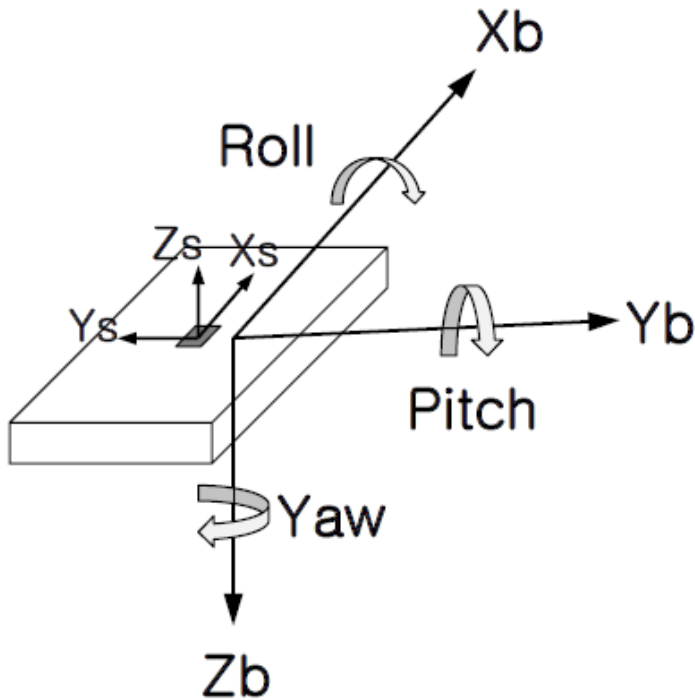
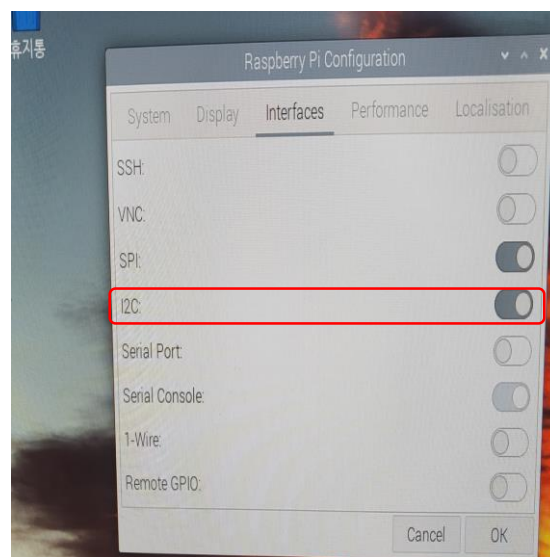
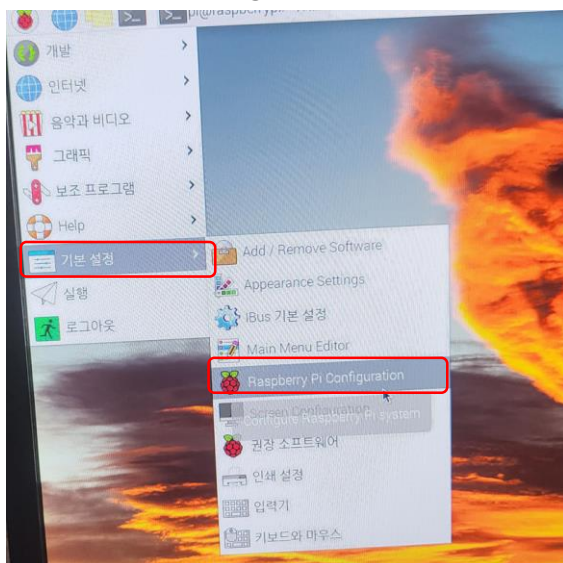


1. 자이로센서 (교재 p. 434, ch9)



* i2c 디바이스 설정 (교재 p.321, ch6)

\$ sudo raspi-config 또는 다음과 같이 설정



\$ sudo nano /boot/config.txt

(dtparam=i2c_arm=on 이렇게 체크되어 있는지 확인)

```
GNU nano 5.4 /boot/config.txt *
# uncomment to increase signal to HDMI, if you have interference, blanking, or
# no display
#config_hdmi_boost=4

# uncomment for composite PAL
#sdtv_mode=2

#uncomment to overclock the arm. 700 MHz is the default.
#arm_freq=800

# Uncomment some or all of these to enable the optional hardware interfaces
dtparam=i2c_arm=on
#dtparam=i2s=on
dtparam=spi=on
```

