. The VMWare player Window will then be maximized:

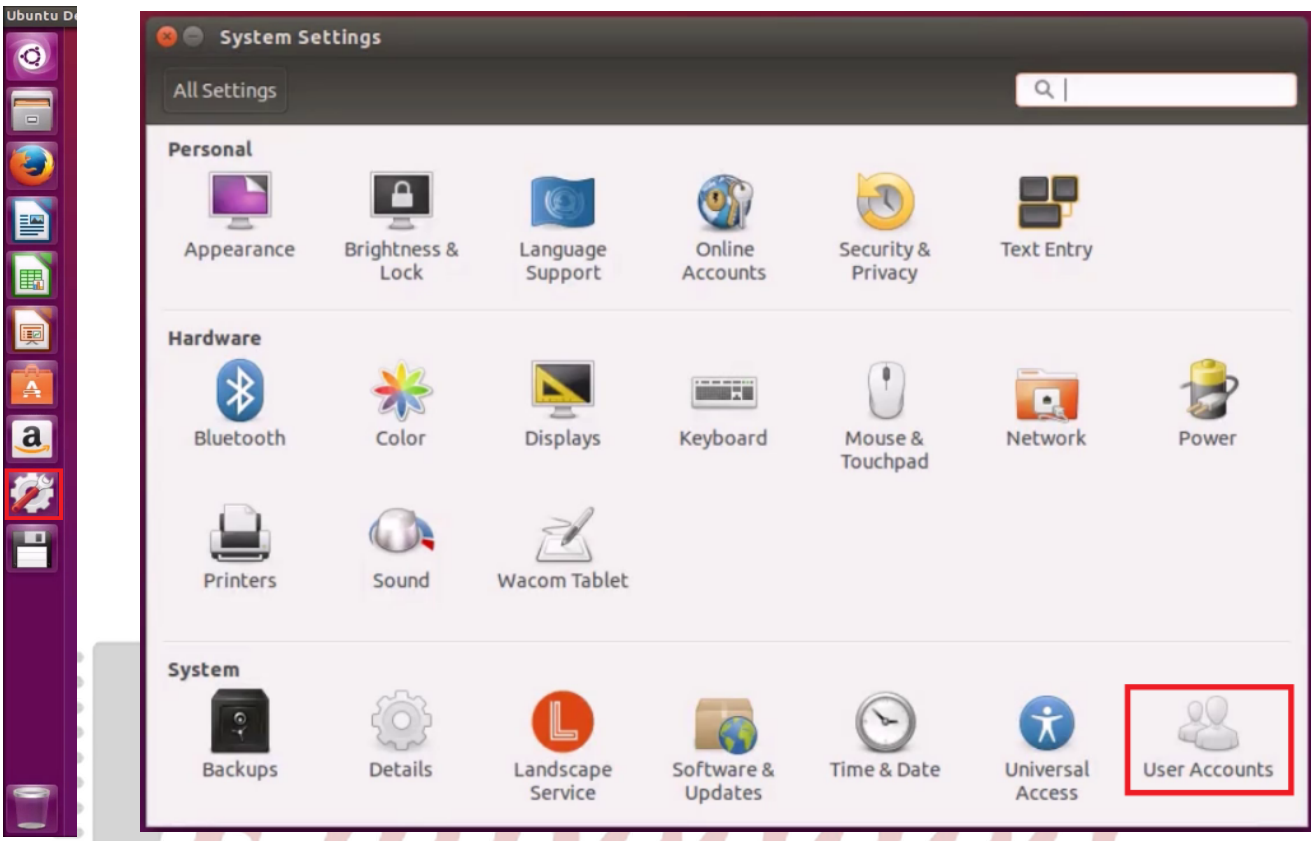


You can also select maximize to occupy the full monitor:

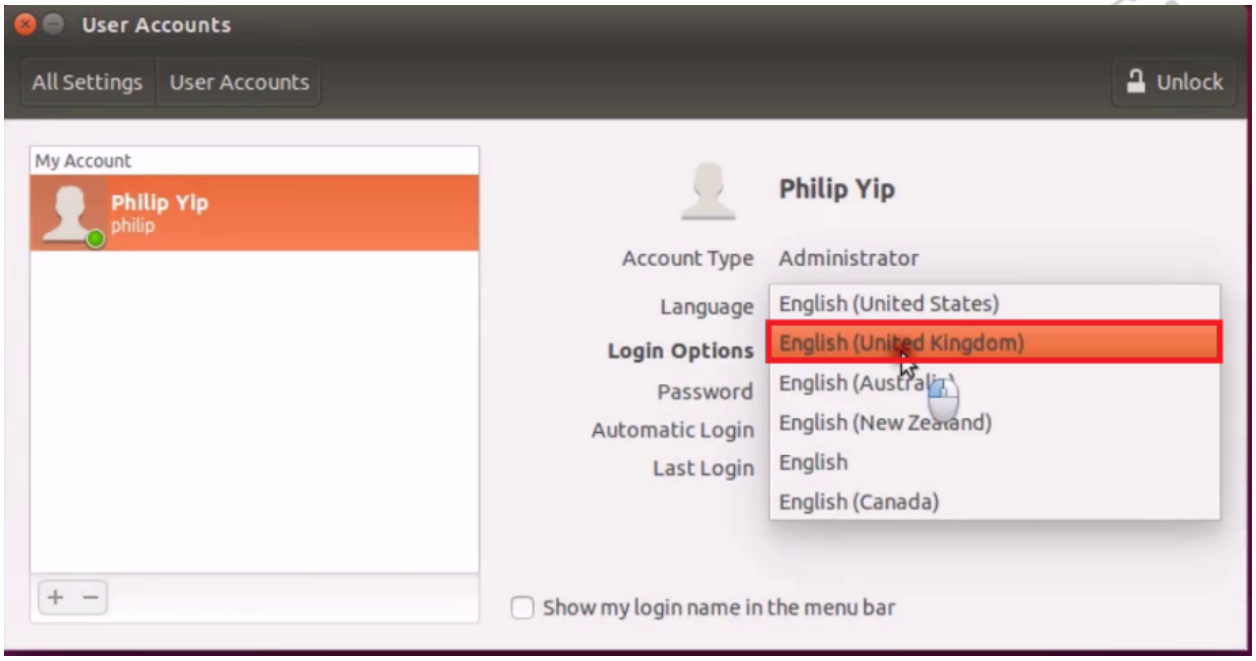


Changing Language and Keyboard

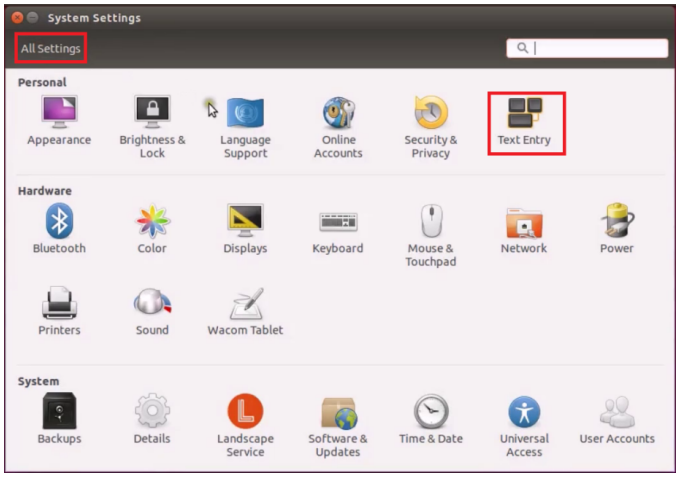
Select the settings crank to the left sidebar and Select User account:



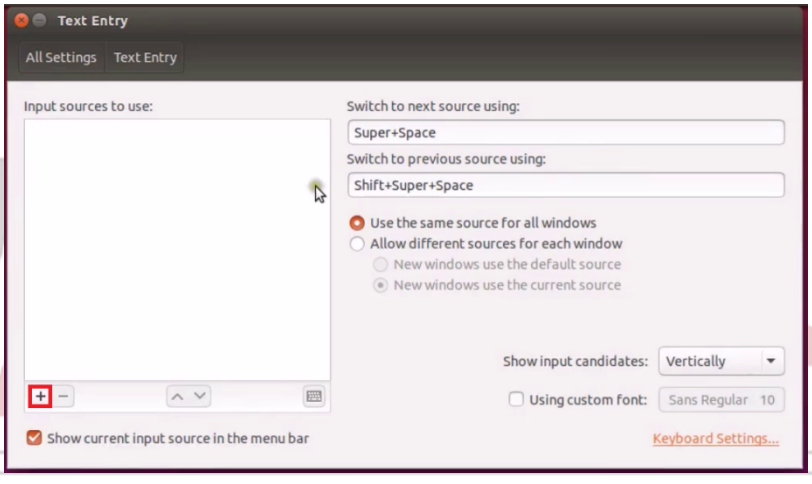
Change language from English (United States) to your desired Language:



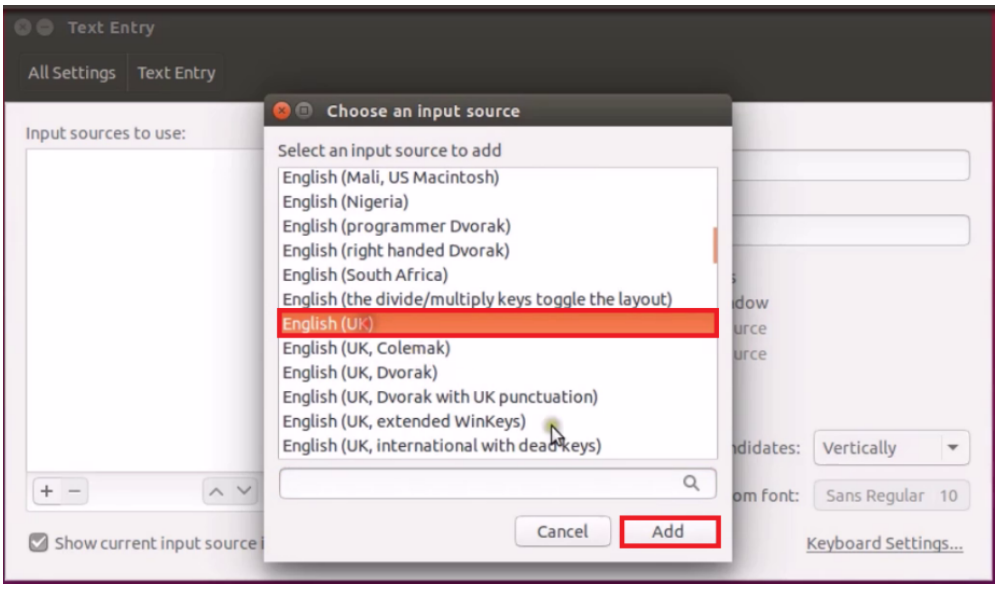
Select All settings and then go to Text Entry:



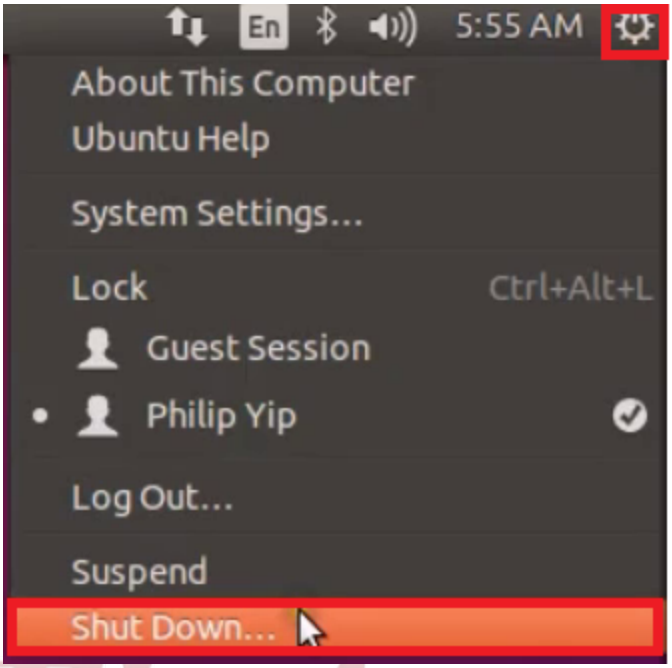
Select [+]



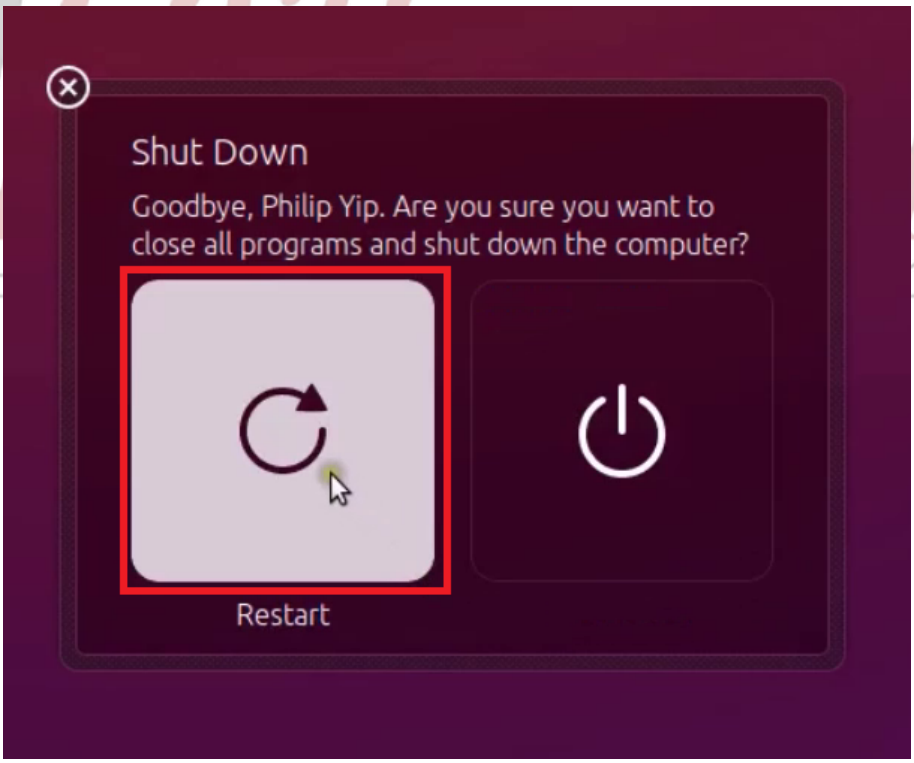
Select English (UK) and then select Add:



Select the power button and then shutdown:



Then restart:



You may now use your Ubuntu VM with your proper keyboard and language settings

Installation of ROS Noetic on Ubuntu

We have 2 methods for install ROS-Noetic are by terminal and synaptic package manager
#Before Install, Let's install useful applications such as Visual Studio and File transfer. It will helpful for programming in Ubuntu

Install Visual Studio for amd64(Work Station)

sudo snap install --classic code

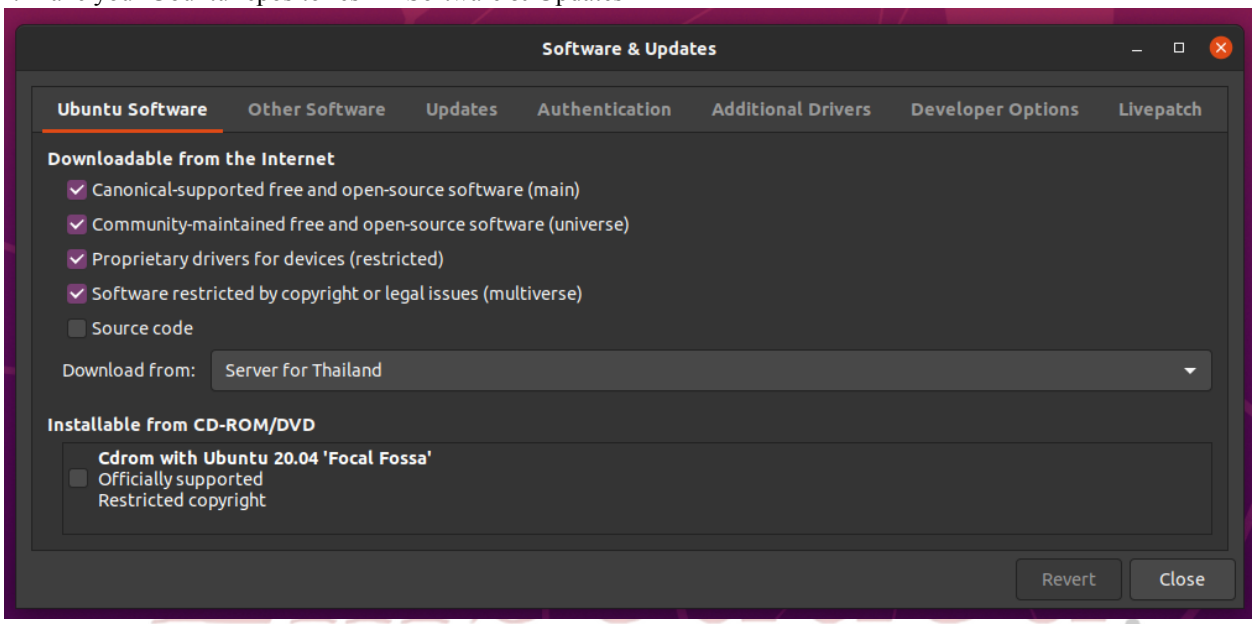
Install File transfers

sudo apt-get install openssh-server openssh-client

So, Let's get started!

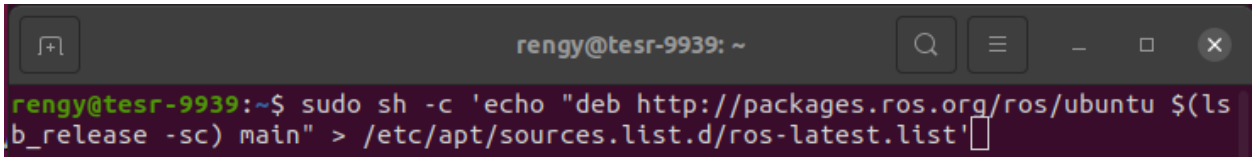
ROS Noetic Terminal method

1. Make your Ubuntu repositories in "Software & Updates"



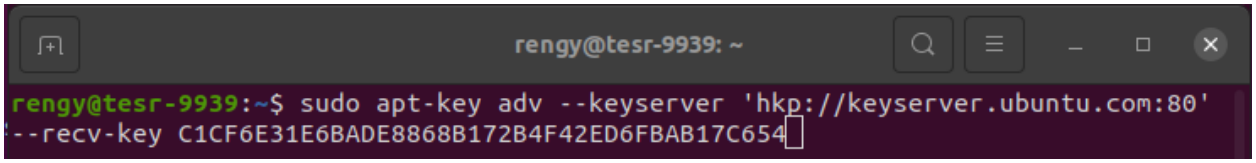
2. Setup your sources.list

sudo sh -c 'echo "deb http://packages.ros.org/ros/ubuntu $(lsb_release -sc) main" > /etc/apt/sources.list.d/ros-latest.list'



3. Setup your keys

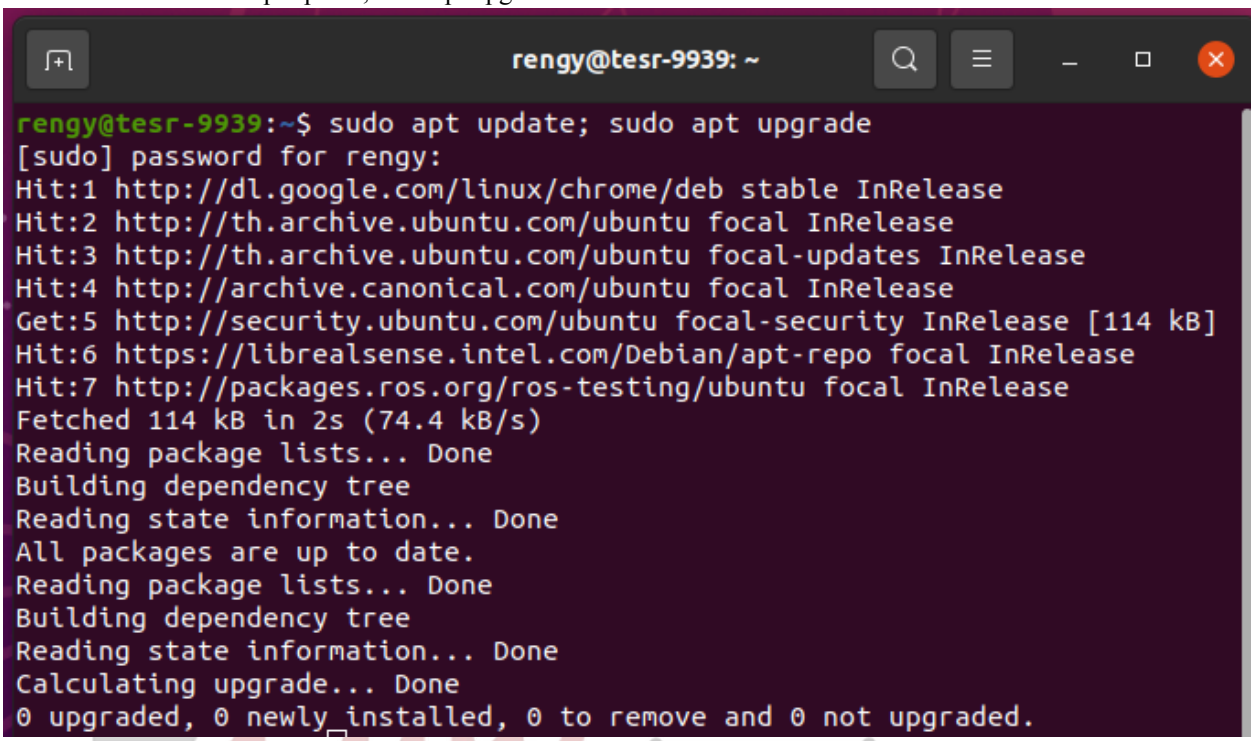
sudo apt-key adv --keyserver 'hkp://keyserver.ubuntu.com:80' --recv-keyC1CF6E31E6BADE8868B172B4F42ED6FBAB17C654



