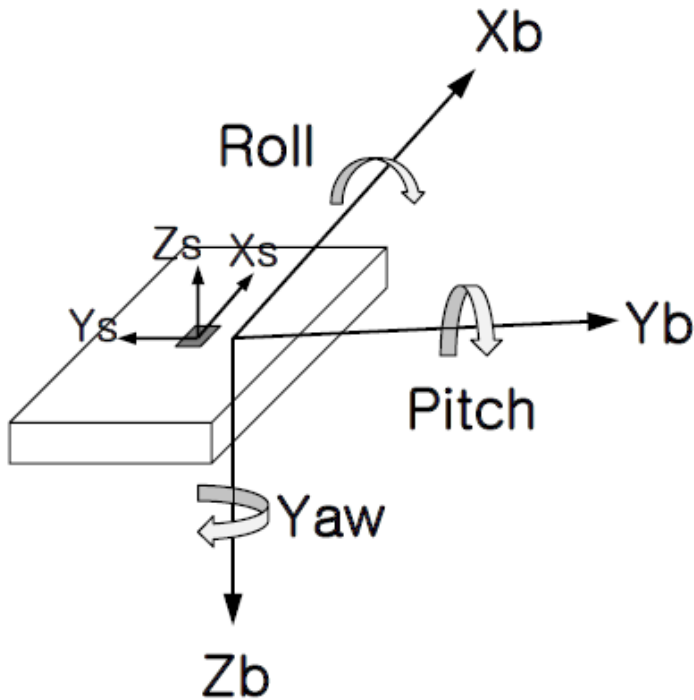
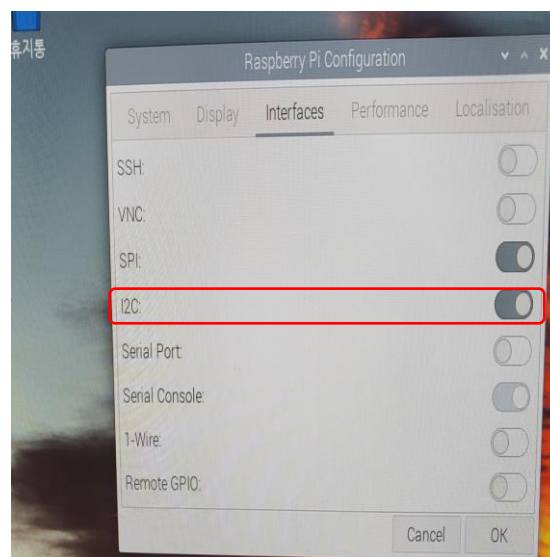
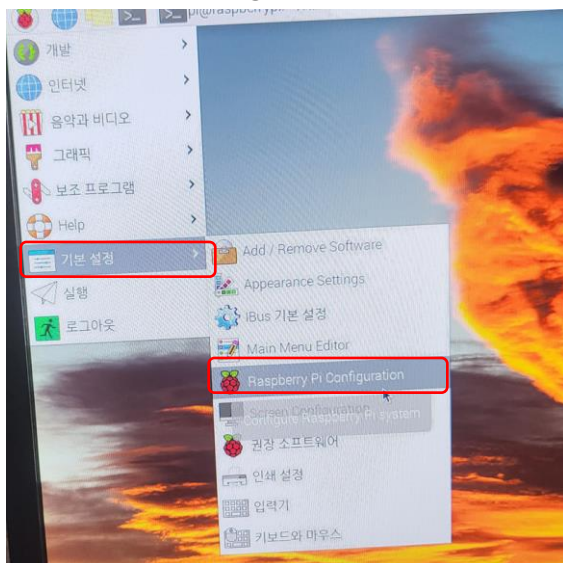


1. 자이로센서 (교재 p. 434, ch9)



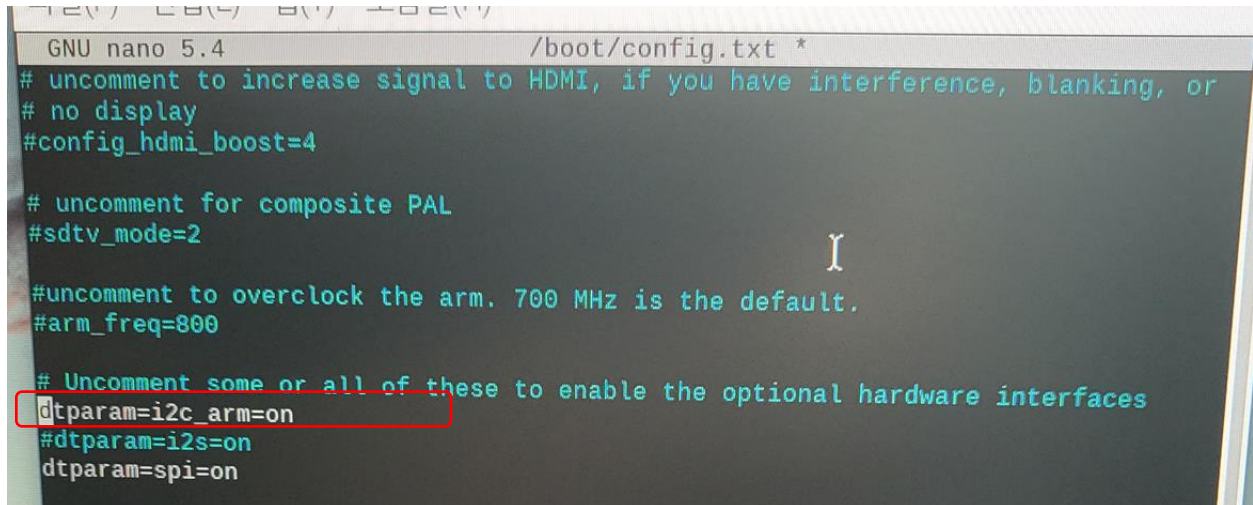
* i2c 디바이스 설정 (교재 p.321, ch6)