\$ sudo adduser pi i2c

```
pi@raspberrypi:~/EduIoT/Ch09_Gyro Sensor $ sudo adduser pi i2c
'pi' 사용자는 이미 i2c의 일원입니다.
pi@raspberrypi:~/EduIoT/Ch09_Gyro Sensor $
```

\$ sudo nano /etc/modules

(i2c-dev 추가)

```
파일(F) 편집(E) 탭(T) 도움말(H)
GNU nano 5.4 /etc/modules
# /etc/modules: kernel modules to load at boot time.
#
# This file contains the names of kernel modules that should be loaded
# at boot time, one per line. Lines beginning with "#" are ignored.
i2c-dev
```

\$ sudo apt-get install i2c-tools

```
pi@raspberrypi:~/EduIoT/Ch09_Gyro Sensor $ sudo apt-get install i2c-tools
패키지 목록을 읽는 중입니다... 완료
의존성 트리를 만드는 중입니다... 완료
상태 정보를 읽는 중입니다... 완료
i2c-tools is already the newest version (4.2-1+b1).
다음 패키지가 자동으로 설치되었지만 더 이상 필요하지 않습니다:
  libfuse2
Use 'sudo apt autoremove' to remove it.
0개 업그레이드, 0개 새로 설치, 0개 제거 및 27개 업그레이드 안 함.
pi@raspberrypi:~/EduIoT/Ch09_Gyro Sensor $
```

```
$ sudo apt-get install python3-smbus
```

```
pi@raspberrypi:~/EduIoT/Ch09_Gyro Sensor $ sudo apt-get install python3-smbus
패키지 목록을 읽는 중입니다... 완료
의존성 트리를 만드는 중입니다... 완료
상태 정보를 읽는 중입니다... 완료
python3-smbus is already the newest version (4.2-1+b1).
다음 패키지가 자동으로 설치되었지만 더 이상 필요하지 않습니다:
  libfuse2
Use 'sudo apt autoremove' to remove it.
0개 업그레이드, 0개 새로 설치, 0개 제거 및 27개 업그레이드 안 함.
pi@raspberrypi:~/EduIoT/Ch09_Gyro Sensor $
```

```
$ sudo i2cdetect -y 1
```

```
pi@raspberrypi:~/EduIoT/Ch09_Gyro Sensor $ sudo i2cdetect -y 1
   0  1  2  3  4  5  6  7  8  9  a  b  c  d  e  f
00:  -- -- -- -- -- -- -- -- -- -- -- -- -- --
10:  -- -- -- -- -- -- -- -- -- -- -- -- -- --
20:  -- -- -- -- -- -- -- -- -- -- -- -- -- --
30:  -- -- -- -- -- -- -- -- -- -- -- -- -- --
40:  -- -- -- -- -- -- -- -- -- -- -- -- -- --
50:  -- -- -- -- -- -- -- -- -- -- -- -- -- --
60:  -- -- -- -- -- 69 -- -- -- -- -- -- -- --
70:  -- -- -- -- -- -- -- -- -- -- -- -- -- --
pi@raspberrypi:~/EduIoT/Ch09_Gyro Sensor $
```

```
$ python3 L3G4200D.py
```

```
GNU nano 5.4 L3G4200D.py
#!/usr/bin/python3
import smbus
import time

class L3G4200D(object):

    # Minimal constants carried over from Arduino library
    L3G4200D_ADDRESS = 0x69 #0110100x
    address = L3G4200D_ADDRESS

    L3G4200D_REGISTER_WHO_AM_I = 0x0F
    L3G4200D_REGISTER_CTRL_REG1 = 0x20
    L3G4200D_REGISTER_CTRL_REG2 = 0x21
    L3G4200D_REGISTER_CTRL_REG3 = 0x22
    L3G4200D_REGISTER_CTRL_REG4 = 0x23
    L3G4200D_REGISTER_CTRL_REG5 = 0x24
    L3G4200D_REGISTER_OUT_X_L = 0x28
    L3G4200D_REGISTER_OUT_X_H = 0x29
    L3G4200D_REGISTER_OUT_Y_L = 0x2A
    L3G4200D_REGISTER_OUT_Y_H = 0x2B
    L3G4200D_REGISTER_OUT_Z_L = 0x2C
    L3G4200D_REGISTER_OUT_Z_H = 0x2D

    g = [0., 0., 0.]

    def __init__(self, debug=False, hires=False):
        # addresses, so invoke a separate I2C instance for each
        self.bus = smbus.SMBus(1) # if rev 1, use SMBus(0)
        if self.bus.read_byte_data(self.address,
            self.L3G4200D_REGISTER_WHO_AM_I)&0xFF is not 0xD3:
            print("error")
        # Enable x, y, z and bandwidth 800Hz, cutoff 30Hz and turn off power down
        self.bus.write_byte_data(self.address,
            self.L3G4200D_REGISTER_CTRL_REG1, 0xCF)
        # adjust/use the HPF cutoff 30Hz
        self.bus.write_byte_data(self.address,
            self.L3G4200D_REGISTER_CTRL_REG2, 0x01)
        # No interrupts used on INT1, Data Ready on INT2
        self.bus.write_byte_data(self.address,
            self.L3G4200D_REGISTER_CTRL_REG3, 0x08)
        # full-scale range
        self.bus.write_byte_data(self.address,
            self.L3G4200D_REGISTER_CTRL_REG4, 0x00)
        # output selection
        self.bus.write_byte_data(self.address,
            self.L3G4200D_REGISTER_CTRL_REG5, 0x02)
```