4. Installation

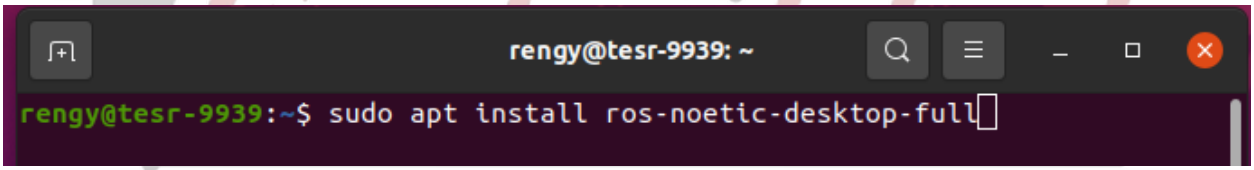
Check software is up to date and upgrade

sudo apt update; sudo apt upgrade



Install ROS desktop-full

sudo apt install ros-noetic-desktop-full



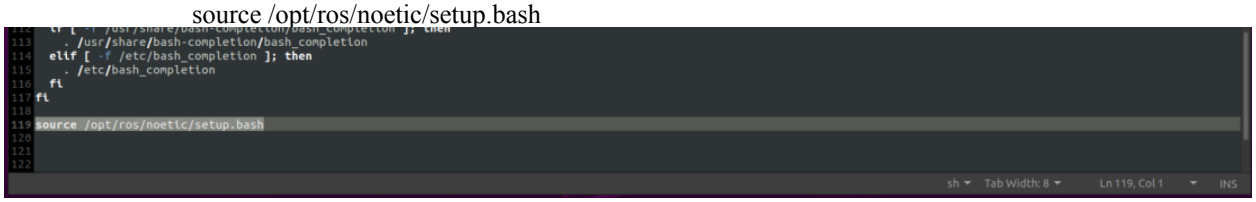
5. Environment setup

Open .bashrc to setup environment by gedit or nano

gedit ~/.bashrc

And then, fill this data to last line of .bashrc

source /opt/ros/noetic/setup.bash



Source .bashrc

source ~/.bashrc

6. Check ROS version

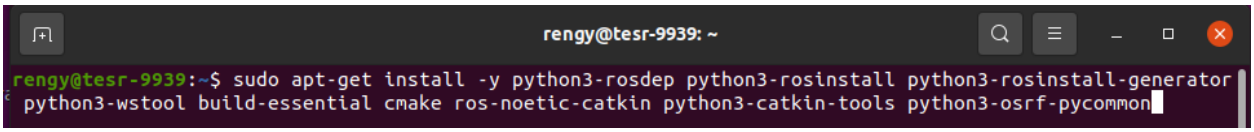
rosversion -d

If your installation is complete and by right version “noetic” will show up

[Optional]

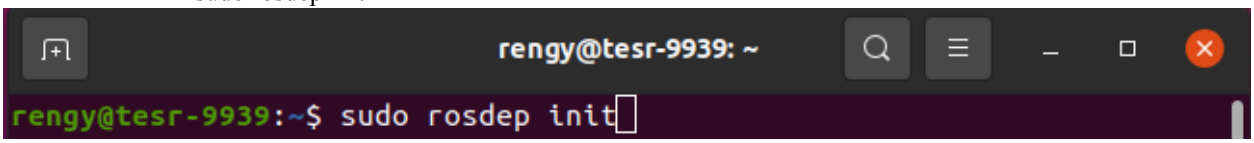
Install dependencies packages for building packages

sudo apt install python3-rosdep python3-rosinstall python3-rosinstall-generator python3-wstool build-essential cmake python3-catkin-tools python3-osrf-pycommon

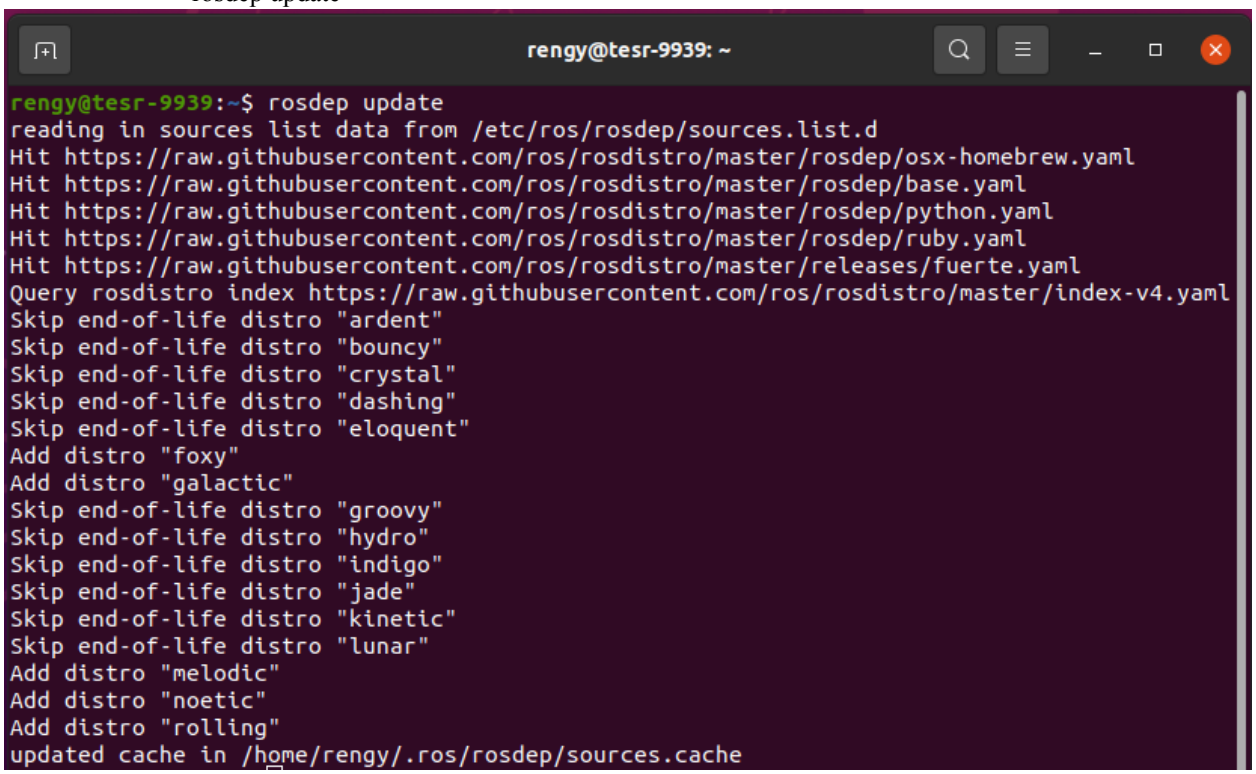


Initialize and update rosdep

sudo rosdep init

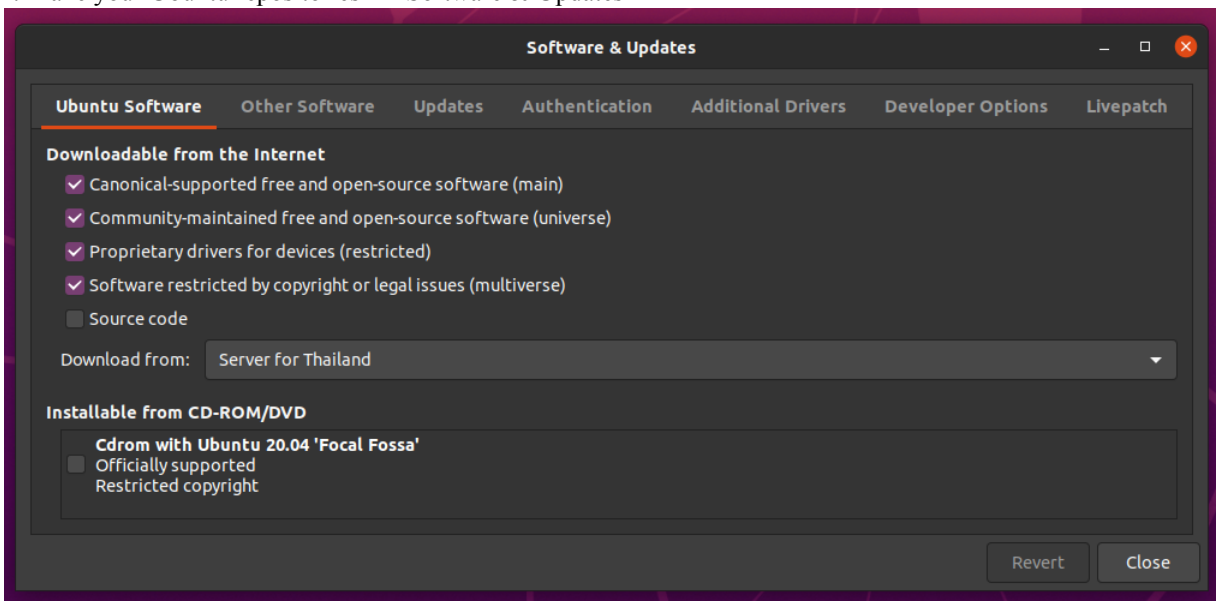


rosdep update



ROS Noetic Synaptic package manager method

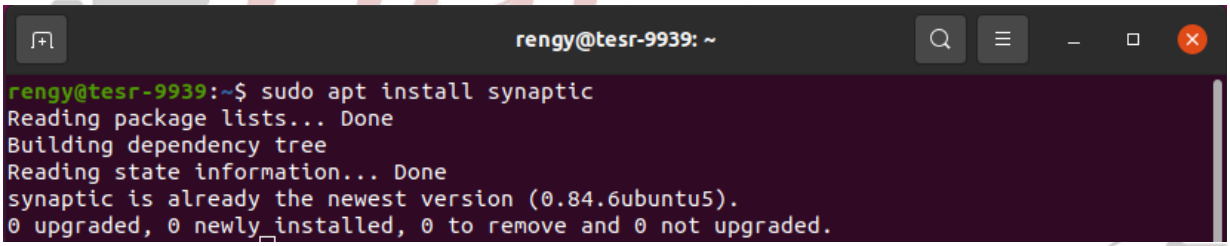
1. Make your Ubuntu repositories in “Software & Updates”



2. Setup Synaptic package manager

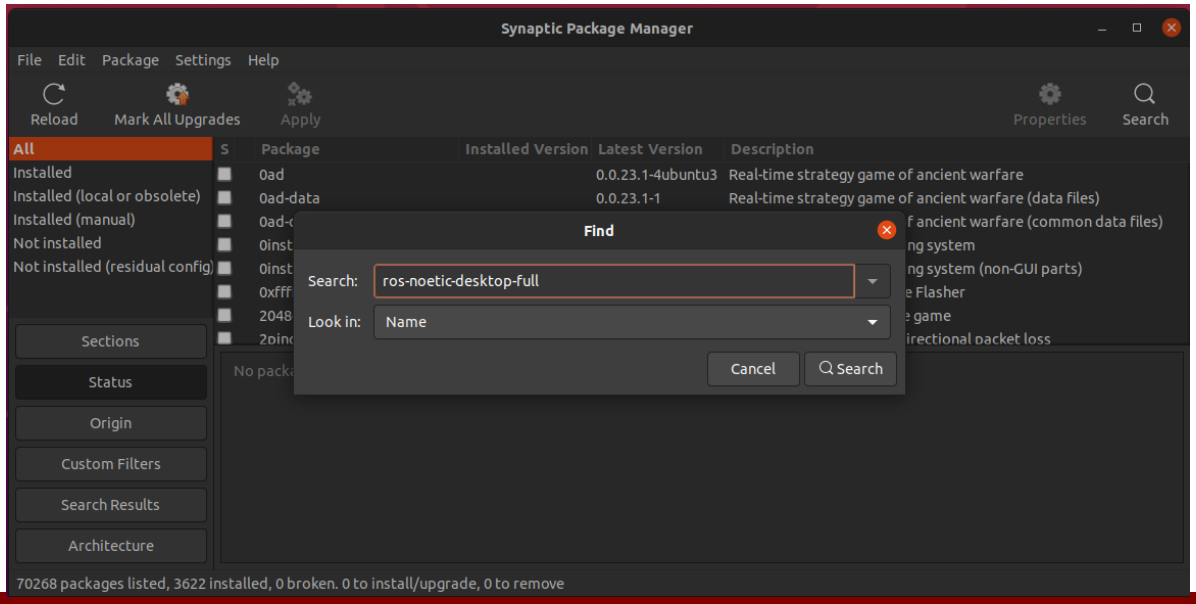
Install “Synaptic package manager”

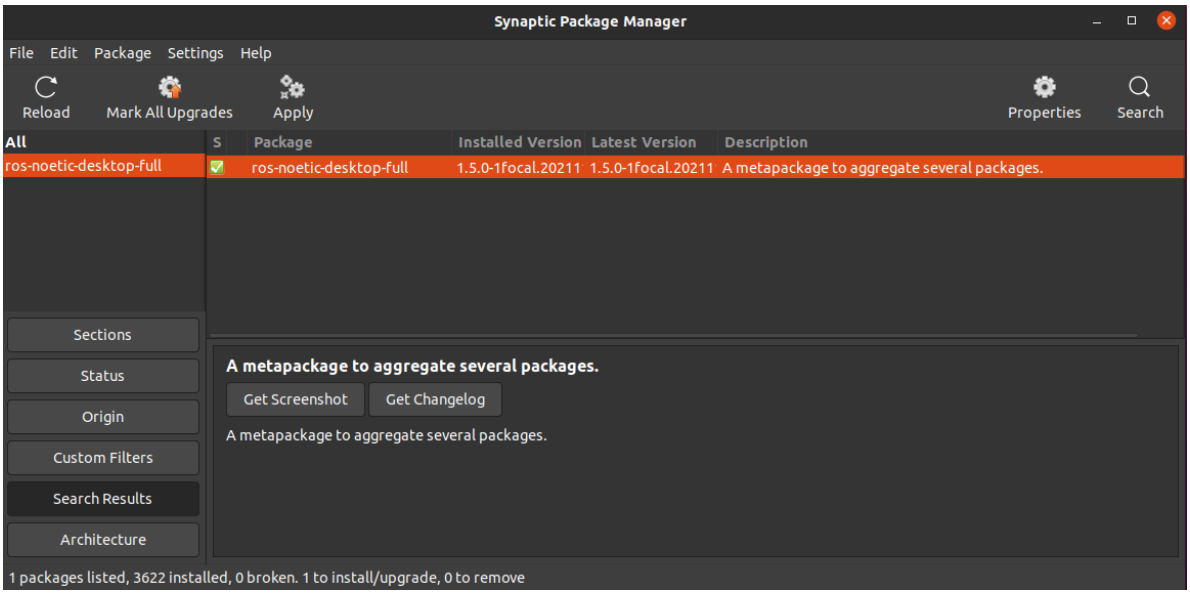
sudo apt synaptic



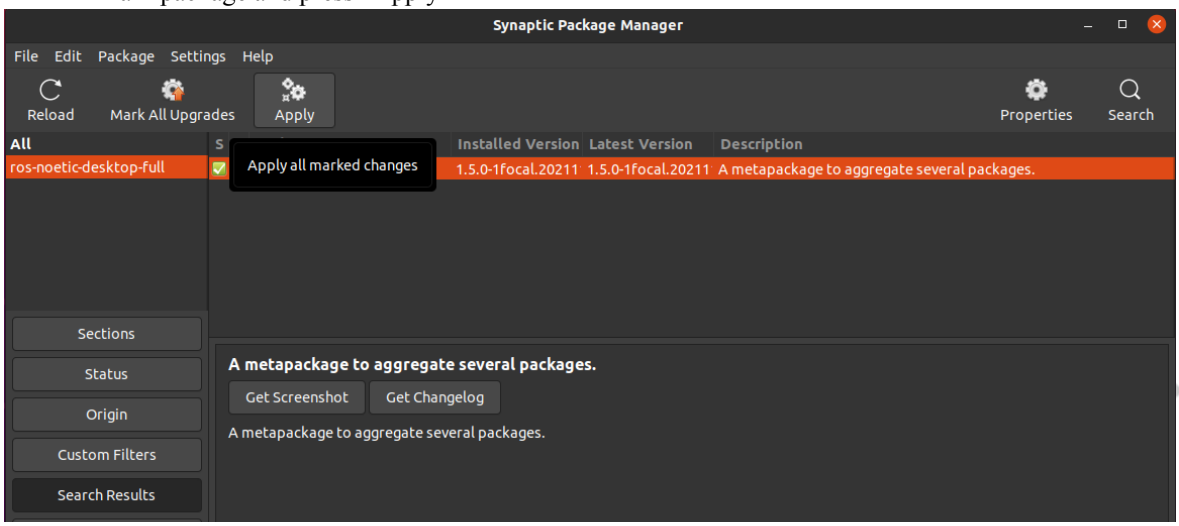
3. Installation

Open Synaptic packages manager and type “ros-noetic-desktop-full” to search box and mark for installation.





Mark package and press “Apply”



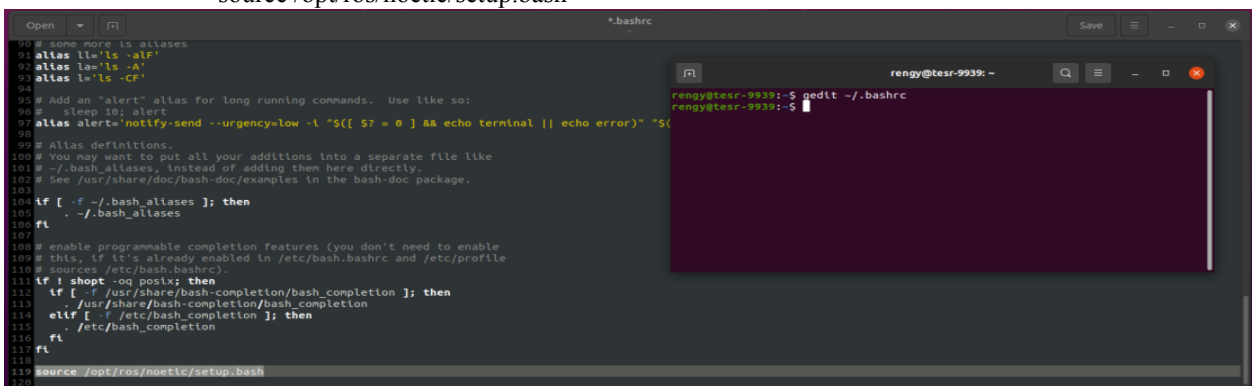
4. Environment setup

Open .bashrc to setup environment by gedit or nano

```
gedit ~/.bashrc
```

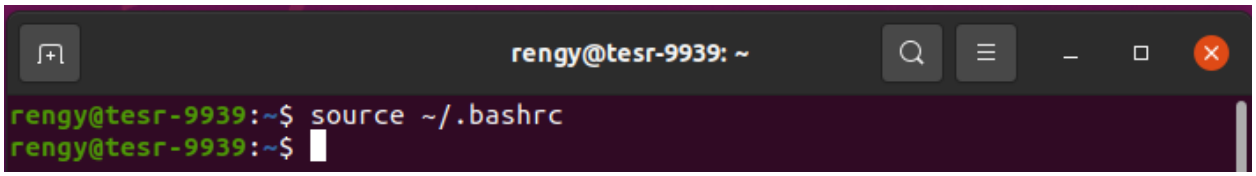
And then, fill this data to last line of .bashrc

```
source /opt/ros/noetic/setup.bash
```



Source .bashrc

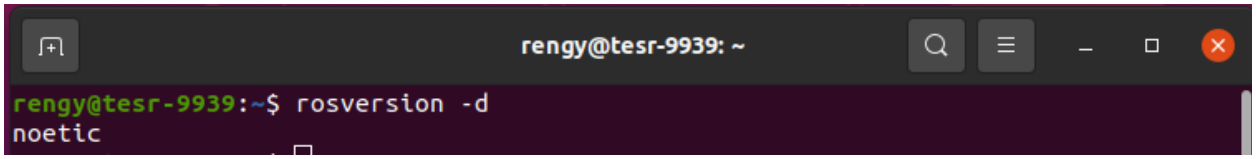
source ~/.bashrc



5. Check ROS version

If your installation is complete and by right version “noetic” will show up

rosversion -d

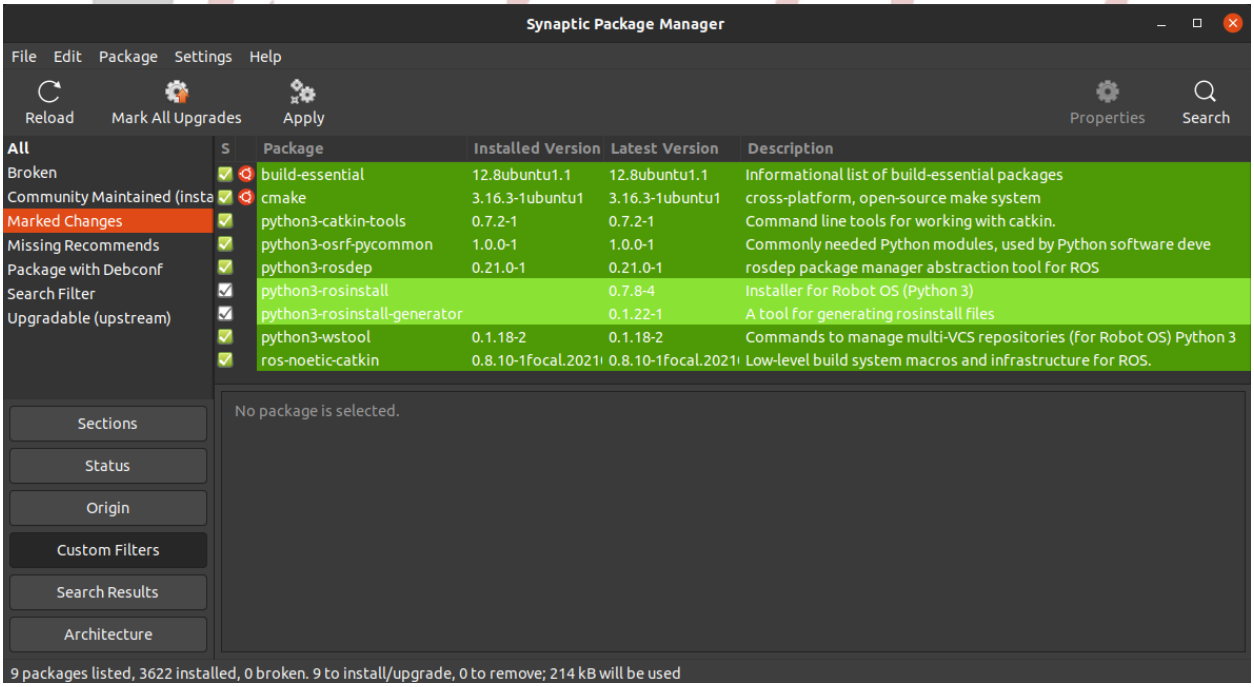


[Optional]

Install dependencies packages for building packages. Type this list in search box and mark it to installation

python3-rosdep
python3-rosinstall
python3-rosinstall-generator
Python3-wstool
Build-essential
Cmake
ros-noetic-catkin
python3-catkin-tools
python3-osrf-pycommon

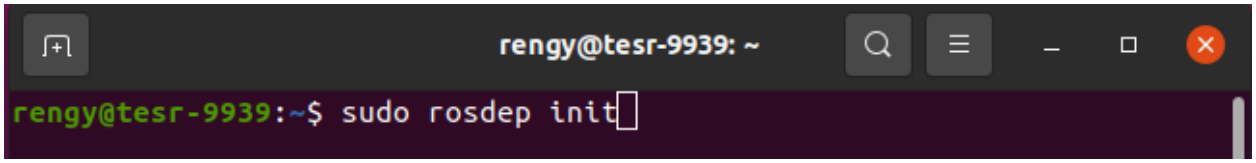
* You can see marked list at “Custom Filter > Marked Changes”



