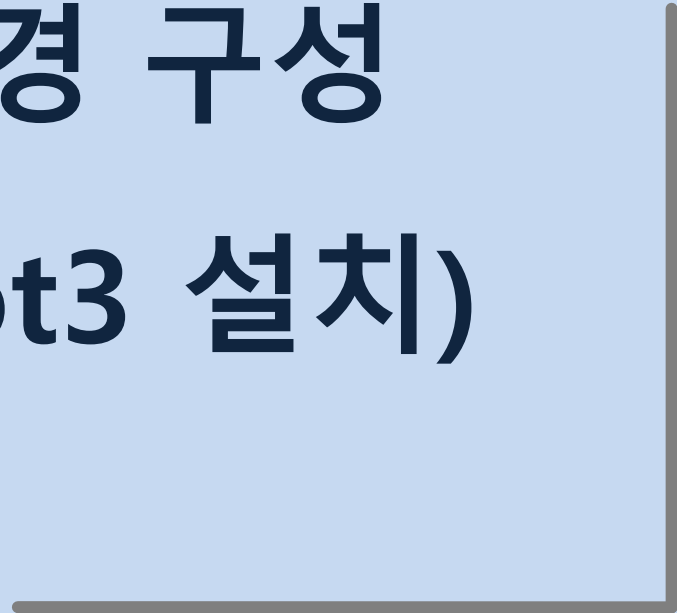


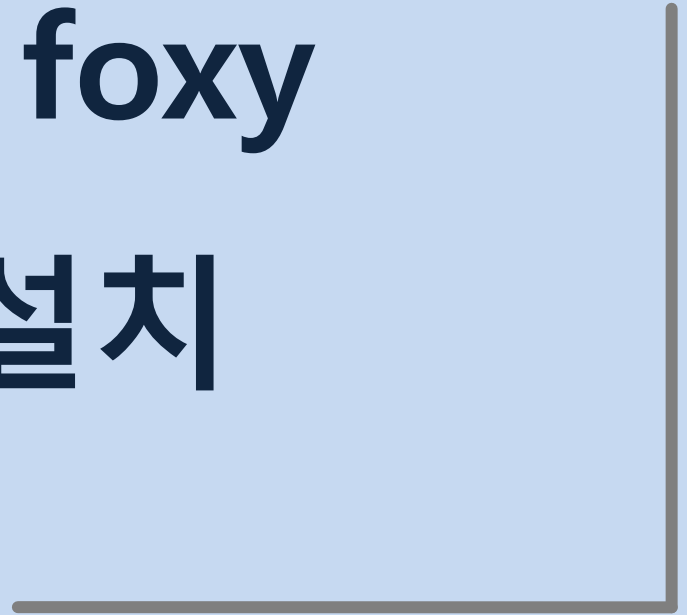


# 개발 환경 구성 (Turtlebot3 설치)





# ROS 2 foxy SBC 설치



# 설치 참고 사이트

## ■ ROS 2 foxy 설치

- [https://emanual.robotis.com/docs/en/platform/turtlebot3/sbc\\_setup/#sbc-setup](https://emanual.robotis.com/docs/en/platform/turtlebot3/sbc_setup/#sbc-setup)
- 링크 접속 후 버전인 **Foxy** 를 반드시 선택

The screenshot shows the TurtleBot3 documentation website. At the top, there is a search bar with the text "Enter Search Terms" and a magnifying glass icon. Below the search bar, there is a navigation menu with the following items: "TurtleBot3", "1. Overview", "2. Features", "3. Quick Start Guide", "3.1. PC Setup", "3.2. SBC Setup", and "3.3. OpenCR Setup". The "3.2. SBC Setup" item is highlighted with a red box. To the right of the search bar, there is a version selection bar with buttons for "Kinetic", "Melodic", "Noetic", "Dashing", "Foxy", "Humble", and "Windows". The "Foxy" button is highlighted with a red box. Below the version selection bar, the "3.2. SBC Setup" section is displayed. It contains a "WARNING" box with the following text: "This process may take long time. Please do not use battery while following this section.", "An HDMI monitor and input devices such as a keyboard and a mouse will be required.", and "In order to use the webOS Robotics Platform, please refer to webOS Robotics Platform". Below the warning box, the "3.2.1. Prepare microSD Card and Reader" section is displayed, with the text "If your PC does not have a microSD slot, please use a microSD card reader to buy".

Enter Search Terms

Kinetic Melodic Noetic Dashing **Foxy** Humble Windows

**TurtleBot3**

1. Overview

2. Features

3. Quick Start Guide

3.1. PC Setup

**3.2. SBC Setup**

3.3. OpenCR Setup

**3.2. SBC Setup**

**WARNING**

- This process may take long time. Please do not use battery while following this section.
- An HDMI monitor and input devices such as a keyboard and a mouse will be required.
- In order to use the webOS Robotics Platform, please refer to [webOS Robotics Platform](#).