pi@raspberrypi: ~/RaspberrypiwithIOT/ch9/imu

파일(F) 편집(E) 탭(T) 도움말(H)

GNU nano 5.4

L3G4200D.py

```
self.bus.write_byte_data(self.address,
    self.L3G4200D_REGISTER_CTRL_REG5, 0x02)

def gyro16(self, high, low):
    n = (high << 8) | low # High, low bytes
    return n # 2's complement signed

def readList(self):
    # Read the gyroscope
    low = self.bus.read_byte_data(self.address,
        self.L3G4200D_REGISTER_OUT_X_L)
    high = self.bus.read_byte_data(self.address,
        self.L3G4200D_REGISTER_OUT_X_H)
    x = self.gyro16(high, low)
    low = self.bus.read_byte_data(self.address,
        self.L3G4200D_REGISTER_OUT_Y_L)
    high = self.bus.read_byte_data(self.address,
        self.L3G4200D_REGISTER_OUT_Y_H)
    y = self.gyro16(high, low)
    low = self.bus.read_byte_data(self.address,
        self.L3G4200D_REGISTER_OUT_Z_L)
    high = self.bus.read_byte_data(self.address,
        self.L3G4200D_REGISTER_OUT_Z_H)
    z = self.gyro16(high, low)
    if x & 0x8000: x -= 65536
    if y & 0x8000: y -= 65536
    if z & 0x8000: z -= 65536

    fs=self.bus.read_byte_data(self.address,
        self.L3G4200D_REGISTER_CTRL_REG4)&0x30
    ci=self.bus.read_byte_data(self.address,
        self.L3G4200D_REGISTER_CTRL_REG1)

    s = 0.
    if fs == 0x00: s=8.75
    elif fs == 0x10: s=17.5
    elif fs == 0x20: s=70
    elif fs == 0x30: s=70
    self.g[0] = float(x) * s / 1000.
    self.g[1] = float(y) * s / 1000.
    self.g[2] = float(z) * s / 1000.

    return self.g

if __name__ == '__main__':
    l3d4200d = L3G4200D()

    while True:
        data = l3d4200d.readList()
        print("read value is %f,\t%f,\t%f" % (data[0], data[1], data[2]))
        time.sleep(1)

    l3d4200d.close()
```

I

```
파일(F) 편집(E) 탭(T) 도움말(H)
read value is 0.612500, -0.848750, 0.026250
read value is 0.726250, -0.883750, -0.385000
read value is 0.612500, -0.918750, -2.170000
read value is 0.498750, -1.058750, 0.140000
read value is 0.866250, -1.050000, -0.087500
read value is 0.586250, -0.673750, -2.231250
read value is 0.962500, -1.076250, -0.061250
read value is 0.805000, -0.822500, -0.061250
read value is 0.752500, -0.805000, -0.253750
read value is 0.708750, -0.813750, 0.157500
read value is 0.568750, -1.085000, 0.437500
read value is 0.953750, -0.656250, -0.078750
read value is 0.796250, -0.962500, -0.157500
read value is 0.612500, -0.638750, -0.315000
read value is 0.665000, -1.050000, -0.061250
read value is 0.647500, -1.015000, 0.017500
read value is 0.813750, -0.840000, 0.000000
read value is 0.673750, -1.093750, 0.533750
read value is 0.647500, -1.198750, -0.096250
read value is 0.621250, -0.980000, 0.498750
read value is 0.787500, -0.918750, -0.140000
read value is 0.988750, -0.883750, -2.213750
read value is 1.050000, -0.918750, -2.161250
```