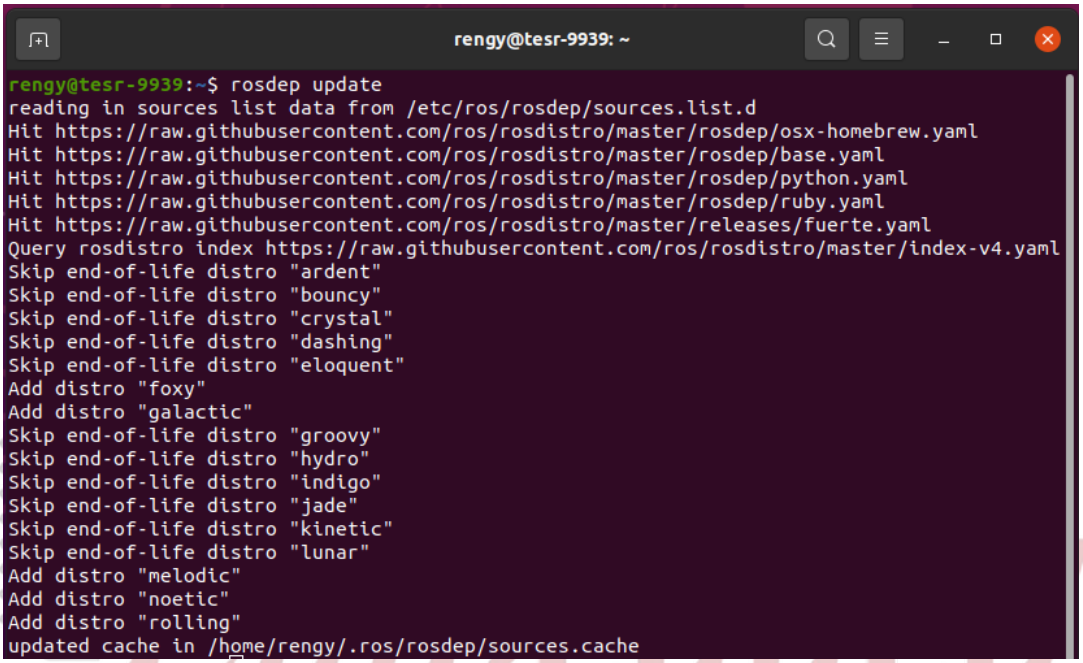
Initialize and update rosdep

Open terminal and initialize rosdep

sudo rosdep init



rosdep update



Install Dependent ROS Packages

Run command line following below:

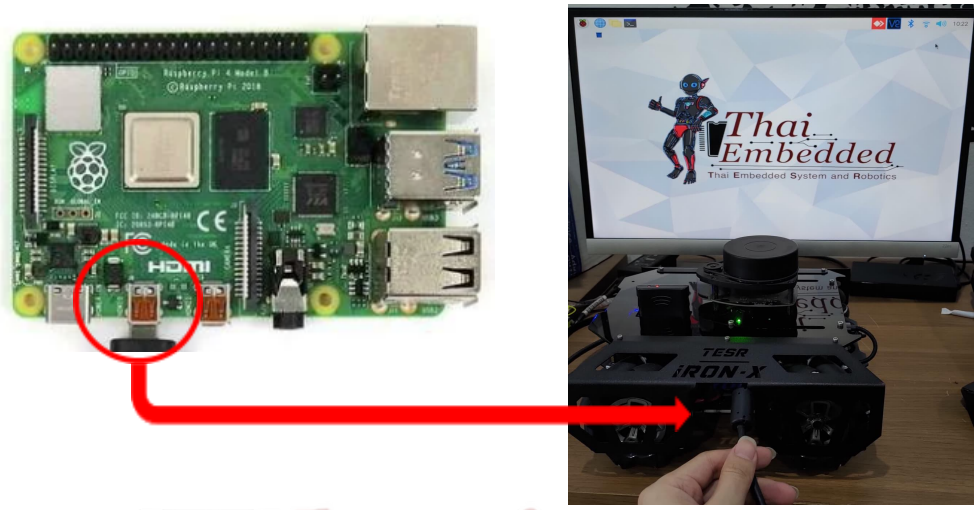
sudo apt-get install ros-noetic-joy ros-noetic-teleop-twist-joy \
ros-noetic-teleop-twist-keyboard ros-noetic-laser-proc \
ros-noetic-rgbd-launch ros-noetic-rosserial-arduino \
ros-noetic-rosserial-python ros-noetic-rosserial-client \
ros-noetic-rosserial-msgs ros-noetic-amcl ros-noetic-map-server \
ros-noetic-move-base ros-noetic-urdf ros-noetic-xacro \
ros-noetic-compressed-image-transport ros-noetic-rqt* ros-noetic-rviz \
ros-noetic-gmapping ros-noetic-navigation ros-noetic-interactive-markers

```
rengy@tesr-9939:~$ sudo apt-get install ros-noetic-joy ros-noetic-teleop-twist-joy \
>   ros-noetic-teleop-twist-keyboard ros-noetic-laser-proc \
>   ros-noetic-rgbd-launch ros-noetic-rosserial-arduino \
>   ros-noetic-rosserial-python ros-noetic-rosserial-client \
>   ros-noetic-rosserial-msgs ros-noetic-amcl ros-noetic-map-server \
>   ros-noetic-move-base ros-noetic-urdf ros-noetic-xacro \
>   ros-noetic-compressed-image-transport ros-noetic-rqt* ros-noetic-rviz \
>   ros-noetic-gmapping ros-noetic-navigation ros-noetic-interactive-markers
[sudo] password for rengy:
```

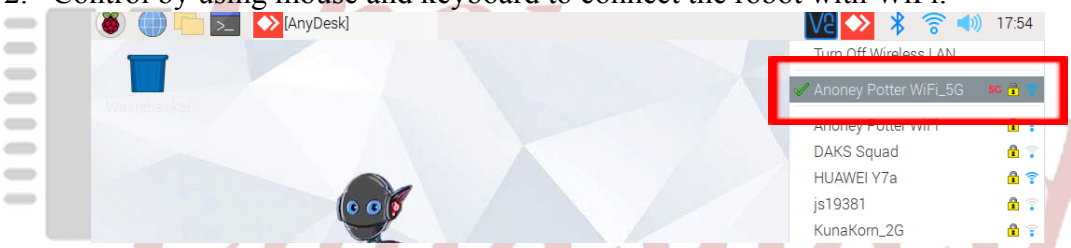
iron-X Setup

Step 1 Check the iron-X's IP(Desktop mode) for the first time setup.

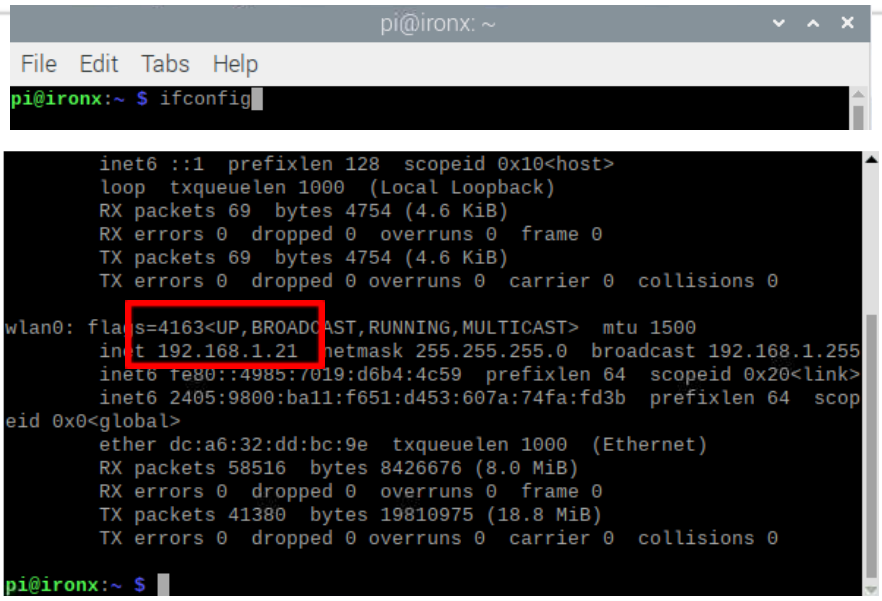
1. Connect your robot to the monitoring screen by Micro HDMI wire.



2. Control by using mouse and keyboard to connect the robot with WiFi.



3. Open terminal and then type **"ifconfig"** to get the iron-X's IP.



(In this case, iron-X's IP is 192.168.1.21)

Step 2 Access iron-X's terminal

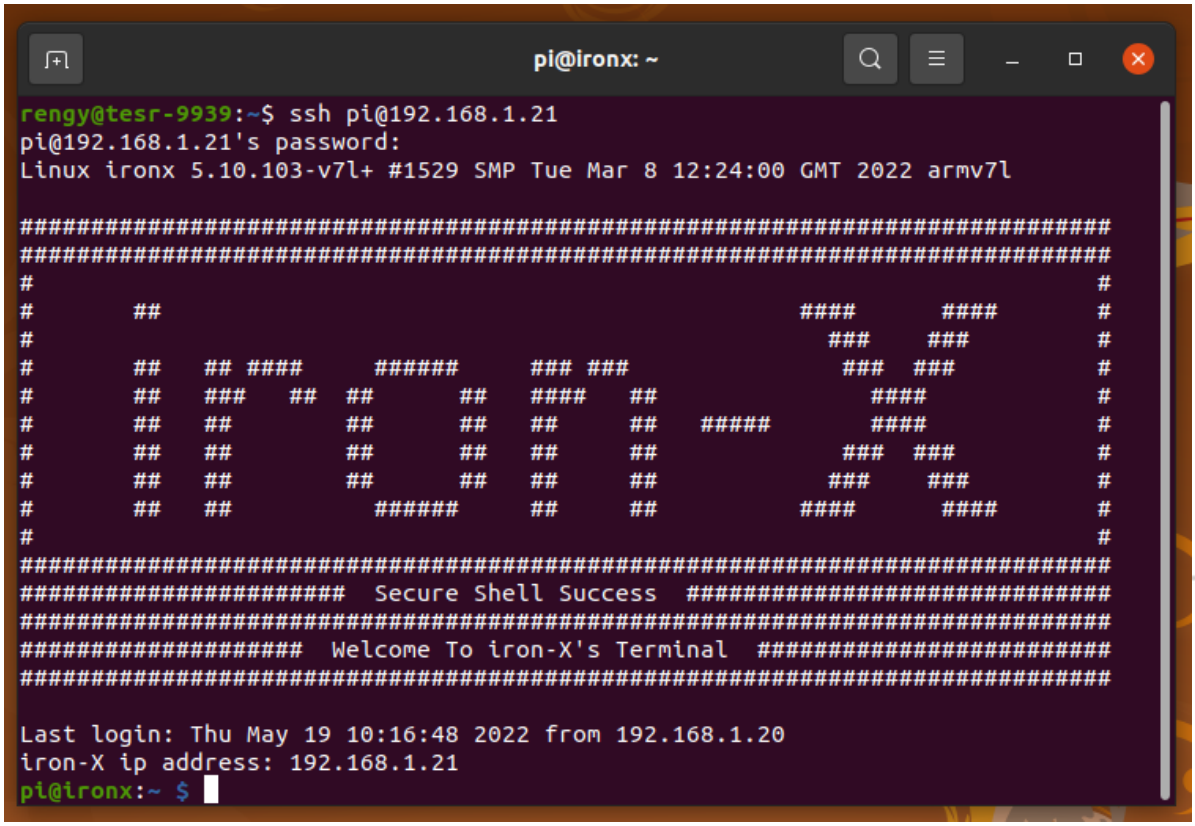
To Access iron-X's terminal we can do 2 methods following as:

- Terminal Mode
- Remote Desktop Mode

(Terminal Mode)

Secure shell to iron-X. *Connect you PC and Robot to the same local network.

1. Open Command Prompt or Terminal on your PC. Type "ssh pi@192.168.1.21".
2. After that, It will ask for password. So, type "ironxtesr".
3. Now, you will access to remote iron-X on your PC/Laptop.

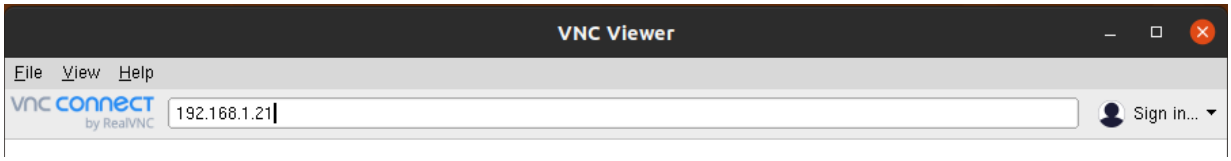


(Remote Desktop Mode)

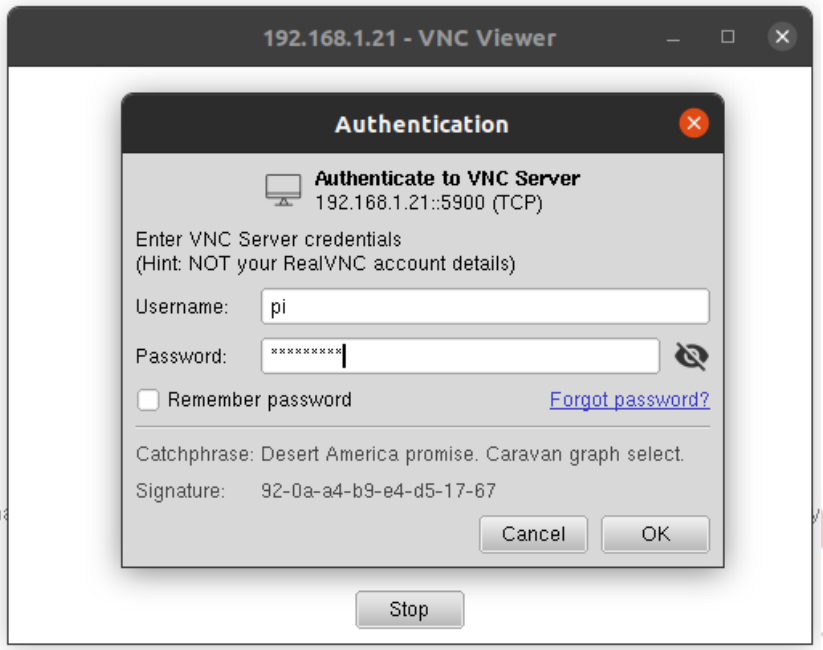
Access to iron-X's desktop by using VNC Viewer. (Local network)

***Your PC/Laptop and iron-X must to connect on the same local network.**

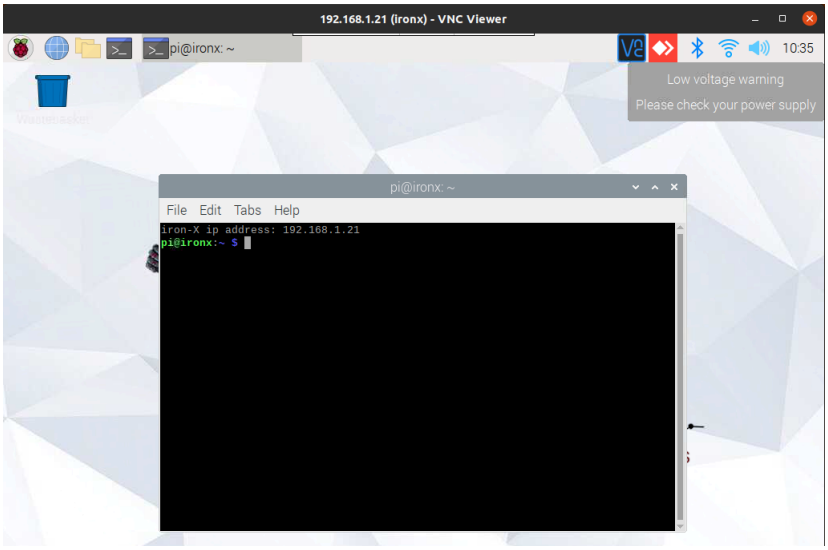
1. Open VNC Viewer and type "192.168.1.21"



2. Press Enter and fill Username "pi" and Password "ironxtesr"



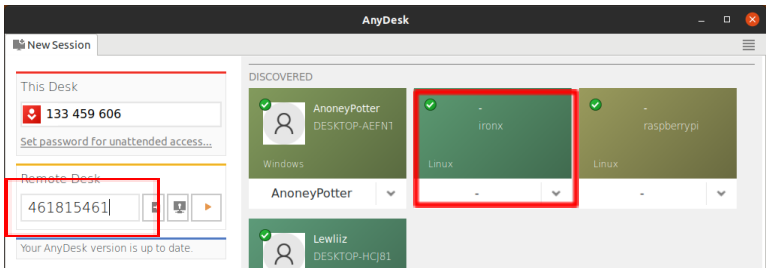
3. Open terminal by click at the Terminal's icon. So, we're finishes.



(Remote Desktop Mode)

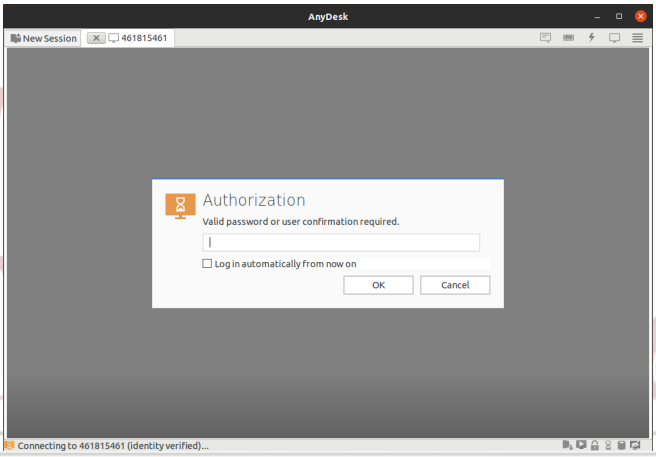
Access to iron-X's desktop by using AnyDesk. (Internet)

1. To use AnyDesk you must to know the Desk code or you can access from DISCOVERED Desk following as picture:

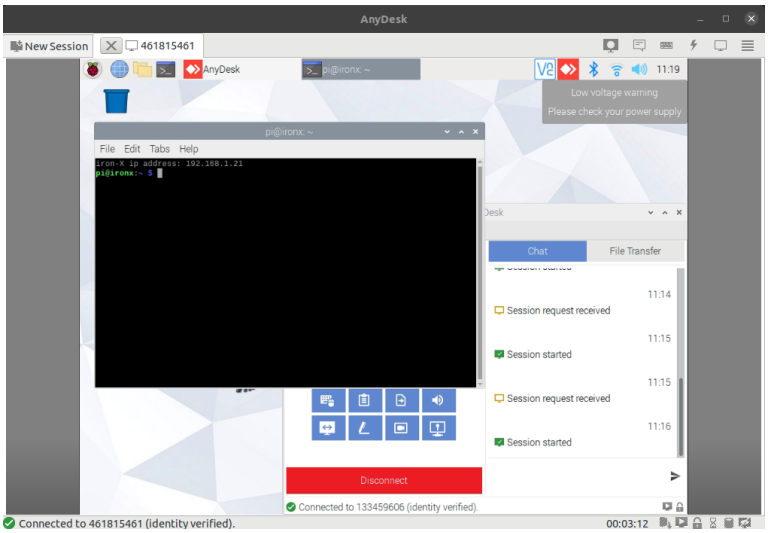


*The desk from DISCOVERED may not pop-up. In that case, you must connect micro HDMI with iron-X's pi to get the Desk code from "This Desk" of iron-X's AnyDesk Screen.

2. Fill the password "ironxtesr112296" And press OK..



3. Open terminal by click at the Terminal's icon. So, we're finishes.



Step 3 Setup ROS-IP's configuration in file .bashrc on PC/Laptop and iron-X.

On PC/Laptop we will check for IP and use it as Master's IP.

(In this case, PC's IP is 192.168.1.20)

```
rengy@tesr-9939:~$ ifconfig
enp2s0: flags=4099<UP,BROADCAST,MULTICAST>  mtu 1500
        ether 04:42:1a:88:d7:a4  txqueuelen 1000  (Ethernet)
        RX packets 0  bytes 0 (0.0 B)
        RX errors 0  dropped 0  overruns 0  frame 0
        TX packets 0  bytes 0 (0.0 B)
        TX errors 0  dropped 0 overruns 0  carrier 0  collisions 0

lo: flags=73<UP,LOOPBACK,RUNNING>  mtu 65536
        inet 127.0.0.1  netmask 255.0.0.0
        inet6 ::1  prefixlen 128  scopeid 0x10<host>
        loop  txqueuelen 1000  (Local Loopback)
        RX packets 5546  bytes 516037 (516.0 KB)
        RX errors 0  dropped 0  overruns 0  frame 0
        TX packets 5546  bytes 516037 (516.0 KB)
        TX errors 0  dropped 0 overruns 0  carrier 0  collisions 0

wlp3s0: flags=4163<UP,BROADCAST,RUNNING,MULTICAST>  mtu 1500
        inet 192.168.1.20  netmask 255.255.255.0  broadcast 192.168.1.255
        inet6 fe80::2ad2:1bee:34d7:e693  prefixlen 64  scopeid 0x20<link>
        inet6 2405:9800:ba11:f651:b531:6539:c9db:39a0  prefixlen 64  scopeid 0x0<global>
        inet6 2405:9800:ba11:f651:7b29:a6a2:4215:8a55  prefixlen 64  scopeid 0x0<global>
```

Setup Master's IP config to use PC/Laptop as Server. **(PC/Laptop's Terminal)**

Type "sudo nano ~/.bashrc"

```
rengy@tesr-9939:~$ sudo nano ~/.bashrc
```

Write in last line of the .bashrc following as:

"export ROS_MASTER_URI=http://192.168.1.20:11311"

"export ROS_HOSTNAME=192.168.1.20"

"export ROS_IP=192.168.1.20"

```
 GNU nano 4.8                    /home/rengy/.bashrc                 Modified

# enable programmable completion features (you don't need to enable
# this, if it's already enabled in /etc/bash.bashrc and /etc/profile
# sources /etc/bash.bashrc).
if ! shopt -oq posix; then
  if [ -f /usr/share/bash-completion/bash_completion ]; then
    . /usr/share/bash-completion/bash_completion
  elif [ -f /etc/bash_completion ]; then
    . /etc/bash_completion
  fi
fi

source /opt/ros/noetic/setup.bash
source ~/catkin_ws/devel/setup.bash
source ~/ws_moveit/devel/setup.bash
source ~/cartographer_ws/devel_isolated/setup.bash
source ~/kobuki_ws/devel/setup.bash

#ROS-IP's configuration:
export ROS_MASTER_URI=http://192.168.1.20:11311
export ROS_HOSTNAME=192.168.1.20
export ROS_IP=192.168.1.20

^G Get Help  ^O Write Out  ^W Where Is  ^K Cut Text  ^J Justify  ^C Cur Pos
^X Exit      ^R Read File  ^\ Replace   ^U Paste Text ^T To Spell  ^_ Go To Line
```

Save by Press "Ctrl+o" and then Enter to confirm and then "Ctrl+x" to exit from nano

After that, type "source .bashrc".

```
rengy@tesr-9939:~$ sudo nano ~/.bashrc
[sudo] password for rengy:
rengy@tesr-9939:~$ source .bashrc
rengy@tesr-9939:~$
```

On iron-X's setup ROS-IP's configuration to Subscriber to Master.