**3.2.1. Prepare microSD Card and Reader**

If your PC does not have a microSD slot, please use a microSD card reader to buy

# TurtleBot3 부팅디스크 생성

- microSD Card에 TurtleBot3 SBC Image를 저장함  
(guide 3.2.1~3.2.5 참조)
  - 준비: microSD, TurtleBot3 SBC Image, image굽는 프로그램
  - PC에 microSD를 연결
  - 이미지 굽는 프로그램을 실행함
  - microSD에 Image를 저장함
  - GParted GUI tool을 활용해서 Partition을 확장함

# TurtleBot3 WiFi Network 설정

- TurtleBot3의 WiFi Network를 설정
  - PC에 microSD를 연결
  - 다음 코드를 실행함
    - microSD 이름이 '**writable**'

```
$ cd /media/$USER/writable/etc/netplan
```

```
$ sudo nano 50-cloud-init.yaml
```

- nano 편집기 사용
  - '**WiFi\_SSID**'와 '**WIFI\_PASSWORD**' 수정
  - 저장(Ctrl+S)하고 종료(Ctrl+X)함
  - 들여쓰기는 공백문자 두칸씩

```
network:
  version: 2
  renderer: networkd
  ethernets:
    eth0:
      dhcp4: yes
      dhcp6: yes
      optional: true
  wifis:
    wlan0:
      dhcp4: yes
      dhcp6: yes
      access-points:
        WIFI_SSID:
          password: WIFI_PASSWORD
```

# TurtleBot3 IP 확인

- TurtleBot3 Raspberry Pi 부팅
  - 라즈베리파이 microHDMI 포트에 '모니터' 연결
  - 라즈베리파이 USB 포트에 '키보드' 연결
  - 라즈베리파이에 'microSD 카드'를 삽입
  - TurtleBot3 '파워' 연결
  - 로그인 하기 - id는 'ubuntu', password는 'turtlebot'
    - 부팅 종료 후 '엔터키' 클릭
    - ubuntu login: **ubuntu**
    - Password: **turtlebot**
- IP 확인
  - wlan0의 inet 이후 적힌 숫자들

```
$ ifconfig
```

# Remote PC에서 TurtleBot3 접속

- Remote PC의 터미널(Ctrl+Alt+T) 열기
- 다음 명령어를 입력한 후 접속
  - `ssh ubuntu@{IP Address of Raspberry Pi}`

```
$ ssh ubuntu@192.168.1.30
```

# 배치파일 수정 및 적용

- 배치파일 확인

```
$ nano ~/.bashrc
```

- 배치파일 수정

- 열린 배치파일에서 다음 내용을 추가한 후,
- 저장(Ctrl+S)하고 종료(Ctrl+X)함

```
export ROS_DOMAIN_ID=30  
TURTLEBOT3_MODEL=waffle_pi  
LDS_MODEL=LDS-02
```

- 배치파일 적용

```
$ source ~/.bashrc
```



# OpenCR 설치

- Remote PC에서 TurtleBot3 접속
- OpenCR 설치 (guide 3.3 참조)

```
$ sudo dpkg --add-architecture armhf
$ sudo apt update
$ sudo apt install libc6:armhf

$ export OPENCNCR_PORT=/dev/ttyACM0
$ export OPENCNCR_MODEL=waffle
$ rm -rf ./opencnrcr_update.tar.bz2

$ wget https://github.com/ROBOTIS-GIT/OpenCR-
Binaries/raw/master/turtlebot3/ROS2/latest/opencnrcr_update.tar.bz2
$ tar -xvf ./opencnrcr_update.tar.bz2

$ cd ~/opencnrcr_update
$ ./update.sh $OPENCNCR_PORT $OPENCNCR_MODEL.opencnrcr
```

# Bringup

- Remote PC의 터미널(Ctrl+Alt+T) 열기

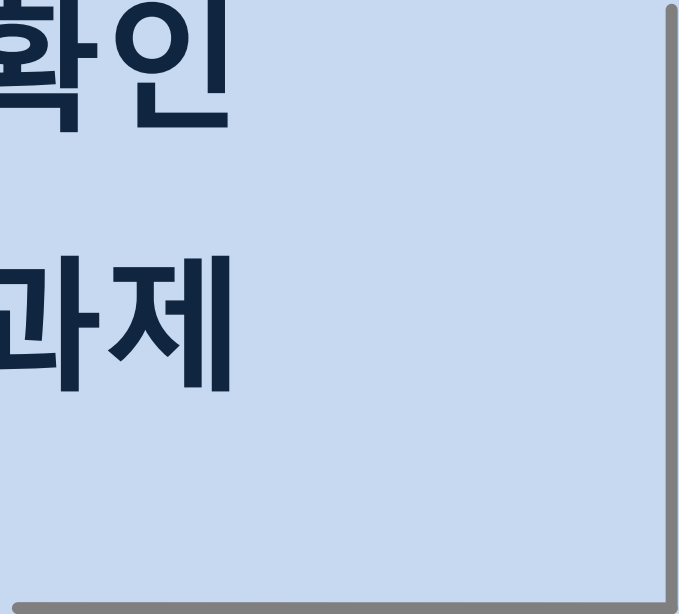
```
$ ssh ubuntu@192.168.1.30
```

- Bring up 실행
  - TurtleBot3의 모든 장치들을 구동함
  - 터미널에 'Run!'이 출력되면 Bringup 성공

```
$ ros2 launch turtlebot3_bringup robot.launch.py
```