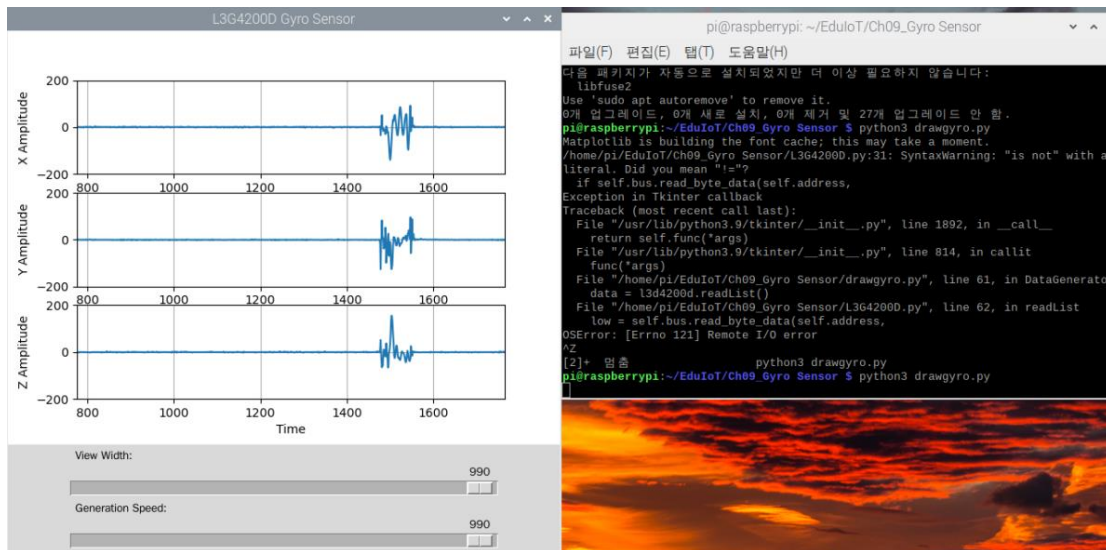
\$ sudo apt update

```
pi@raspberrypi:~/EduIoT/Ch09_Gyro Sensor $ sudo apt update
기존:1 http://deb.debian.org/debian bullseye InRelease
기존:2 http://deb.debian.org/debian bullseye-updates InRelease
기존:3 http://security.debian.org/debian-security bullseye-security InRelease
기존:4 http://archive.raspberrypi.org/debian bullseye InRelease
패키지 목록을 읽는 중입니다... 완료
의존성 트리를 만드는 중입니다... 완료
상태 정보를 읽는 중입니다... 완료
27 packages can be upgraded. Run 'apt list --upgradable' to see them.
pi@raspberrypi:~/EduIoT/Ch09_Gyro Sensor $
```

\$ sudo apt install python3-matplotlib

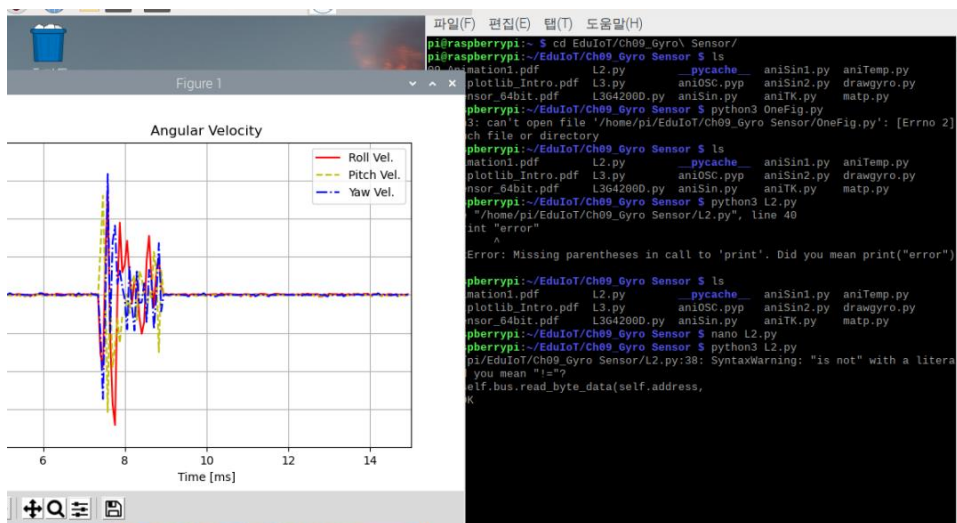
```
pi@raspberrypi:~/EduIoT/Ch09_Gyro Sensor $ sudo apt install python3-matplotlib
패키지 목록을 읽는 중입니다... 완료
의존성 트리를 만드는 중입니다... 완료
상태 정보를 읽는 중입니다... 완료
python3-matplotlib is already the newest version (3.3.4-1).
python3-matplotlib 패키지는 수동설치로 지정합니다.
다음 패키지가 자동으로 설치되었지만 더 이상 필요하지 않습니다:
  libfuse2
Use 'sudo apt autoremove' to remove it.
0개 업그레이드, 0개 새로 설치, 0개 제거 및 27개 업그레이드 안 함.
pi@raspberrypi:~/EduIoT/Ch09_Gyro Sensor $
```