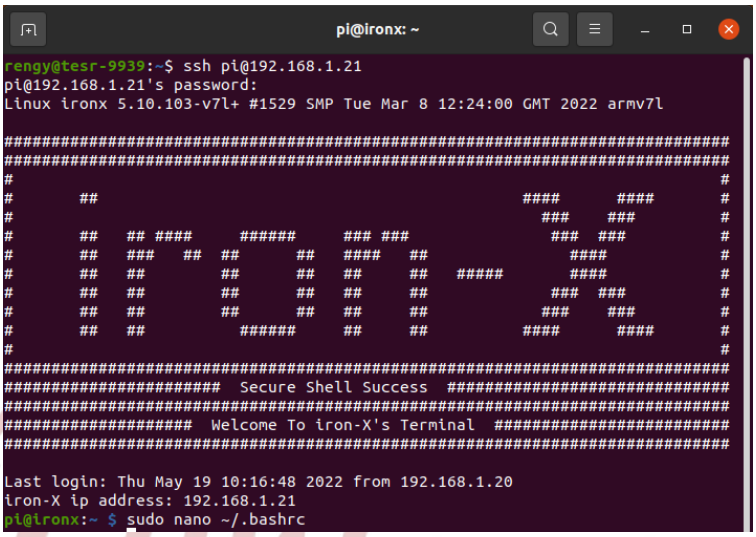
***Keep that in mind, using robot's IP refer with the check the iron-X's IP topic part.**

Terminal mode

(In this case, iron-X's IP is 192.168.1.21)

Type "ssh pi@192.168.1.21"

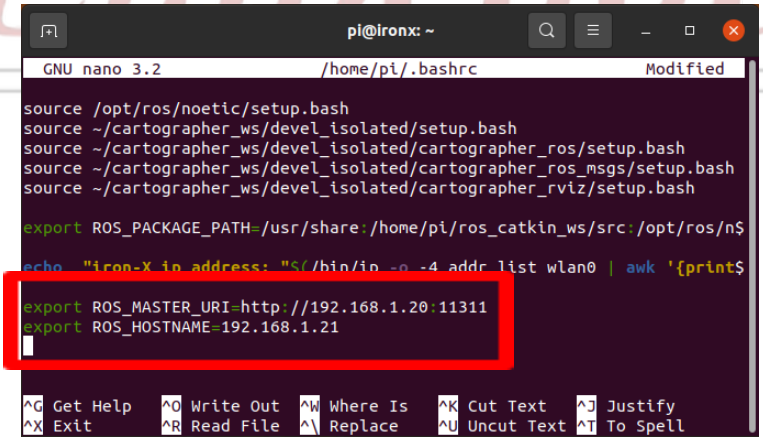
Type "sudo nano ~/.bashrc"



Write in last line of the .bashrc following as:

"export ROS_MASTER_URI=http://192.168.1.20:11311"

"export ROS_HOSTNAME=192.168.1.21"

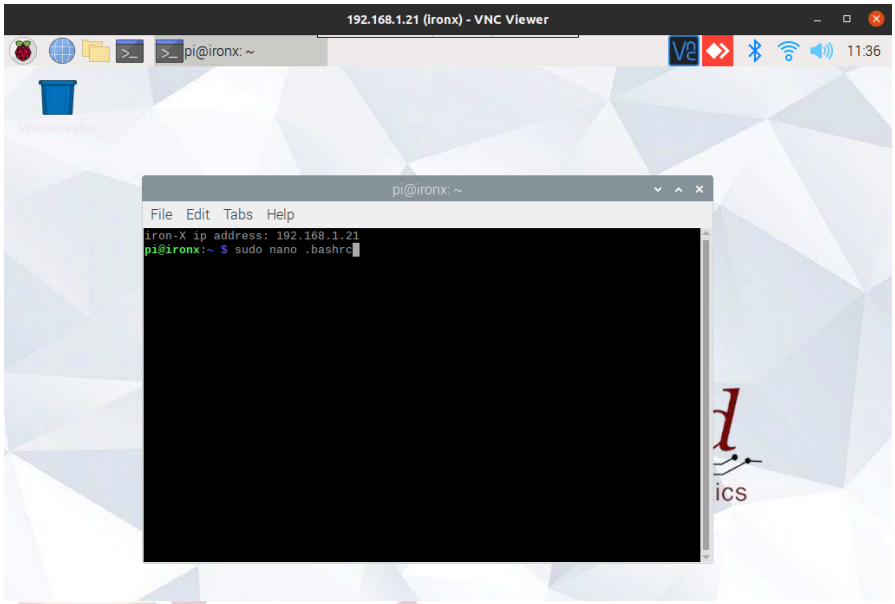


Save by Press "Ctrl+o" and then Enter to confirm and then "Ctrl+x" to exit from nano

After that, type "source .bashrc".

Remote Desktop mode

Type “sudo nano ~/.bashrc”

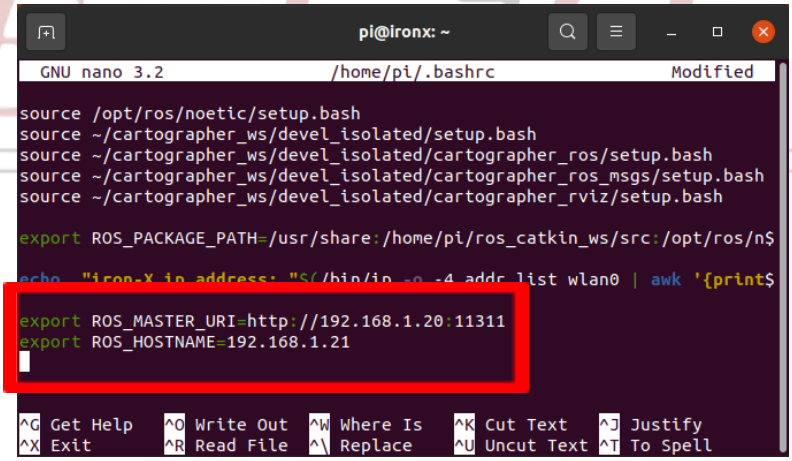


Write in last line of the .bashrc following as:

"export ROS_MASTER_URI=http://192.168.1.20:11311"

"export ROS_HOSTNAME=192.168.1.21"

(In this case, iron-X’s IP is 192.168.1.21)



Save by Press "Ctrl+o" and then Enter to confirm and then "Ctrl+x" to exit from nano

After that, type "source .bashrc".

Basic Files Transfer to iron-X.

WinSCP [Recommended]

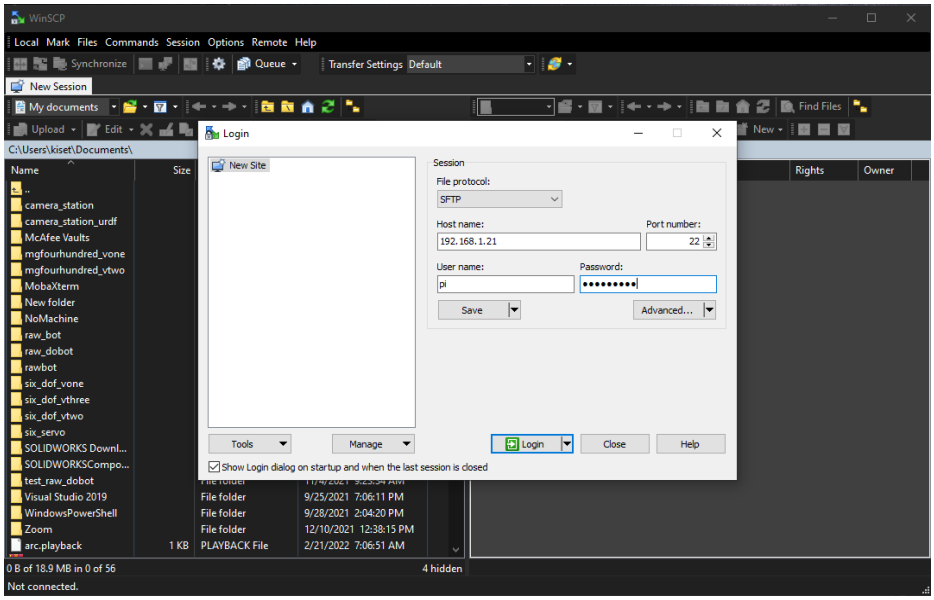
*WinSCP is available for Window OS only if you using Linux OS you must use Anydesk or VNC Viewer method instead.

Download and Install WinSCP

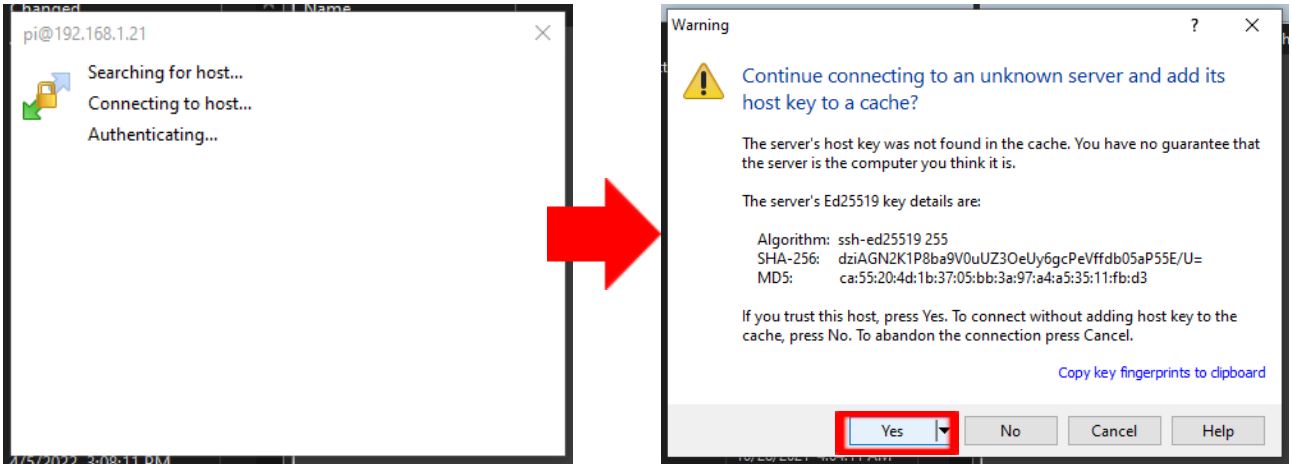
https://winscp.net/eng/downloads.php

Open WinSCP and fill IP, Username and Password

(In this case, IP = 192.168.1.21, Username: pi , Password: ironxtesr)

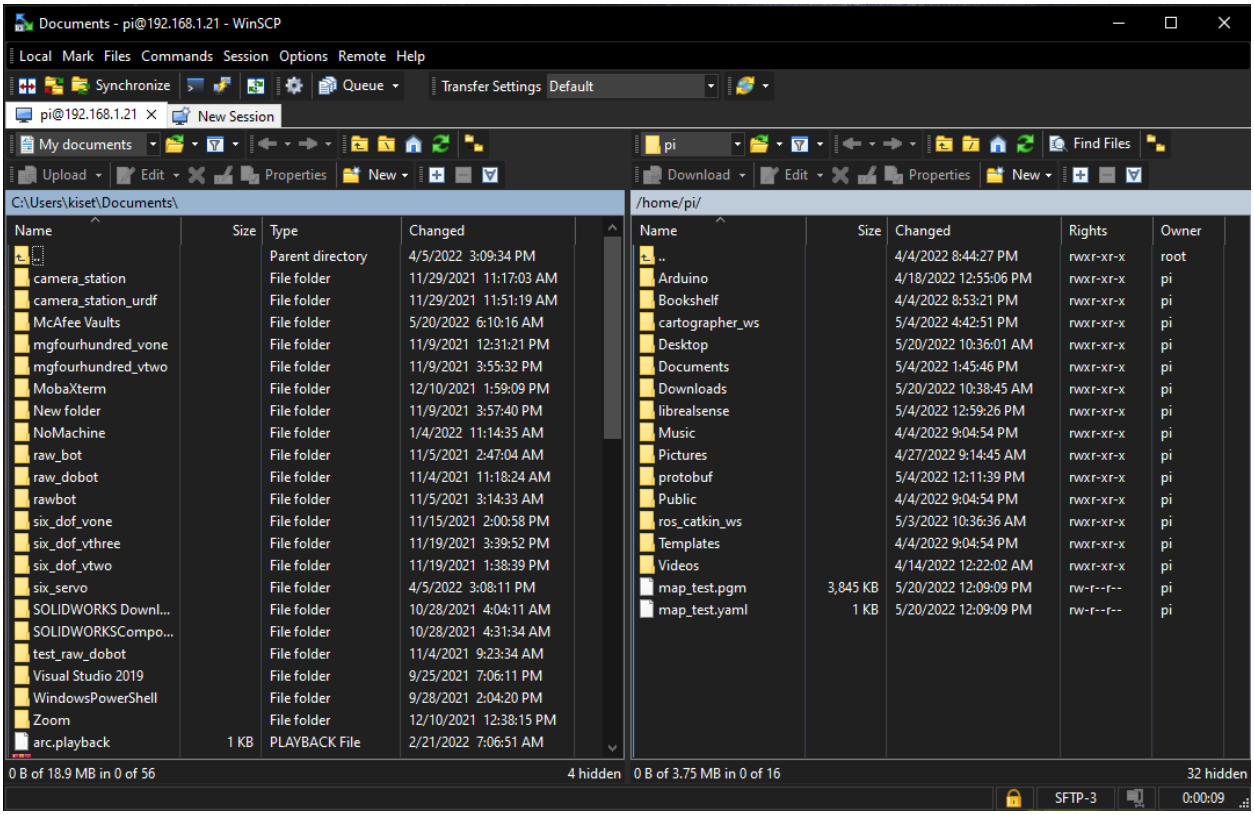


Wait for Authentication and Press “Yes” to confirm to add host key to a cache.



Now, you can transfer file from PC/Laptop to iron-X by Drag and Drop

(Left panel’s PC/Laptop and Right panel’s iron-X)

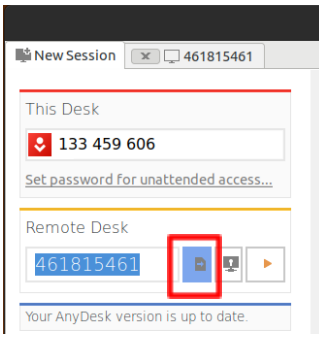


(Desktop mode)

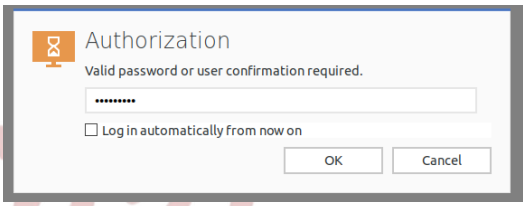
Remote iron-X through Desktop mode by Anydesk or VNC Viewer

Transfer file using Anydesk

Open Anydesk and Select iron-X's desk and click at file transfer icon.

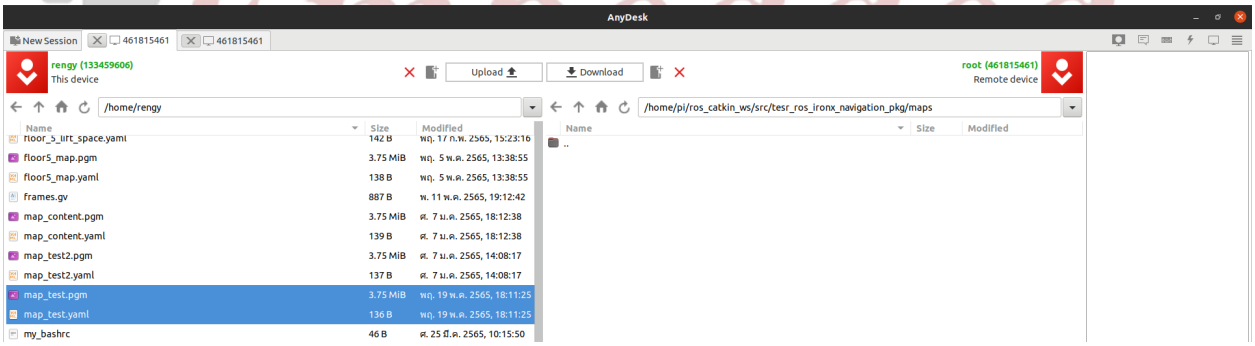


Fill the valid Password "ironxtesr112296" and Click "OK"

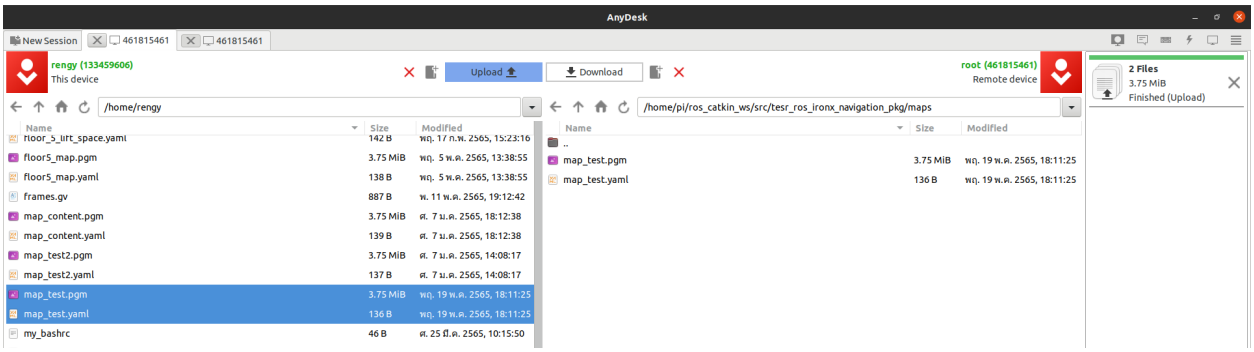


AnyDesk's File Transfer panel will show up. So, you can select file (left panel) and select File path (right panel) Then, click "Upload".

(In this case, select map_test.pgm and map_test.yaml)



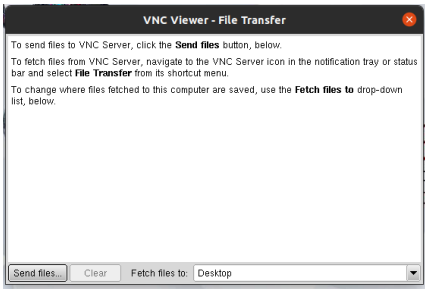
After "Finished(Upload)" pop-up that mean file transfer is completed.



Transfer file using VNC Viewer

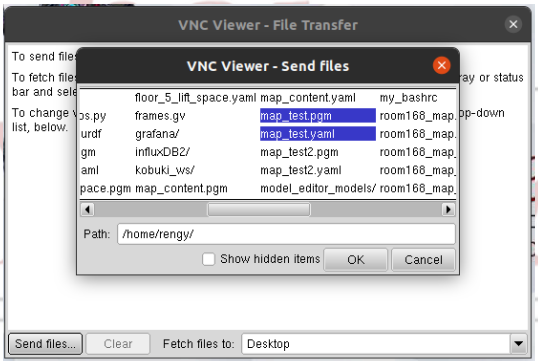
Open and Connect VNC Viewer to iron-X. And then, move cursor around the top-middle of VNC Viewer. The Tools bar is show up and then click at “Transfer Files” icon.

VNC Viewer - File Transfer will show up and then click “Send files…”



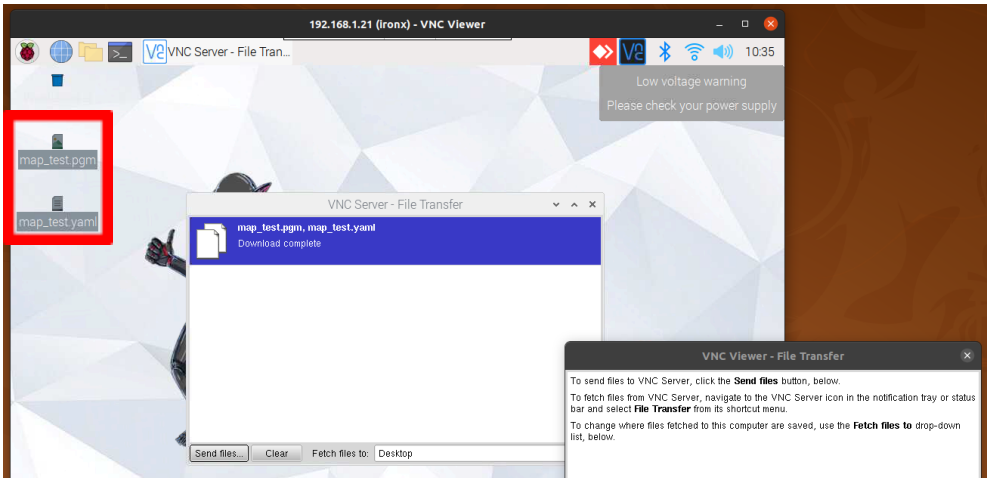
Select file you’re prefer to transfer and click “OK”

(In this case, select map_test.pgm and map_test.yaml)



After that, VNC Server will pop-up and Show “Download Complete”

So, both of the map_file will show on iron-X’s Desktop.