# 설치 확인 실습 과제



# TurtleBot3 Bringup

TurtleBot3를 Bringup한 후 다음 코드를 실행한 후 캡처함

```
$ ros2 topic list
```

```
$ ros2 service list
```

ubuntu@ubuntu: ~

ubuntu@ubuntu: ~ 115x5

```
[turtlebot3_ros-3] [INFO] [1690466829.246432636] [turtlebot3_node]: Succeeded to create sound server  
[turtlebot3_ros-3] [INFO] [1690466829.249593980] [turtlebot3_node]: Run!  
[turtlebot3_ros-3] [INFO] [1690466829.290653677] [diff_drive_controller]: Init Odometry  
[turtlebot3_ros-3] [INFO] [1690466829.301637308] [diff_drive_controller]: Run!
```

ksh3717@teacher-com: ~ 56x29

```
ksh3717@teacher-com:~$ ros2 topic list  
/battery_state  
/cmd_vel  
/imu  
/joint_states  
/magnetic_field  
/odom  
/parameter_events  
/robot_description  
/rosout  
/scan  
/sensor_state  
/tf  
/tf_static
```

ksh3717@teacher-com: ~ 57x29

```
ksh3717@teacher-com:~$ ros2 service list  
/diff_drive_controller/describe_parameters  
/diff_drive_controller/get_parameter_types  
/diff_drive_controller/get_parameters  
/diff_drive_controller/list_parameters  
/diff_drive_controller/set_parameters  
/diff_drive_controller/set_parameters_atomically  
/ld08_driver/describe_parameters  
/ld08_driver/get_parameter_types  
/ld08_driver/get_parameters  
/ld08_driver/list_parameters  
/ld08_driver/set_parameters  
/ld08_driver/set_parameters_atomically  
/motor_power
```

# TurtleBot3 움직임

터미널을 2개 열고 아래 코드를 각각 실행시킨 다음  
TurtleBot3를 Remote의 키보드로 움직이고, 결과를 캡처함

```
$ ssh ubuntu@{IP_ADDRESS_OF_RASPBERRY_PI}  
$ ros2 launch turtlebot3_bringup robot.launch.py
```

```
$ ros2 run turtlebot3_teleop teleop_keyboard
```

ksh3717@teacher-com: ~

ubuntu@ubuntu: ~ 56x23

```
[turtlebot3_ros-3] [INFO] [1690466829.229300427] [turtlebot3_node]: Succeeded to create battery state publisher  
[turtlebot3_ros-3] [INFO] [1690466829.233875629] [turtlebot3_node]: Succeeded to create imu publisher  
[turtlebot3_ros-3] [INFO] [1690466829.237156695] [turtlebot3_node]: Succeeded to create sensor state publisher  
[turtlebot3_ros-3] [INFO] [1690466829.239867876] [turtlebot3_node]: Succeeded to create joint state publisher  
[turtlebot3_ros-3] [INFO] [1690466829.240001282] [turtlebot3_node]: Add Devices  
[turtlebot3_ros-3] [INFO] [1690466829.240043634] [turtlebot3_node]: Succeeded to create motor power server  
[turtlebot3_ros-3] [INFO] [1690466829.243493346] [turtlebot3_node]: Succeeded to create reset server  
[turtlebot3_ros-3] [INFO] [1690466829.246432636] [turtlebot3_node]: Succeeded to create sound server  
[turtlebot3_ros-3] [INFO] [1690466829.249593980] [turtlebot3_node]: Run!  
[turtlebot3_ros-3] [INFO] [1690466829.290653677] [diff_drive_controller]: Init Odometry  
[turtlebot3_ros-3] [INFO] [1690466829.301637308] [diff_drive_controller]: Run!
```

ksh3717@teacher-com: ~ 57x23

```
ksh3717@teacher-com:~$ ros2 run turtlebot3_teleop teleop_keyboard
```

Control Your TurtleBot3!

-----  
Moving around:

w		
a	s	d
	x	

w/x : increase/decrease linear velocity (Burger : ~ 0.22, Waffle and Waffle Pi : ~ 0.26)

a/d : increase/decrease angular velocity (Burger : ~ 2.84, Waffle and Waffle Pi : ~ 1.82)

space key, s : force stop

CTRL-C to quit

currently: linear velocity 0.01 angular velocity 0.0

currently: linear velocity 0.02 angular velocity 0.0

# Topic Monitor

TurtleBot3를 움직이며 다음 ROS 도구를 실행한 후 변화를 캡처함

\$ rqt

[Plugins]-[Topics]-[Topic Monitor] 메뉴 클릭

'/odom' 왼쪽 체크 후 header, pose, twist의 모든 값을 얻 후 값의 변화를 확인함