\$ python3 drawgyro.py



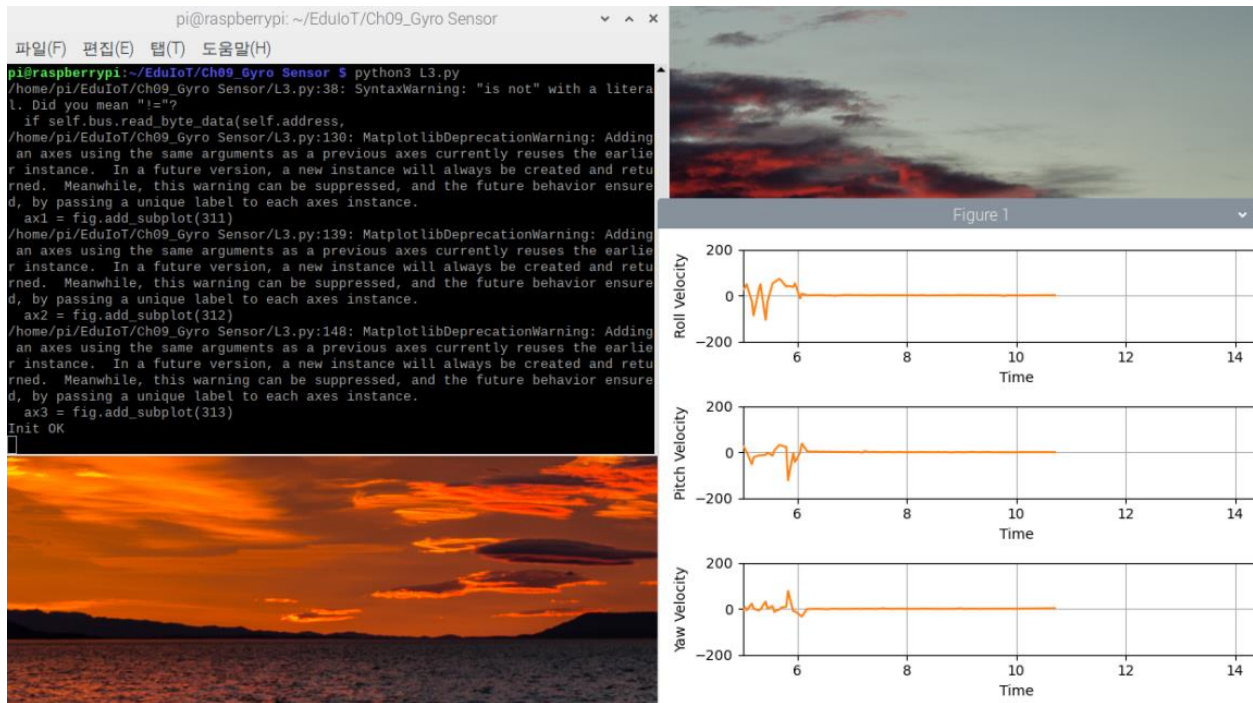
\$ python3 L2.py

(print ("error")에서 괄호 추가 후 실행)



\$ python3 L3.py

(print ("error")에서 괄호 추가 후 실행)



\$ python3 aniSin1.py