How to launch iron-X ROS package

Package lists (In iron-X's workspace "ros_catkin_ws")

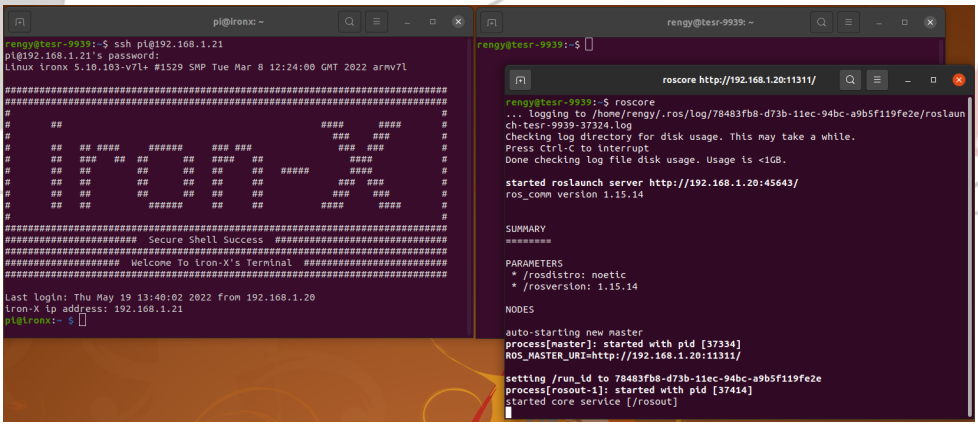
- tesr_ros_ironx_driver_pkg
- tesr_ros_ironx_navigation_pkg

Launch file lists

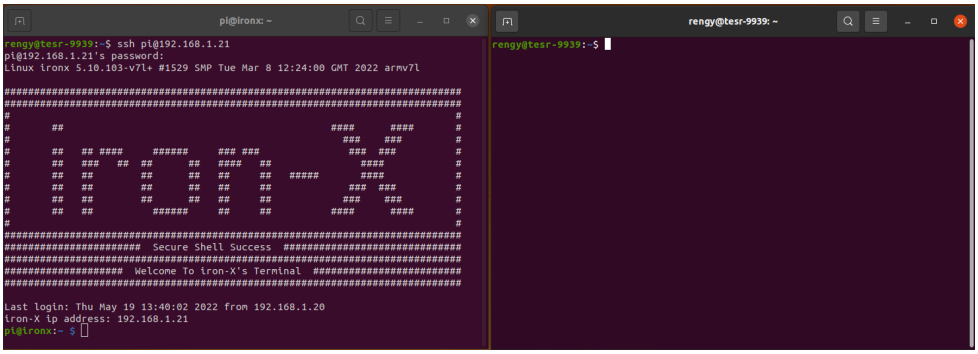
- **tesr_ros_ironx_driver_pkg**
  - ironx_driver.launch
  - ironx_bringup.launch
- **tesr_ros_ironx_navigation_pkg** (exclude the non-application launch file)
  - ironx_slam.launch
  - ironx_mapping_gmapping.launch
  - ironx_mapping_hector.launch
  - ironx_mapping_cartographer.launch
  - ironx_nav.launch

Start to Run iron-X applications (Terminal Mode)

First thing first, type "roscore" to open the ROS based system on PC/Laptop terminal. After that, you may minimize the terminal that run "roscore" and open the new one by press "Ctrl+Alt+t".



We will operate on both of Remote Terminal **(Left panel)** and PC Terminal**(Right panel)**



Remote Terminal PC/Laptop Terminal

iron-X's driver

Launch ironx_driver.launch **(On Remote terminal)**

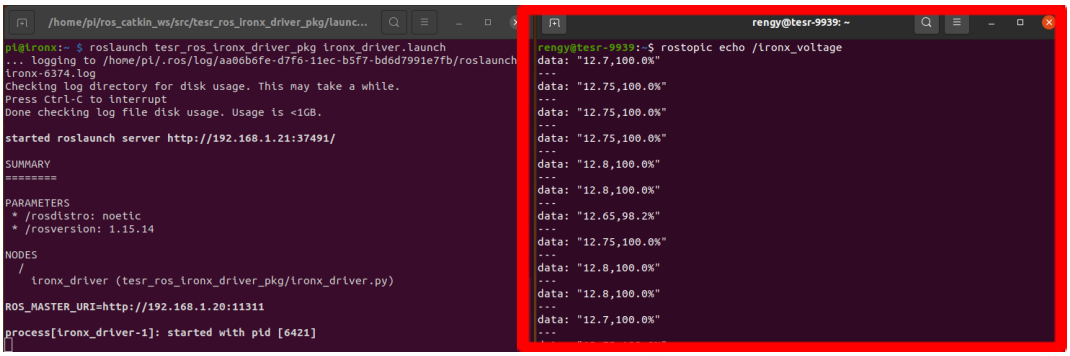
Type "roslaunch tesr_ros_ironx_driver_pkg ironx_driver.launch".

```
pi@ironx:~ $ roslaunch tesr_ros_ironx_driver_pkg ironx_driver.launch
```

Check iron-X is working properly by check Voltage, odom_raw and imu.

Battery Data

(On PC/Laptop terminal) Check Voltage data by type "rostopic echo ironx_voltage".



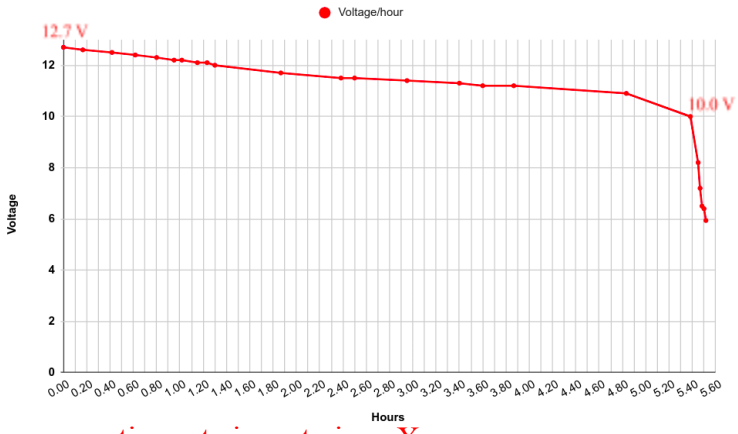
Battery's Data: "Voltage, Percentage"

12.7 V showed on 7-Segment

LED Alarm when battery lower than 10.5 V

Battery is maxed at 12.7~13.0 V [100%] and should recharge when less than 10.5V. Battery can operate around 3 - 5 hours and need to recharge for 2 hours

The battery consumption is following as graph below:

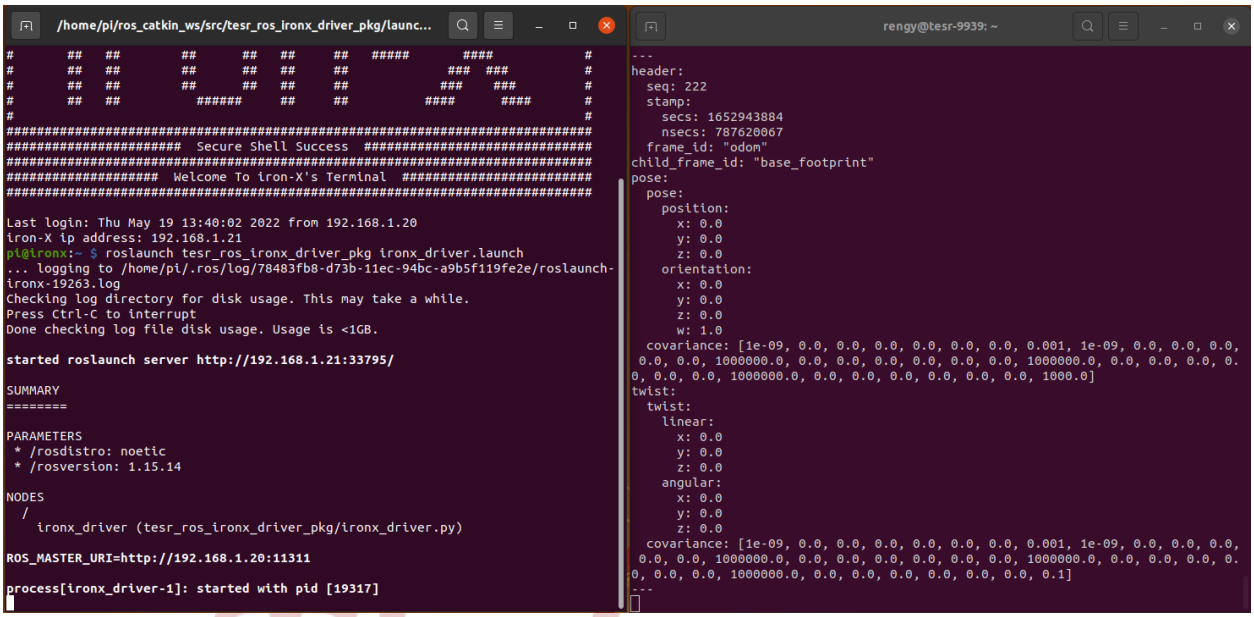


*Battery consumption rate is up to iron-X usage.

**Please be aware to not let the Battery consumed to be less than 10.0V for good of battery's life time. And recharge while open the iron-X is not recommend too.

Odometry_raw Data

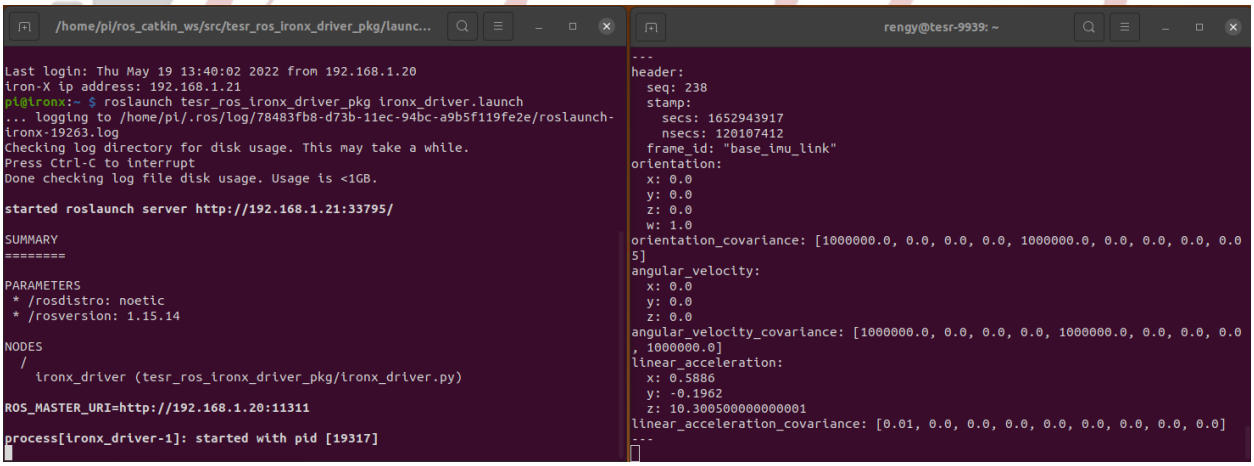
(On PC/Laptop terminal) Check Imu data by type “rostopic echo /odom_raw”.



Remote Terminal **PC/Laptop Terminal**

Imu Data

(On PC/Laptop terminal) Check Imu data by type “rostopic echo /imu”.

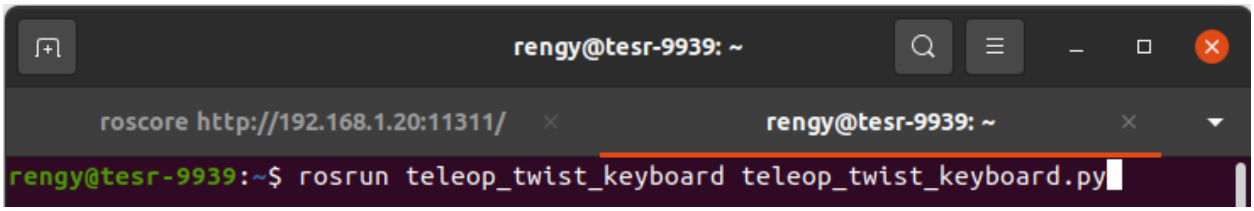


Remote Terminal **PC/Laptop Terminal**

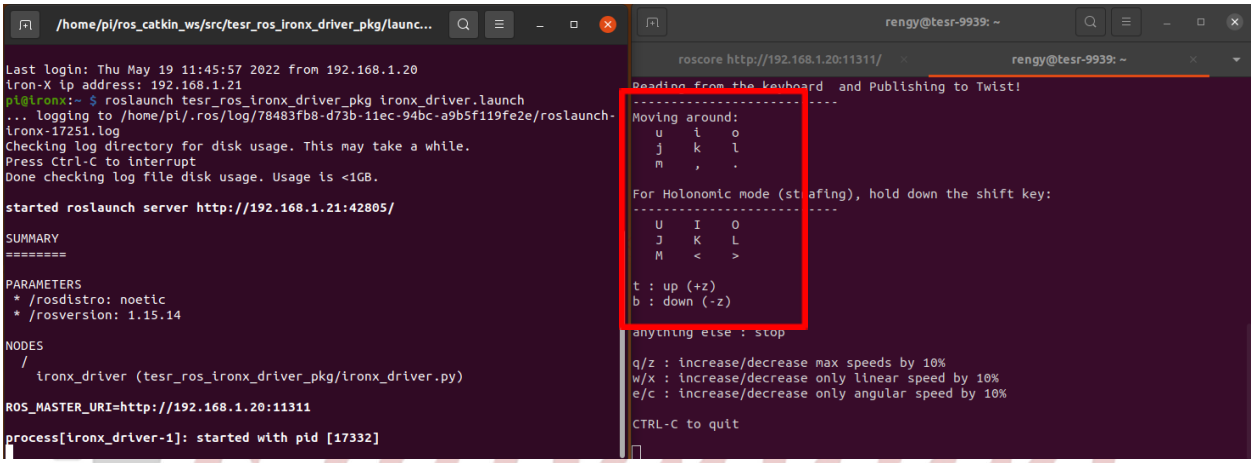
Keyboard & Joy

Keyboard's control (On PC/Laptop terminal)

After launch ironx_driver, type to PC/Laptop terminal following as:
"rosrun teleop_twist_keyboard teleop_twist_keyboard.py"



*ros-noetic-teleop-twist-keyboard is included in **dependent ROS packages**. If you can't use it properly. You may re-install ros-noetic-teleop-twist-keyboard and try again.



Remote Terminal PC/Laptop Terminal

The Keyboard Control button will show the list as the right terminal following the explanation in the right panel.

Joy's control

The Joystick module is connected directly to the STM32 microcontroller board. So, after launch the "ironx_driver.launch" you can turn on the Joystick switch and wait for it pair to the module. If joystick is paired LED on module will not blinking. So, you're ready to use the joystick.

Joystick module

Joystick's status isn't blinking

Joystick controlling by 2 Analog stick and L1 button following as:

1. Right Analog stick use to Rotation of iron-X itself as CW and CCW. (CW: Clockwise and CCW: Counter Clockwise)
2. Left Analog stick use to Move in 8-direction.

iron-X's bringup

*You **should** stop the ironx_driver before run ironx_bringup. Because ironx_bringup is already set to run ironx_driver.

iron_bringup.launch is launch file that run to bringup the other components required to use in iron-X system. The component that ironx_bringup.launch is bringup is following as:

- iron-X's driver
- iron-X's model
- RPLIDAR A1

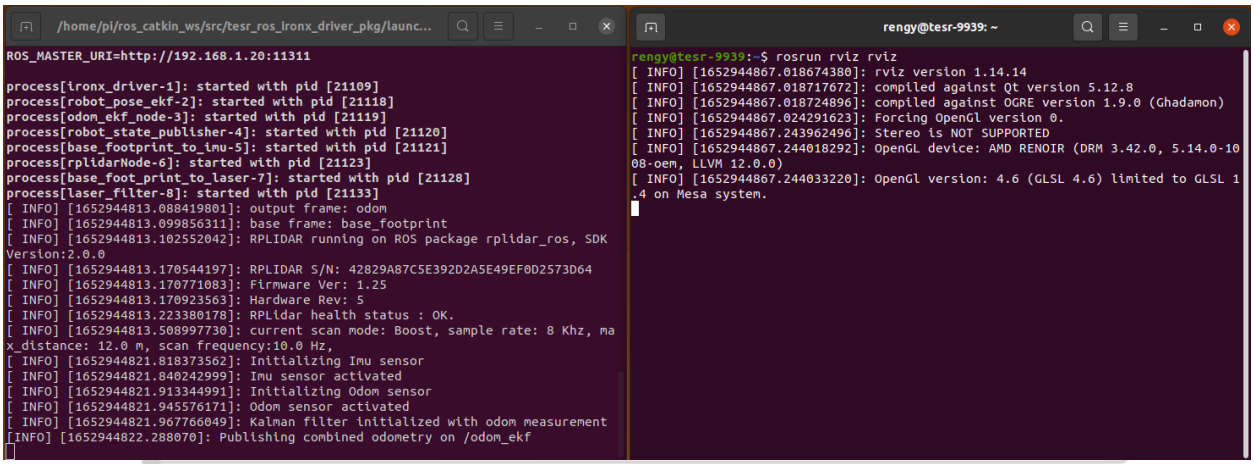
(On Remote Terminal)

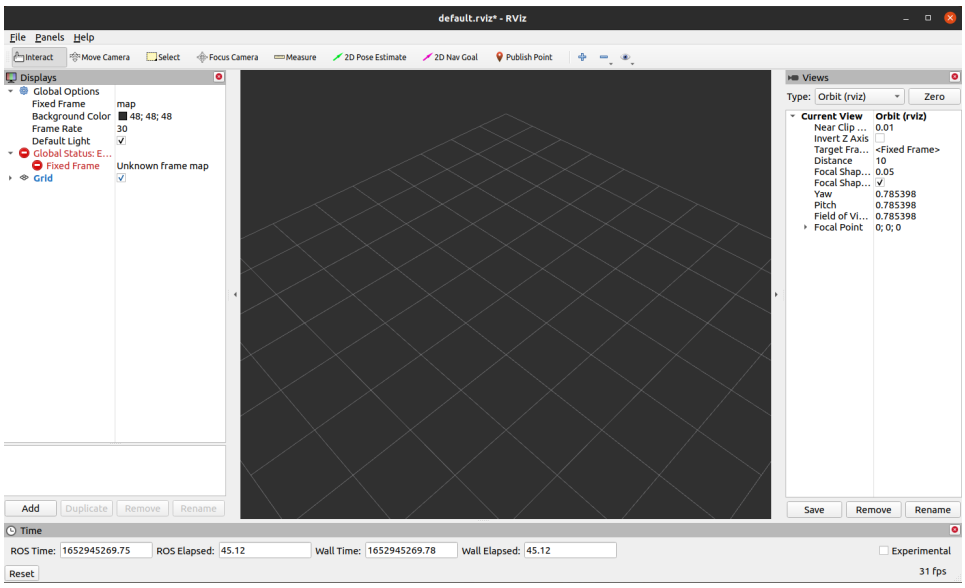
Type "roslaunch tesr_ros_ironx_driver_pkg ironx_bringup.launch"

```
pi@ironx:~ $ roslaunch tesr_ros_ironx_driver_pkg ironx_bringup.launch
```

(On PC/Laptop Terminal)

Type **"rviz"** or **"rosrun rviz rviz"** is also work the same to open rviz.





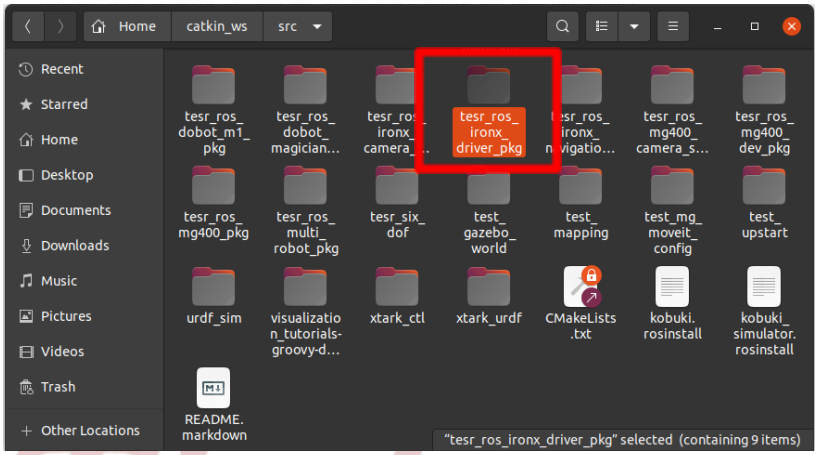
Download iron-X's model for show on Rviz

(On PC/Laptop Terminal)

To show iron-X's model. Please download tesr_ros_ironx_driver_pkg to src of your ros_workspace **(In this case, ros_workspace is catkin_ws)**

from link below:

https://drive.google.com/drive/folders/1DeE5T1W0gDIersN1_Ynw_VF_31eEHKRC?usp=sharing



*If you're not download package to workspace. It will cause an error from unable to find the URDF file of iron-X's model.

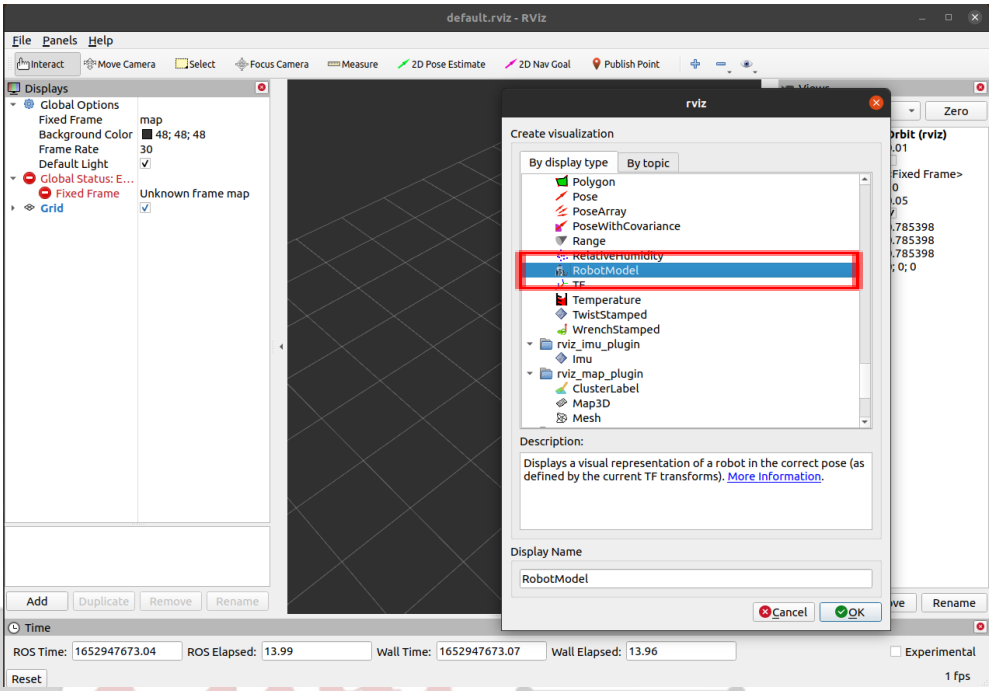
After that, type "cd catkin_ws/" and type "catkin_make" and wait until [100%]

```
rengy@tesr-9939:~$ cd catkin_ws/
rengy@tesr-9939:~/catkin_ws$ catkin_make
```

```
rengy@tesr-9939: ~/catkin_ws
[ 50%] Built target std_msgs_generate_messages_py
[ 50%] Built target std_msgs_generate_messages_nodejs
[ 53%] Built target std_msgs_generate_messages_lisp
[ 53%] Built target std_msgs_generate_messages_eus
[ 63%] Built target std_msgs_generate_messages_cpp
[ 63%] Built target _roscpp_generate_messages_check_deps_GetLoggers
[ 69%] Built target rosgraph_msgs_generate_messages_cpp
[ 69%] Built target rosgraph_msgs_generate_messages_eus
[ 69%] Built target rosgraph_msgs_generate_messages_lisp
[ 69%] Built target rosgraph_msgs_generate_messages_py
[ 69%] Built target std_msgs_generate_messages
[ 73%] Built target roscpp_generate_messages_nodejs
[ 73%] Built target rosgraph_msgs_generate_messages_nodejs
[ 73%] Built target roscpp_generate_messages_py
[ 74%] Built target roscpp_generate_messages_lisp
[ 77%] Built target roscpp_generate_messages_eus
[ 78%] Built target roscpp_generate_messages_cpp
[ 78%] Built target rosgraph_msgs_generate_messages
[ 78%] Built target roscpp_generate_messages
[ 93%] Built target roscpp
[ 97%] Built target jpeg_streamer
[ 97%] Built target uvc_camera_node
[ 97%] Built target uvc_stereo_node
[100%] Built target nodelet_uvc_camera
rengy@tesr-9939:~/catkin_ws$
```

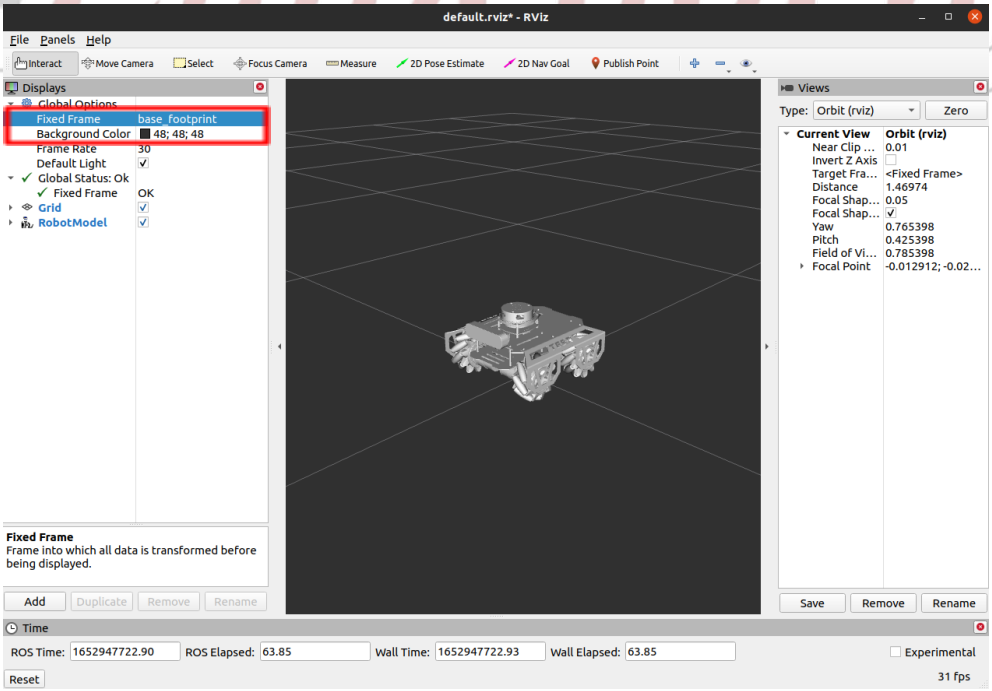
Show iron-X's model on Rviz

To show RobotModel. Select "Add" at left below of Display panel go to "By display type" and Select "RobotModel" and then "OK".



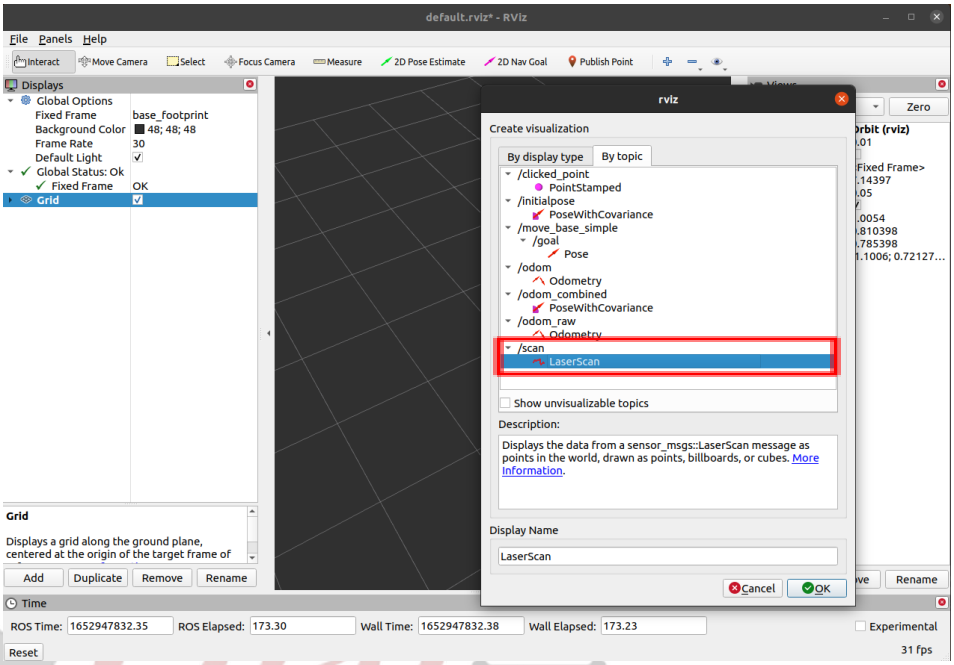
*Set Fixed Frame as "base_footprint"

Result on Rviz



LaserScan from RPLIDAR A1 on Rviz

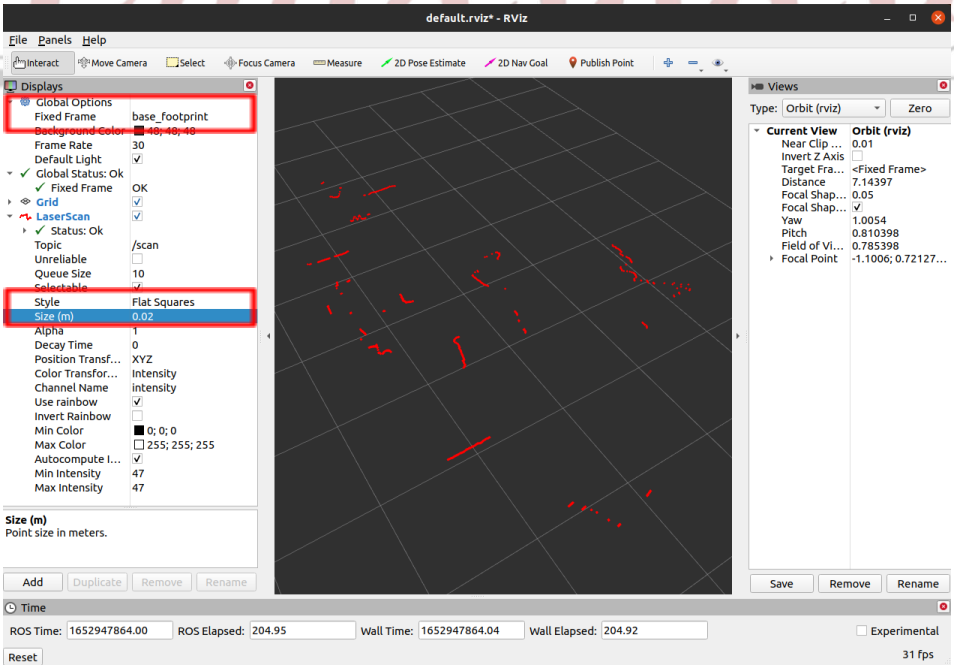
To show lidar_scan. Select "Add" at left below of Display panel go to By topic and select topic "/scan" > "LaserScan"



*Make sure Fixed Frame is set as “base_footprint” or “laser”

**You can change Size of LaserScan by increase values of Size(m)

Result on Rviz



SLAM

(Simultaneous Localization and Mapping)

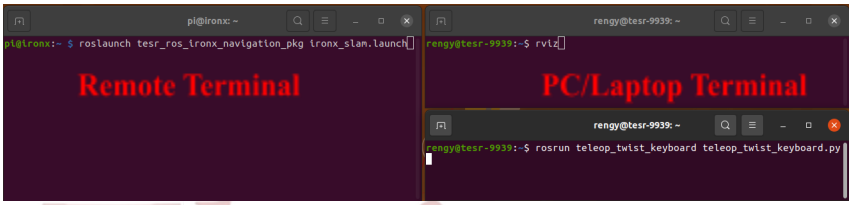
*Keep that in mind, you **should** close the ironx_bringup before run the SLAM because within SLAM's launch file is already set to launch the ironx_bringup.

SLAM methods

iron-X have 3 SLAM methods available for now following as:

- Gmapping SLAM method
- Hector SLAM method
- Cartographer SLAM method

Gmapping SLAM(default)



(On Remote Terminal)

Type "roslaunch tesr_ros_ironx_navigation_pkg ironx_slam.launch"

(wait until "Publishing combined odometry on /odom_ekf" is show)

```
process[slam_gmapping-9]: started with pid [2451]
[ INFO] [1652955686.934018534]: RPLIDAR running on ROS package rplidar_ros, SDK Version:2.0.0
[ INFO] [1652955687.012529391]: RPLIDAR S/N: 42829A87C5E392D2A5E49EF0D2573D64
[ INFO] [1652955687.012777338]: Firmware Ver: 1.25
[ INFO] [1652955687.012909284]: Hardware Rev: 5
[ INFO] [1652955687.064715869]: RPLidar health status : OK.
[ INFO] [1652955687.349116684]: current scan mode: Boost, sample rate: 8 Khz, max_distance: 12.0
 m, scan frequency:10.0 Hz,
[ INFO] [1652955694.646204124]: Initializing Odom sensor
[ INFO] [1652955694.648483515]: Initializing Imu sensor
[ INFO] [1652955694.665853334]: Odom sensor activated
[ INFO] [1652955694.668369079]: Imu sensor activated
[ INFO] [1652955694.682455702]: Kalman filter initialized with odom measurement
[INFO] [1652955694.759984]: Publishing combined odometry on /odom_ekf
```

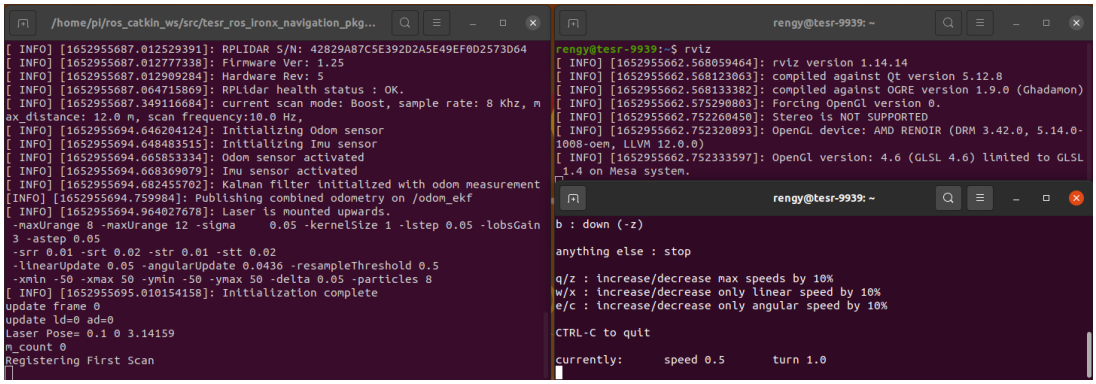
(On PC/Laptop Terminal)

And then, run Keyboard and Rviz

Type "rosrun teleop_twist_keyboard teleop_twist_keyboard.py"

Or you may use joystick instead of a keyboard.

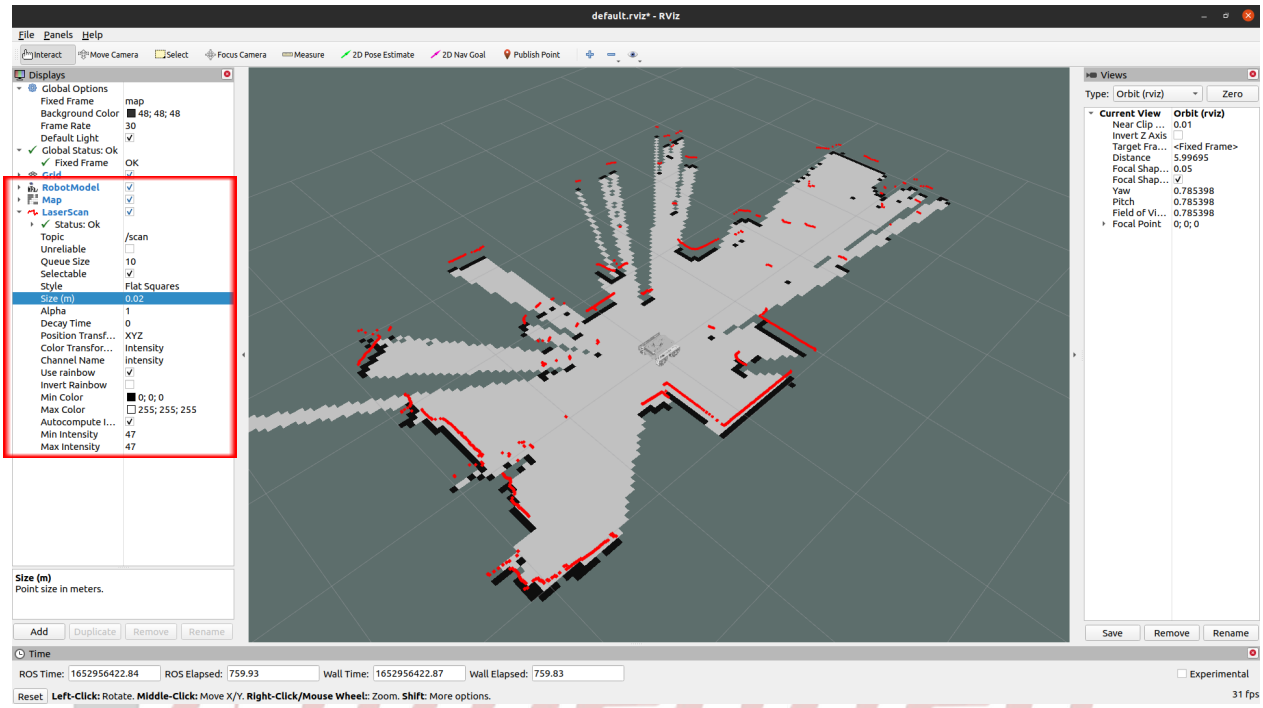
Type "rviz"



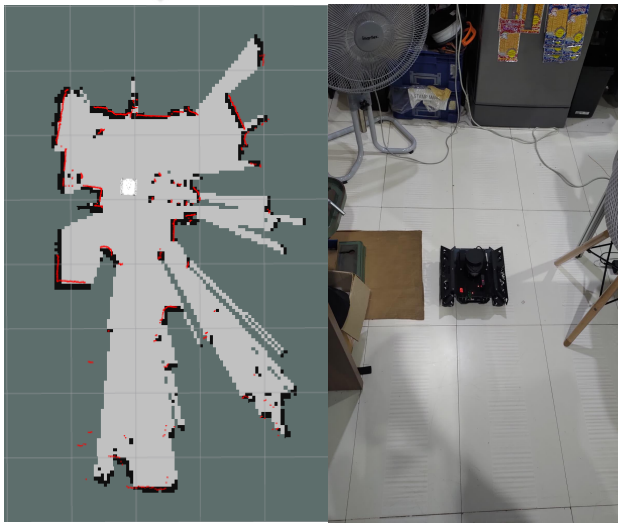
Setup configuration to show RobotModel, Map and LaserScan in Rviz

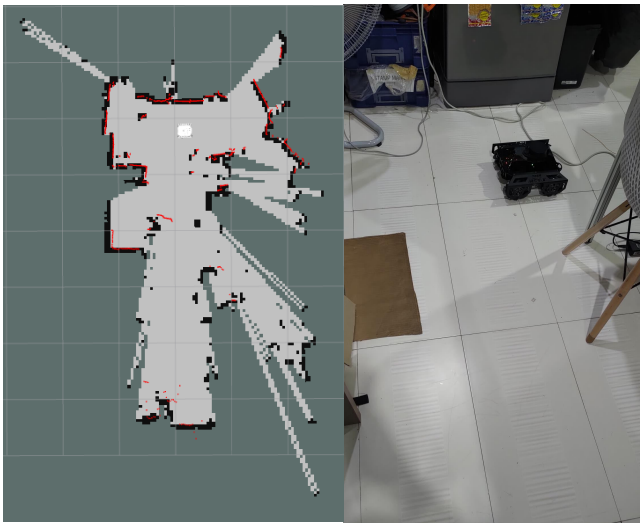
1. Add “RobotModel” from select topic in list of “By display type”
2. Add “Map” by select from “By topic” > “/map” > Map
3. Add “LaserScan” by select from “By topic” > “/scan” > LaserScan

After Setup, This is Result on Rviz



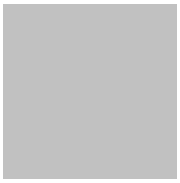
And this is the example of exploring around the room.





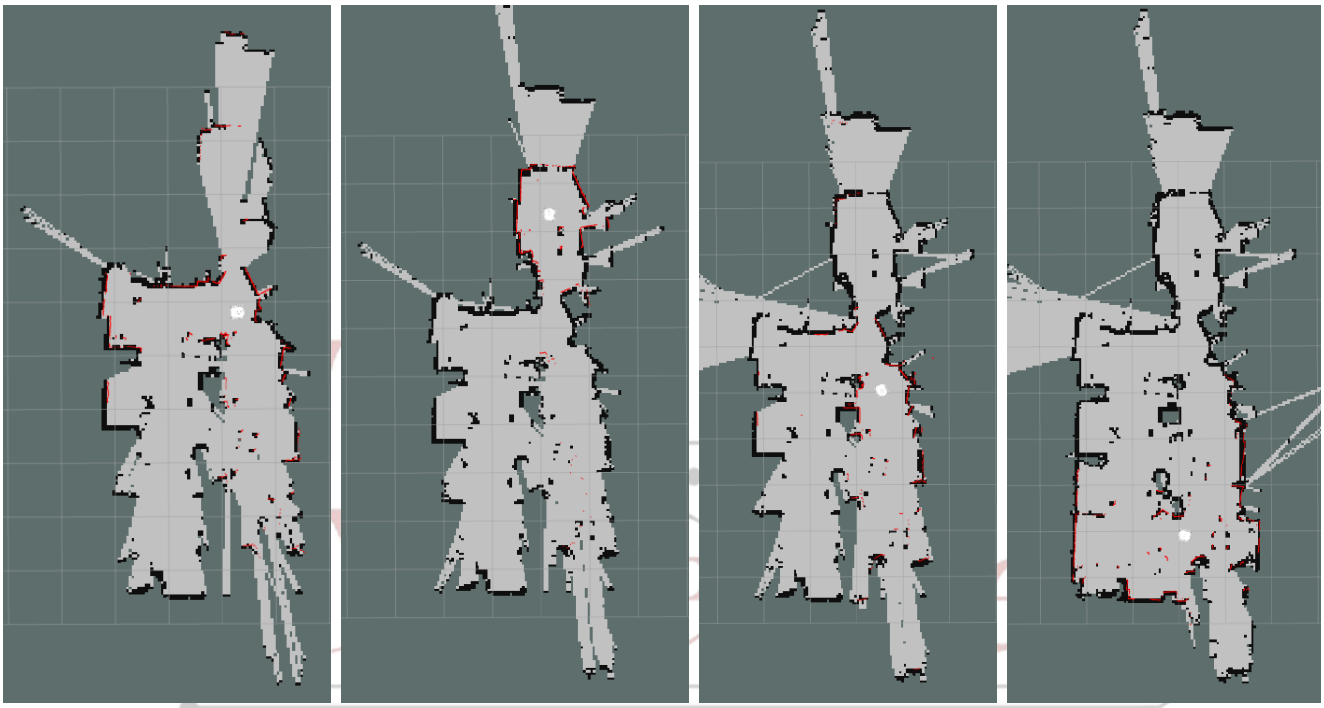
Map’s display is the occupancy grid is treated the way the navigation stack treats it.

Grey is unknown space



White is unoccupied space

Black is occupied space.



Save a map from gmapping SLAM

(On Remote Terminal)

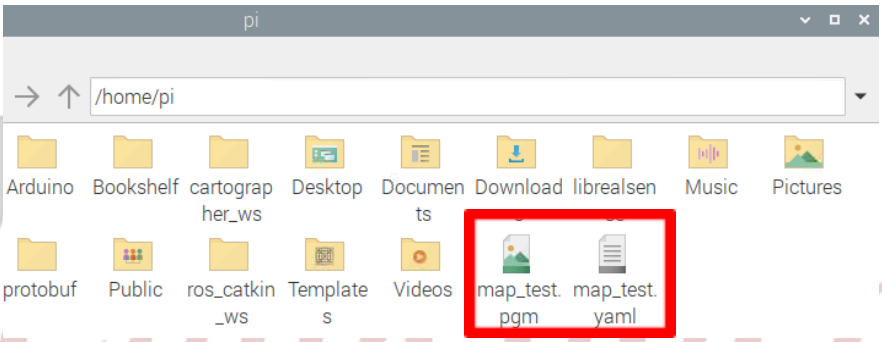
1. Open the new Remote terminal and type “rosrun map_server map_saver -f map_test”

```
Last login: Fri May 20 11:37:37 2022 from 192.168.1.20
iron-X ip address: 192.168.1.21
pi@ironx:~ $ rosrun map_server map_saver -f map_test
[ INFO] [1653023348.566520081]: Waiting for the map
[ INFO] [1653023348.855629494]: Received a 1984 X 1984 map @ 0.050 m/pix
[ INFO] [1653023348.855872531]: Writing map occupancy data to map_test.pgm
[ INFO] [1653023349.625065297]: Writing map occupancy data to map_test.yaml
[ INFO] [1653023349.625847411]: Done
```

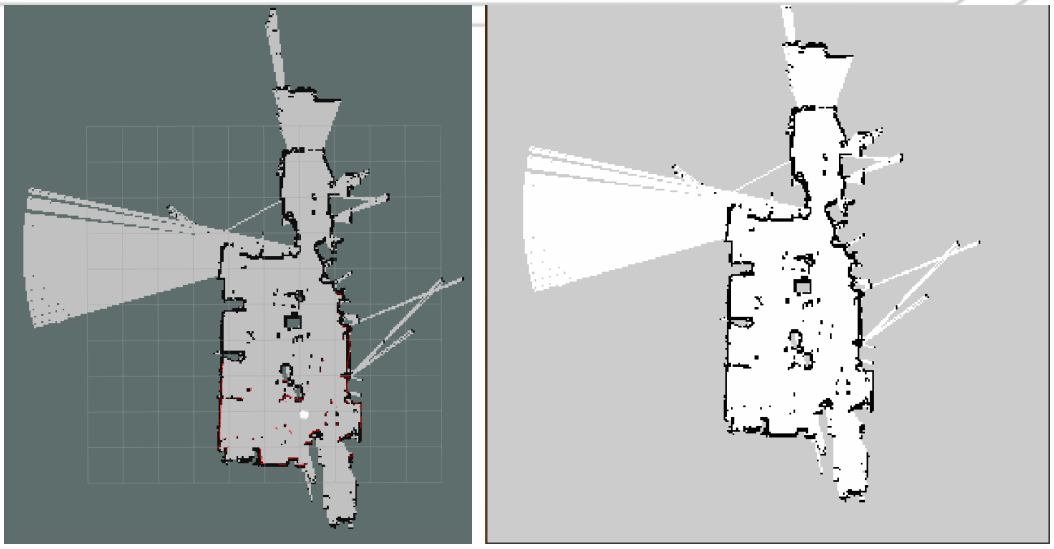
* rosrun [rosnode_pkg] [rosnode_service] [-f map’s name]

** map_saver retrieves map data and writes it out to map.pgm and map.yaml. Use the -f option to provide a different base name for the output files.

2. You will get the map file as "map_test.pgm" and "map_test.yaml".

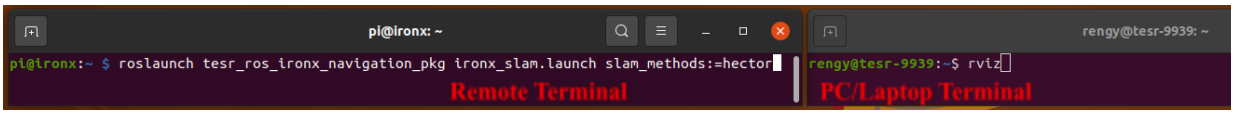


You can see the map_test.pgm is as same as map from Rviz.



*Save a map by map_saver can work on PC/Laptop and Remote Terminal

Hector SLAM



(On Remote Terminal)

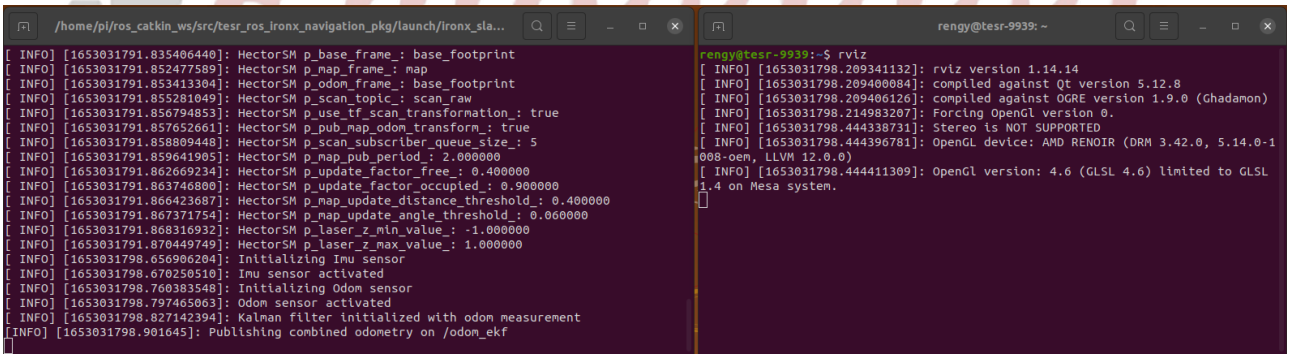
Type “roslaunch tesr_ros_ironx_navigation_pkg ironx_slam.launch slam_methods:=hector”

(wait until “Publishing combined odometry on /odom_ekf” is show)

```
[ INFO] [1653031791.835406440]: HectorSM p_base_frame_: base_footprint
[ INFO] [1653031791.852477589]: HectorSM p_map_frame_: map
[ INFO] [1653031791.853413304]: HectorSM p_odom_frame_: base_footprint
[ INFO] [1653031791.855281049]: HectorSM p_scan_topic_: scan_raw
[ INFO] [1653031791.856794853]: HectorSM p_use_tf_scan_transformation_: true
[ INFO] [1653031791.857652661]: HectorSM p_pub_map_odom_transform_: true
[ INFO] [1653031791.858809448]: HectorSM p_scan_subscriber_queue_size_: 5
[ INFO] [1653031791.859641905]: HectorSM p_map_pub_period_: 2.000000
[ INFO] [1653031791.862669234]: HectorSM p_update_factor_free_: 0.400000
[ INFO] [1653031791.863746800]: HectorSM p_update_factor_occupied_: 0.900000
[ INFO] [1653031791.866423687]: HectorSM p_map_update_distance_threshold_: 0.400000
[ INFO] [1653031791.867371754]: HectorSM p_map_update_angle_threshold_: 0.060000
[ INFO] [1653031791.868316932]: HectorSM p_laser_z_min_value_: -1.000000
[ INFO] [1653031791.870449749]: HectorSM p_laser_z_max_value_: 1.000000
[ INFO] [1653031798.656906204]: Initializing Imu sensor
[ INFO] [1653031798.670250510]: Imu sensor activated
[ INFO] [1653031798.760383548]: Initializing Odom sensor
[ INFO] [1653031798.797465063]: Odom sensor activated
[ INFO] [1653031798.827142394]: Kalman filter initialized with odom measurement
[INFO] [1653031798.901645]: Publishing combined odometry on /odom_ekf
```

(On PC/Laptop Terminal)

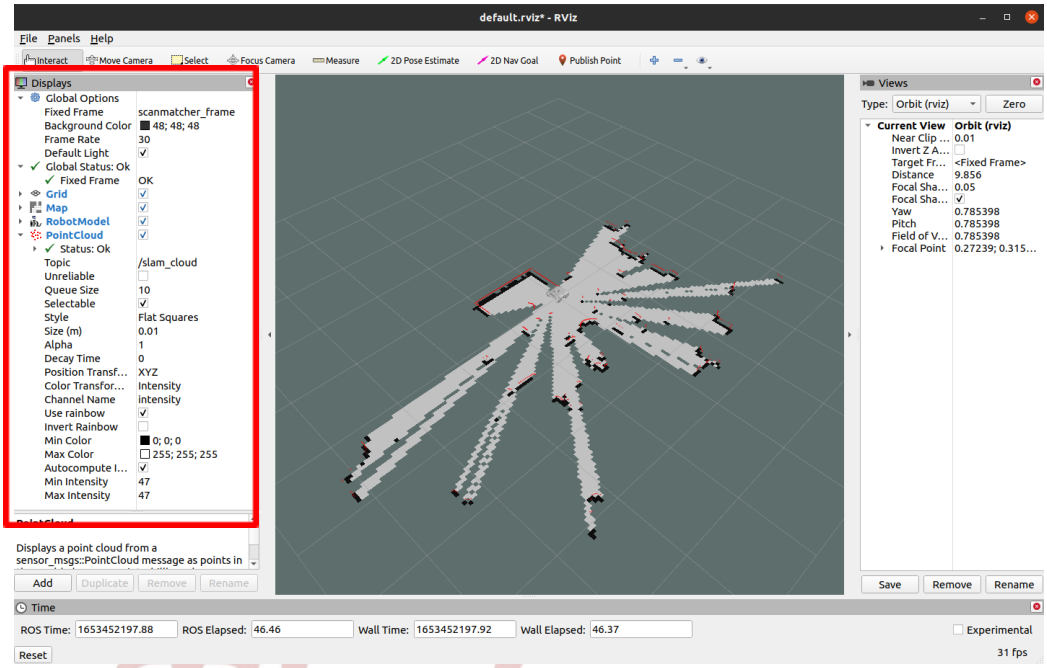
Type “rviz”



Setup configuration to show RobotModel, Map and LaserScan in Rviz

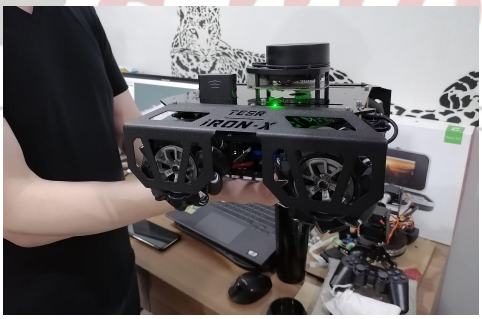
1. Select Fixed Frame to “scanmatcher_frame”
2. Add “RobotModel” from select topic in list of “By display type”
3. Add “Map” by select from “By topic” > “/map” > Map
4. Add “PointCloud” by select from “By topic” > “/slam_cloud” > PointCloud

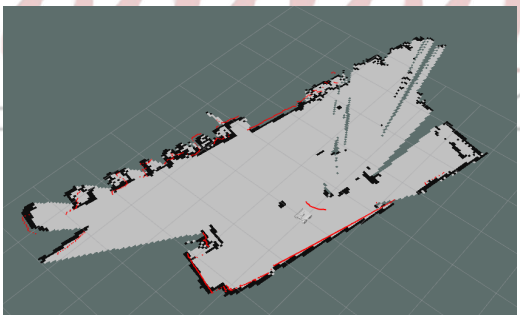
After Setup, This is Result on Rviz

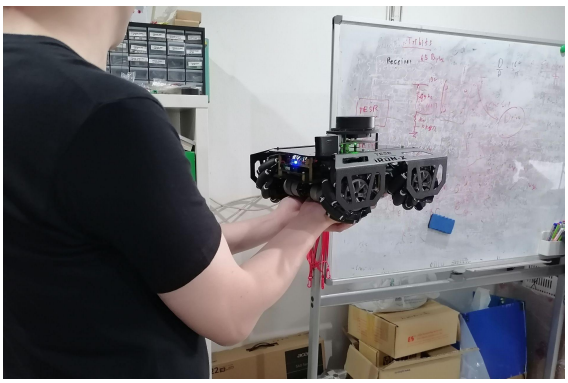


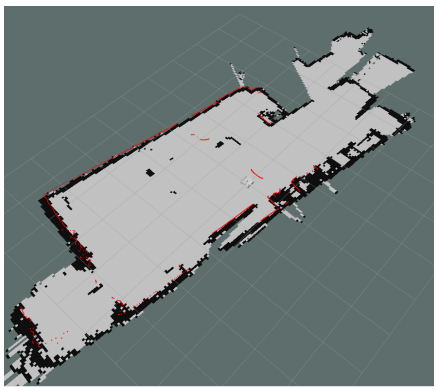
And this is an example of exploring the room. Since Hector slam using only LaserScan -Data to draw the map. So, you can carry a robot around your place.

*Moving or rotating too fast will cause noise and error on Map drawing. So, while using hector slam you must move slow and carefully to draw the map perfectly.









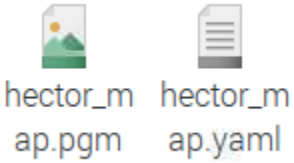
Save map from hector slam

(On Remote Terminal)

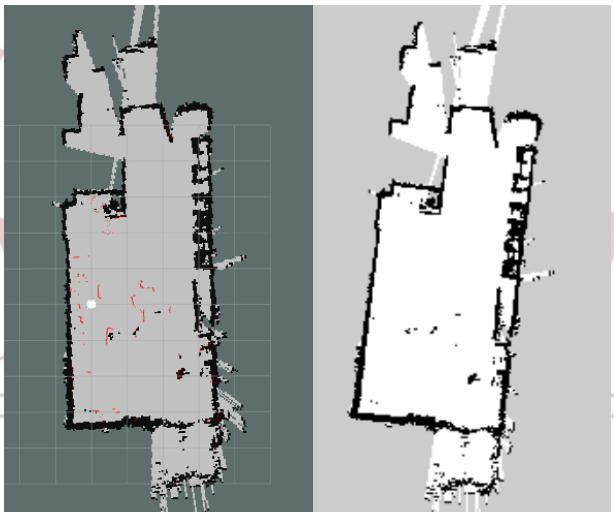
1. Open the new Remote terminal and type “rosrun map_server map_saver -f hector_map”

```
Last login: Fri May 20 14:20:31 2022 from 192.168.1.20
iron-X ip address: 192.168.1.21
pi@ironx:~ $ rosrun map_server map_saver -f hector_map
[ INFO] [1653035040.944652928]: Waiting for the map
[ INFO] [1653035041.836053836]: Received a 2048 X 2048 map @ 0.050 m/pix
[ INFO] [1653035041.836298223]: Writing map occupancy data to hector_map.pgm
[ INFO] [1653035042.692920561]: Writing map occupancy data to hector_map.yaml
[ INFO] [1653035042.694223123]: Done
```

2. You will get the map file as "hector_map.pgm" and "hector_map.yaml".



You can see the hector_map.pgm ıs as same as map from Rviz.



The comparison between Hector SLAM with gmapping SLAM

Hector slam is uses scan-matching algorithm. So, it’s more efficient to use in the complex area that mobile robot is difficult or require a long time to transport.

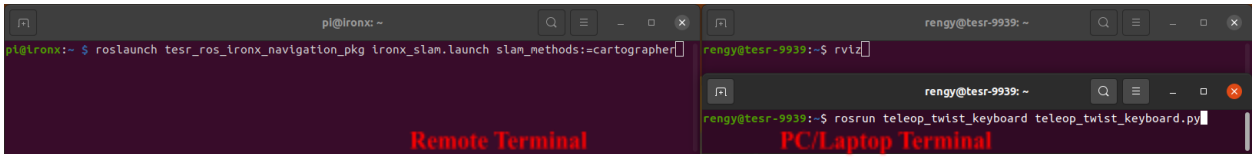
Pros.

- Use only LaserScan Data.
- Require low computational resources.
- More flexible to travel around the place with human’s help.

Cons.

- The map is misplaced and get noise easily because it uses only LaserData.
- The map shape can be completely broken by even one mistake.
- Map’s detail may not real as same as robot transportation.

Cartographer SLAM



(On Remote Terminal)

Type “roslaunch tesr_ros_ironx_navigation_pkg ironx_slam.launch slam_methods:=cartographer”

(wait until “Publishing combined odometry on /odom_ekf” is show)

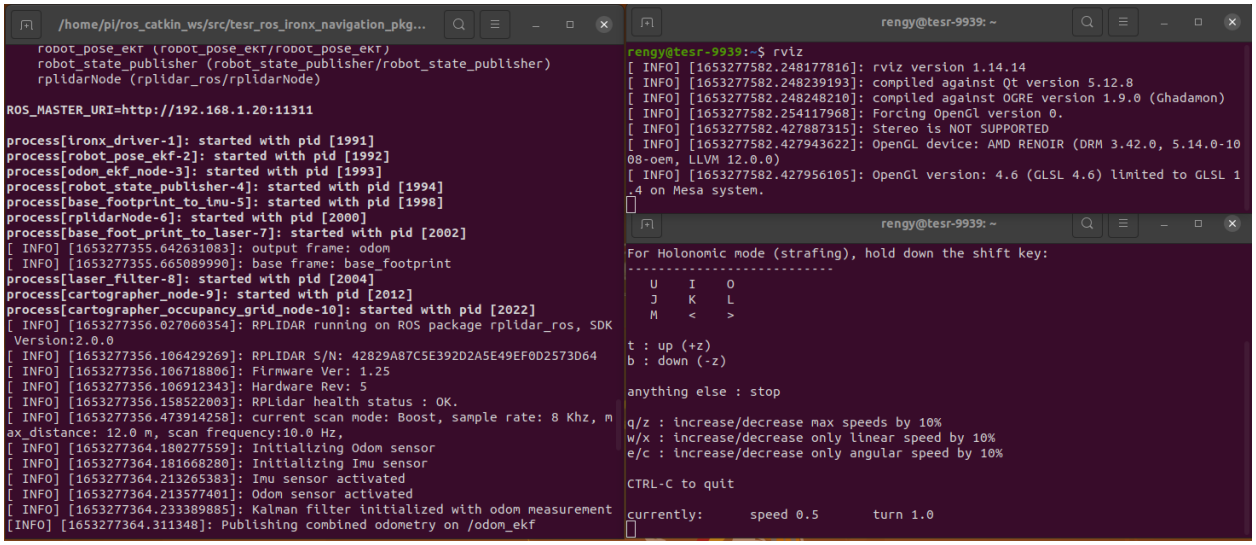
(On PC/Laptop Terminal)

And then, run Keyboard and Rviz

Type “rosrun teleop_twist_keyboard teleop_twist_keyboard.py”

Or you may use joystick instead of a keyboard.

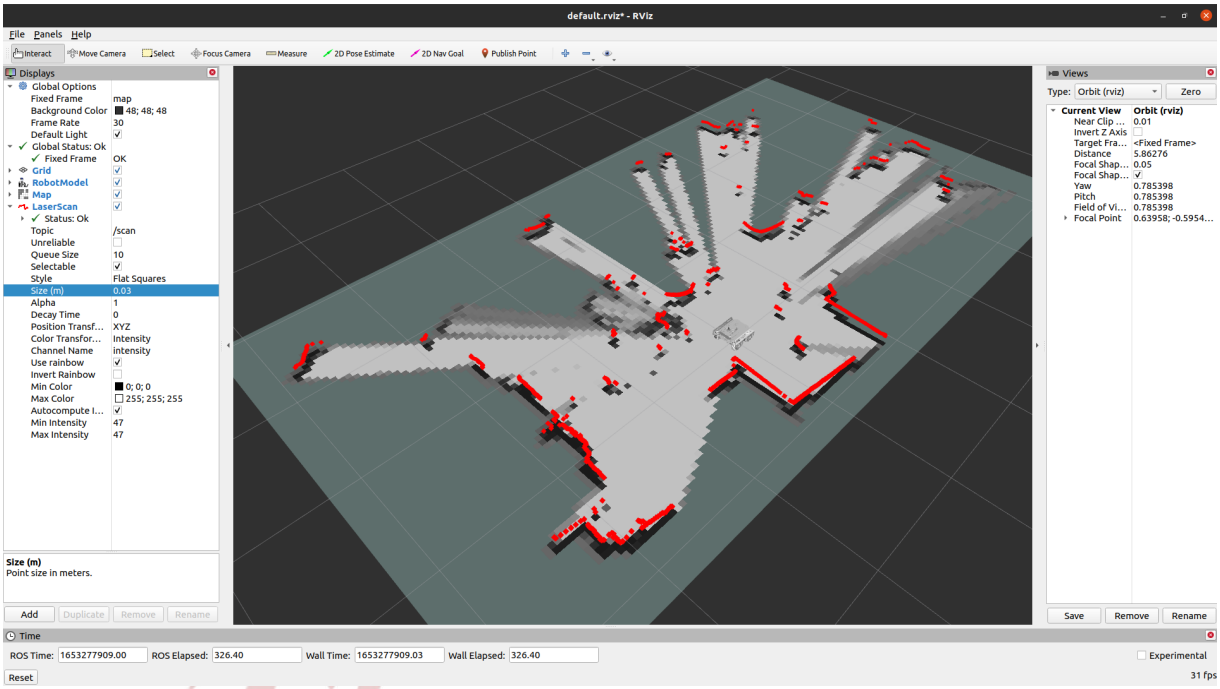
Type “rviz”



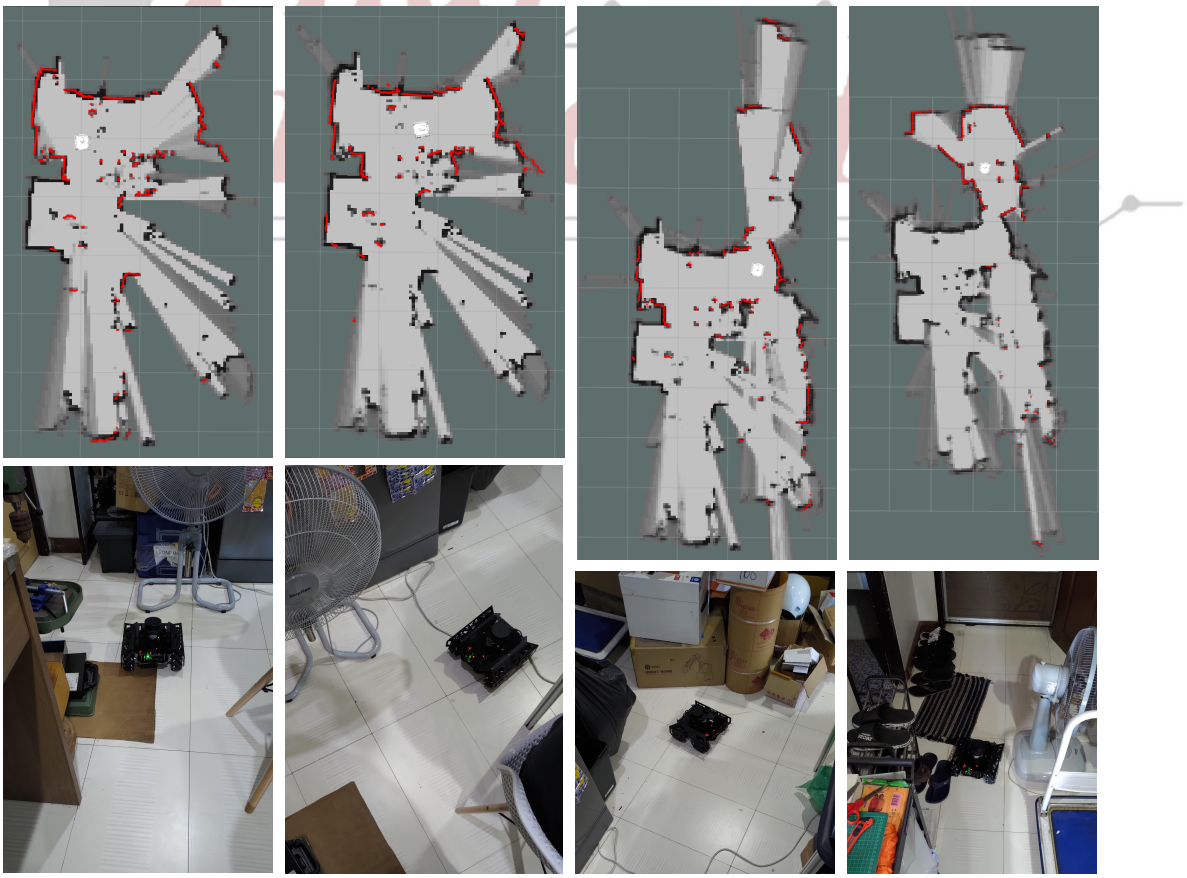
Setup configuration to show RobotModel, Map and LaserScan in Rviz

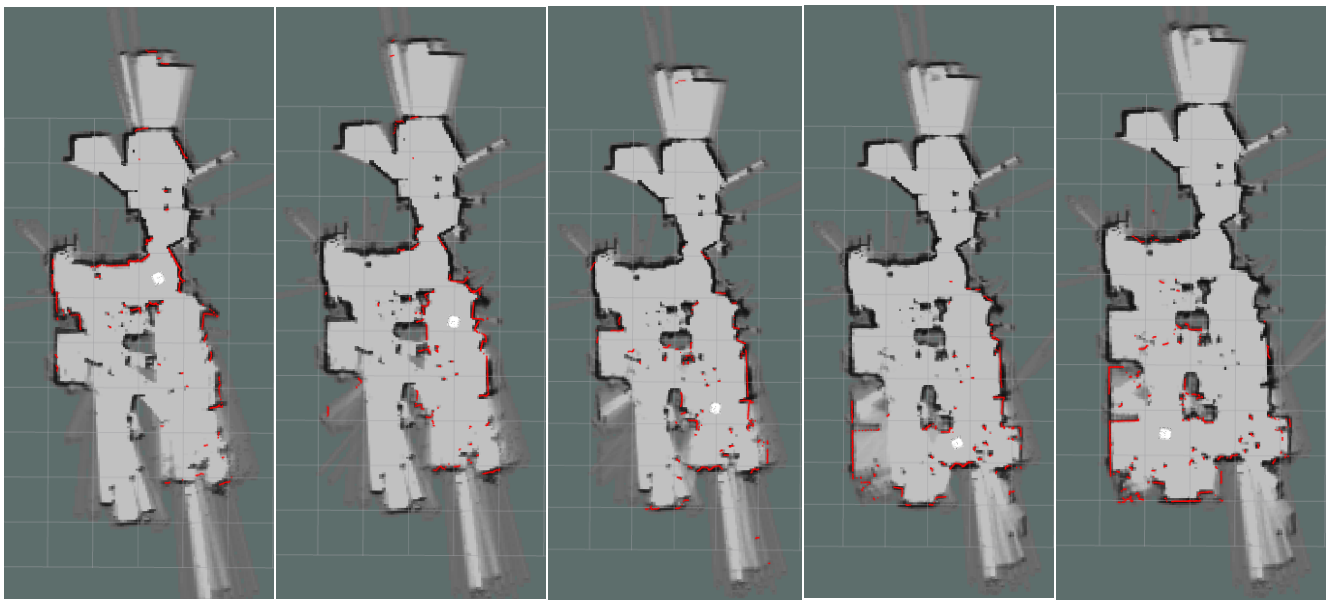
1. Add “RobotModel” from select topic in list of “By display type”
2. Add “Map” by select from “By topic” > “/map” > Map
3. Add “LaserScan” by select from “By topic” > “/scan” > LaserScan

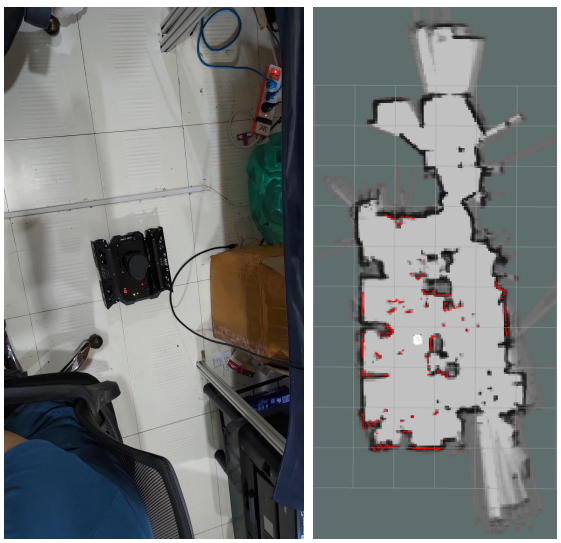
After Setup, This is Result on Rviz



And this is an example of exploring the room. The cartographer uses odometry data, imu data, and laser scan data. So, the precision of the map is quite good.







Finish

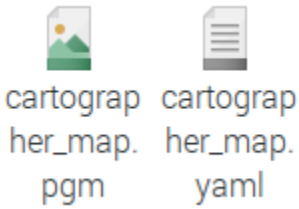
Save map from cartographer SLAM

(On Remote Terminal)

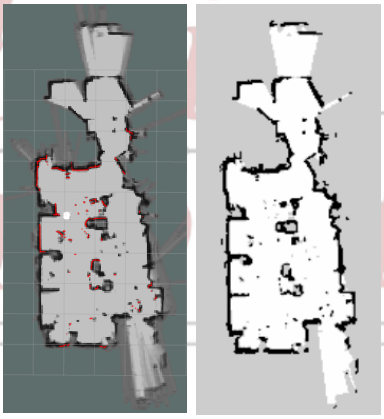
1. Open the new Remote terminal and type “rosrun map_server map_saver -f cartographer_map”

```
Last login: Mon May 23 10:38:02 2022 from 192.168.1.20
iron-X ip address: 192.168.1.21
pi@ironx:~ $ rosrun map_server map_saver -f cartographer_map
[ INFO] [1653280703.410352398]: Waiting for the map
[ INFO] [1653280703.652752506]: Received a 321 X 170 map @ 0.050 m/pix
[ INFO] [1653280703.652966079]: Writing map occupancy data to cartographer_map.pgm
[ INFO] [1653280703.669747552]: Writing map occupancy data to cartographer_map.yaml
[ INFO] [1653280703.671779480]: Done
```

2. You will get the map file as "cartographer_map.pgm" and "cartographer_map.yaml".



You can see the cartographer_map.pgm is as same as map from Rviz.



The comparison between cartographer SLAM with gmapping SLAM

Cartographer slam’s algorithm use scan-matcing and loop detection while gmapping is uses particle filter pairing algorithm. In term of data analysis, the cartographer will use odometry -data, imu data and laser scan while gmapping does not use imu data. Not only that, cartographer is capable to use RGB-D algorithm is an algorithm for mapping using depth images too.

Pros.

- More Precision and Accuracy by use combined data
- Harder to misplace when compare with gmapping
- By loop detection algorithm slam can clear occupied from noise or error.

Cons.

- Require high computational resources.
- Can be misplace with unexpect error from some data
- Can get a noise from changed environment while loop detection.

Navigation

Launch ironx_nav.launch

(On Remote Terminal)

1. Type “roslaunch tesr_ros_ironx_navigation_pkg ironx_nav.launch map_file:=/home/pi/cartographer_map.yaml”
   (wait until “odom received!” showup.)

```
[ INFO] [1653283337.114945129]: Recovery behavior will clear layer 'obstacles'
[ INFO] [1653283337.184110924]: Recovery behavior will clear layer 'obstacles'
[ INFO] [1653283337.600162081]: odom received!
```

(On PC/Laptop Terminal)

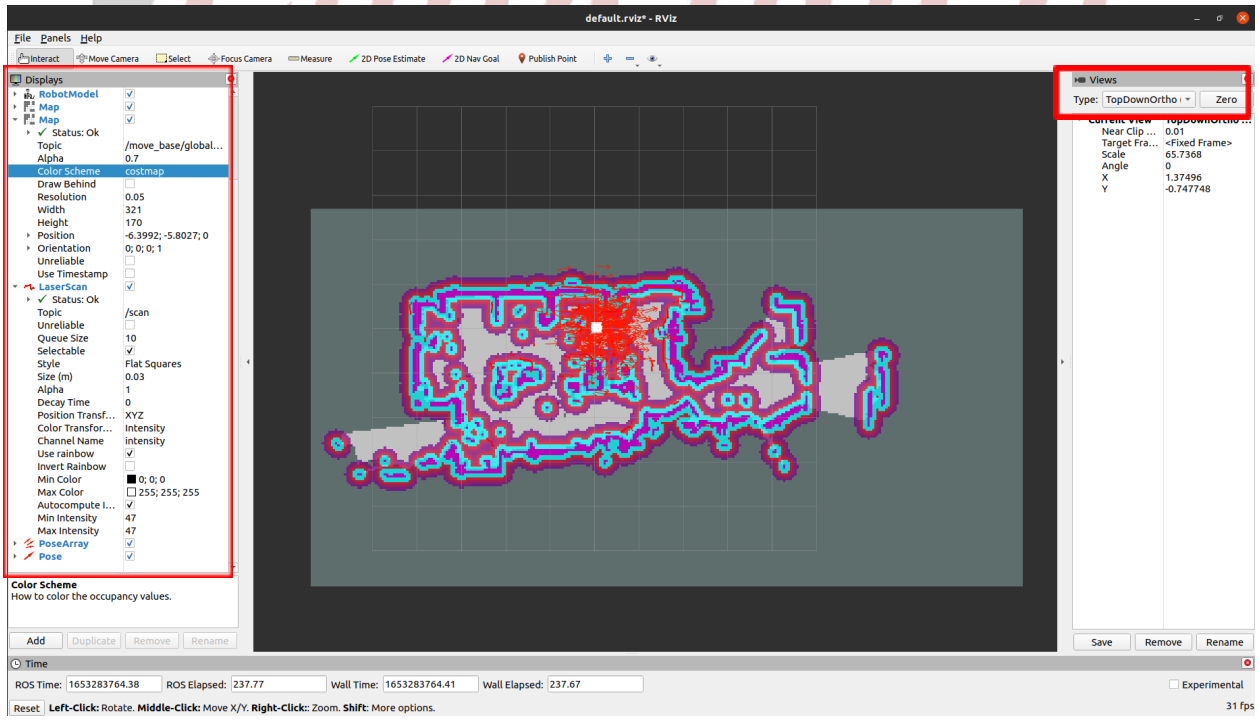
2. Type “rviz” or “rosrun rviz rviz”

Setup configuration to show RobotModel, Map and LaserScan in Rviz

1. Add “RobotModel” from “By display type”
2. Add topic from “By topic” following as: “/map > Map”,
   “/move_base > /global_costmap > /costmap > Map” (costmap),
   (“Color scheme” should be: costmap)
   “ /scan > LaserScan”,
   “ /particlecloud > PoseArray”,
   “ /move_base_simple > /goal > Pose”

*At the top right of rviz panel you can change the point of view for different view of Rviz’s interface (“TopDownOrtho(rviz)” is Recommended for Navigation application *default is “Orbit(rviz)”)

After Setup, This is Result on Rviz

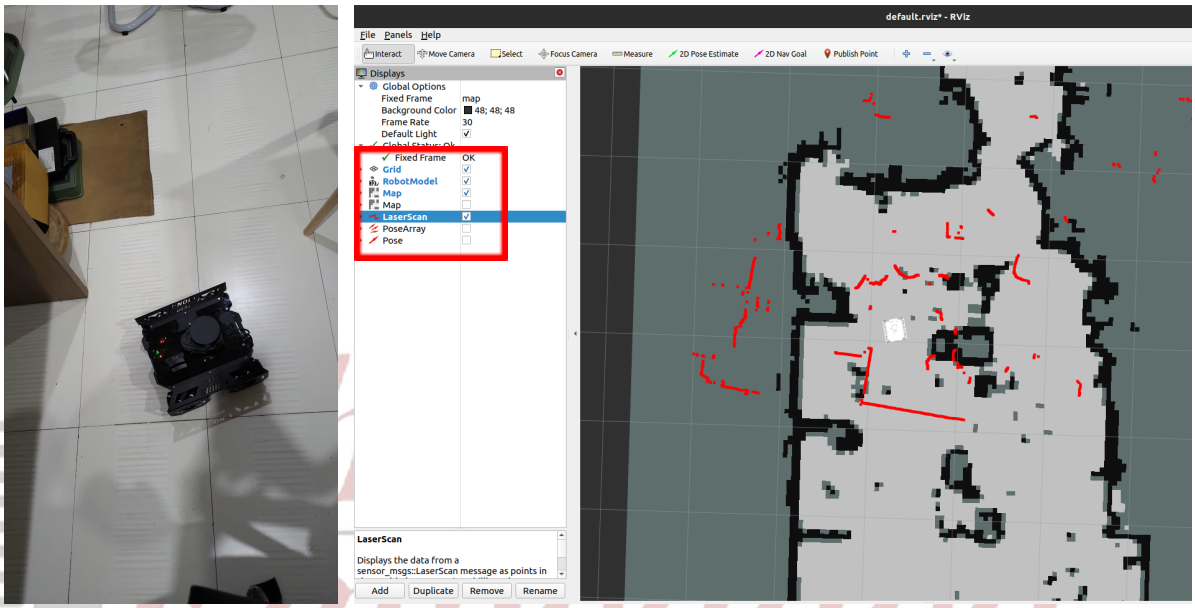


2D Pose Estimate

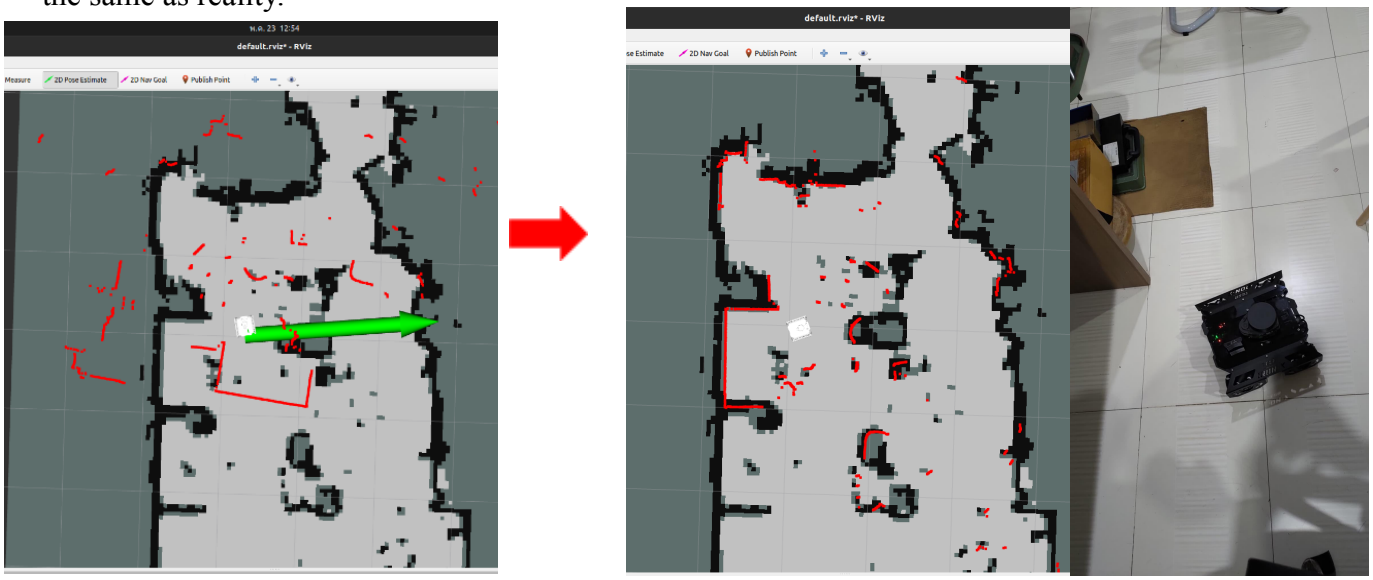
After setting, check if your robot are already at same position on the map. You can re-estimate pose of robot model on the map by click to “2D Pose Estimate”.

You can see if your robot is misplace from the map by observe to laser data or observe from posture of your robot. Compare to the posture in rviz screen.

*you may hide Map>costmap and Pose Array to make you see the different clearly

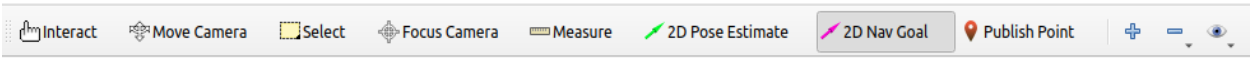


And then, re-estimate pose by press and hold on the map the set position and drag to set the direction for robot on the map. After re-estimate pose, the position and posture will be more the same as reality.

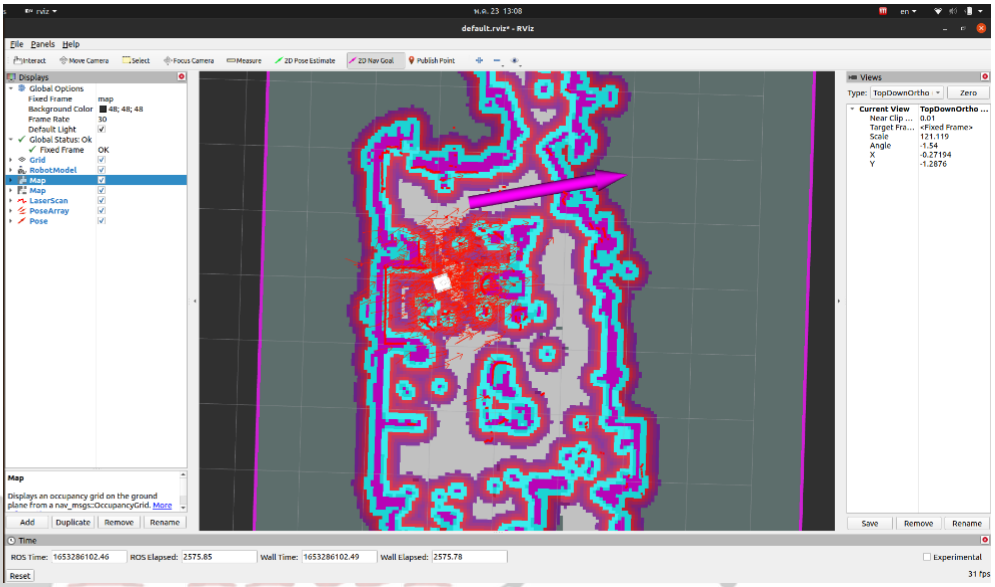


2D Nav Goal

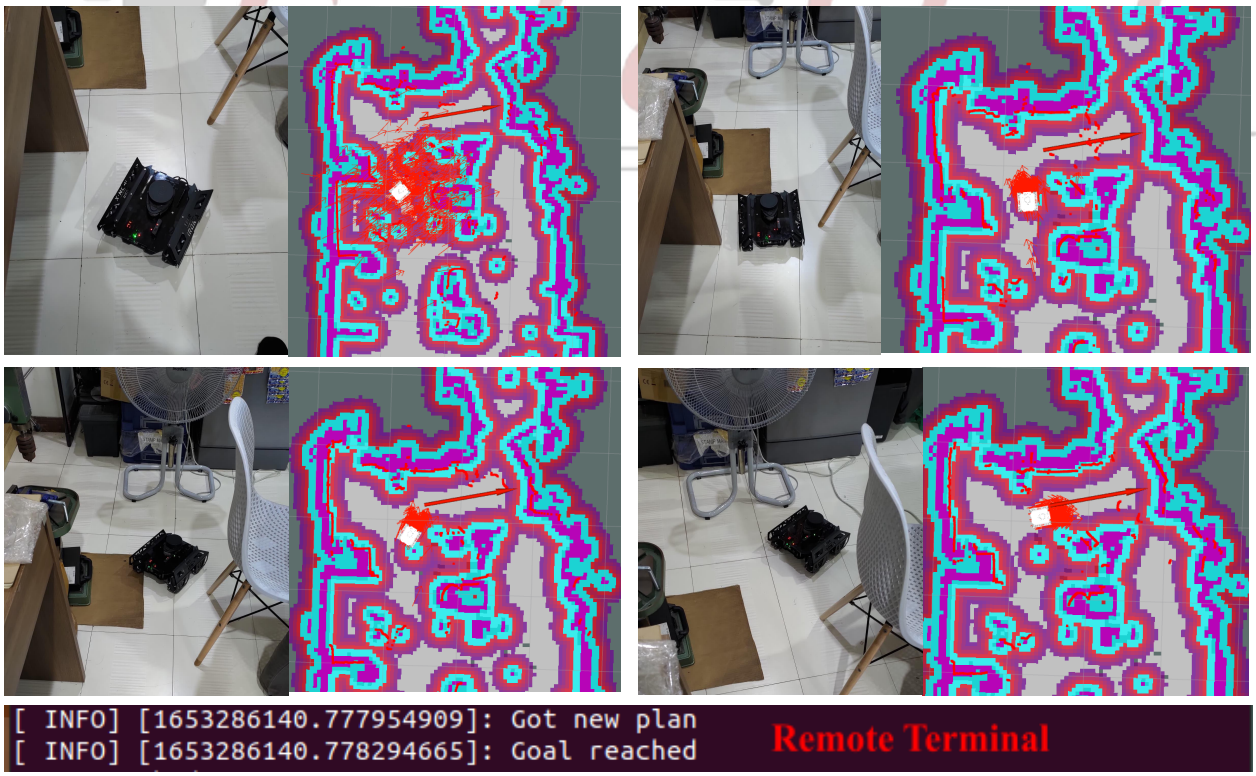
Now, your iron-X will be able to use the navigation for moving around your place or for according to your map_file by “2D Nav Goal” on tools bar of Rviz.



Click “2D Nav Goal” and Click and Drag on the map. The purple arrow will display.



The iron-X will navigate and move to the arrow’s position.



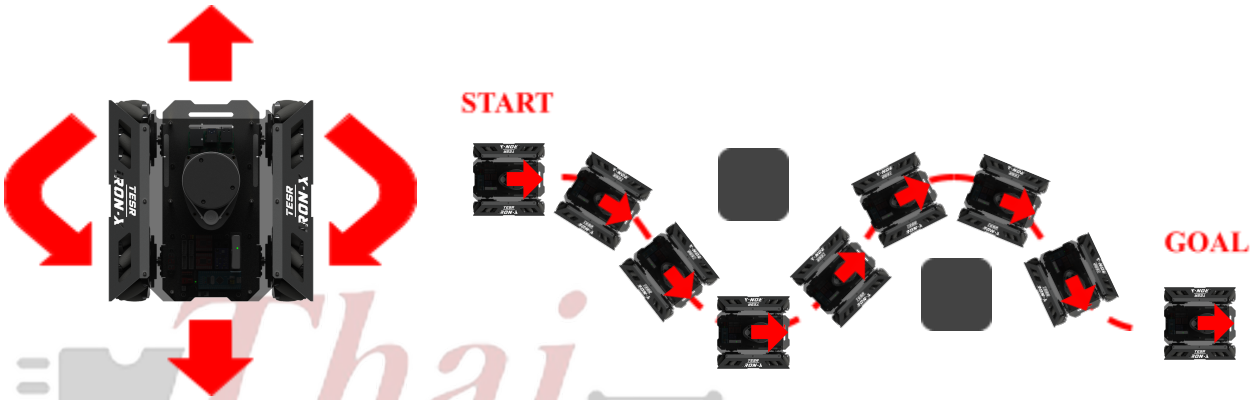
iron-X's move_base type

iron-X is designed to capable for move in 2 system are holonomic and non-holonomic. It can give the definition of move_base_type as:

- Differential drive(non-holonomic)
- Omni drive(holonomic)

Differential Drive(non-holonomic)

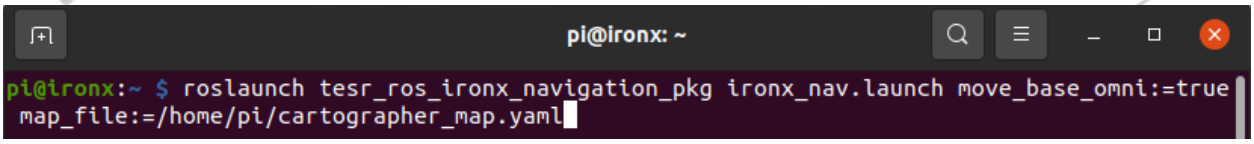
Differential Drive or diff-drive is the default move_base_type of iron-X. This move_base is move as car-like in use case is suitable to transport the objects more than omni-drive.



Omni Drive(holonomic)

Omni Drive is move in holonomic system. So, it give a priority to the motions to goal more than diff-drive. It will suitable to use with robot that needed high mobility.

You can add argument "move_base_omni:=true" in command line to change movement of iron-X to holonomic or "omni-drive" same as below:



"roslaunch tesr_ros_ironx_navigation_pkg ironx_nav.launch **move_base_omni:=true** map_file:=/home/pi/cartographer_map.yaml"