\$ sudo raspi-config 또는 다음과 같이 설정



\$ sudo nano /boot/config.txt

(dtparam=i2c_arm=on 이렇게 체크되어 있는지 확인)



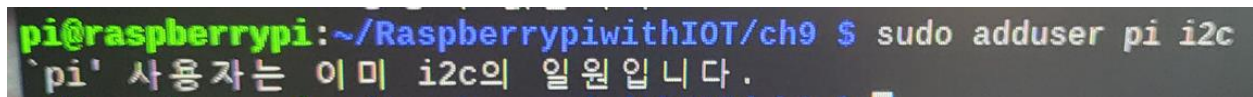
```
GNU nano 5.4 /boot/config.txt *
# uncomment to increase signal to HDMI, if you have interference, blanking, or
# no display
#config_hdmi_boost=4

# 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
```

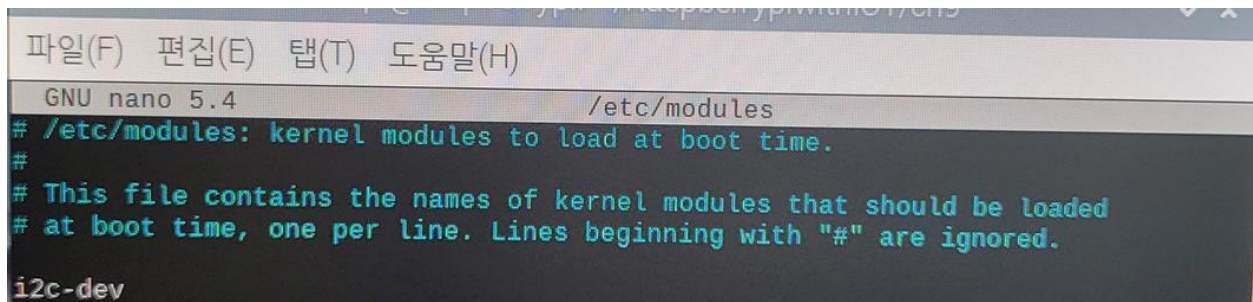
\$ sudo adduser pi i2c



```
pi@raspberrypi:~/RaspberrypiwithIOT/ch9 $ sudo adduser pi i2c
'pi' 사용자는 이미 i2c의 일원입니다.
```

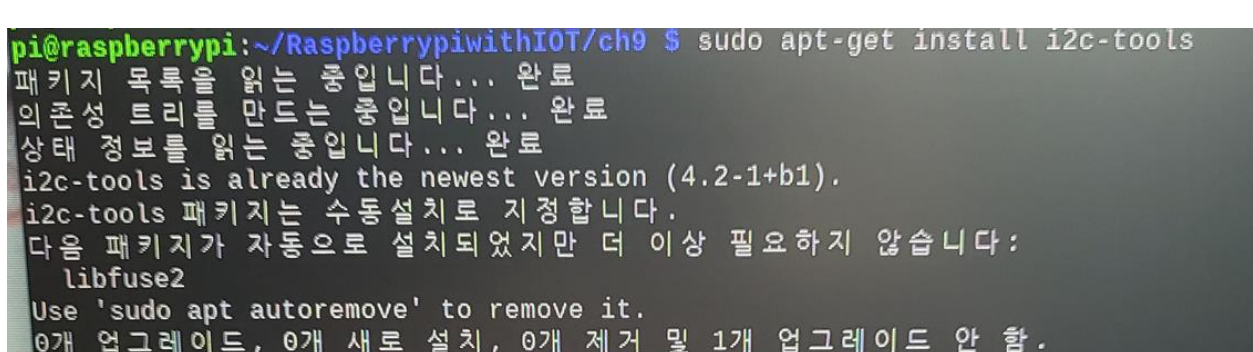
\$ sudo nano /etc/modules

(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:~/RaspberrypiwithIOT/ch9 $ 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).
i2c-tools 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 1개 업그레이드 안 함.
```

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

```
pi@raspberrypi:~/RaspberrypiwithIOT/ch9 $ 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 1개 업그레이드 안 함.
pi@raspberrypi:~/RaspberrypiwithIOT/ch9 $
```

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

```
L3G4200D_spi.py MPU6050.py ThreeI2C.py
pi@raspberrypi:~/RaspberrypiwithIOT/ch9/imu $ 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:~/RaspberrypiwithIOT/ch9/imu $ python3
```

```
$ 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 RPF 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, 0x00)
        # 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)
```



```

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,%t" % (data[0], data[1], data[2]))
        time.sleep(1)

    l3d4200d.close()

```

\$ sudo apt update

```
ImportError: No module named matplotlib
pi@raspberrypi:~/RaspberrypiwithIOT/ch9/imu $ sudo apt update
기존:1 http://deb.debian.org/debian bullseye InRelease
기존:2 http://security.debian.org/debian-security bullseye-security InRelease
기존:3 http://deb.debian.org/debian bullseye-updates 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
pi@raspberrypi:~/RaspberrypiwithIOT/ch9/imu $
```

\$ sudo apt install python3-matplotlib

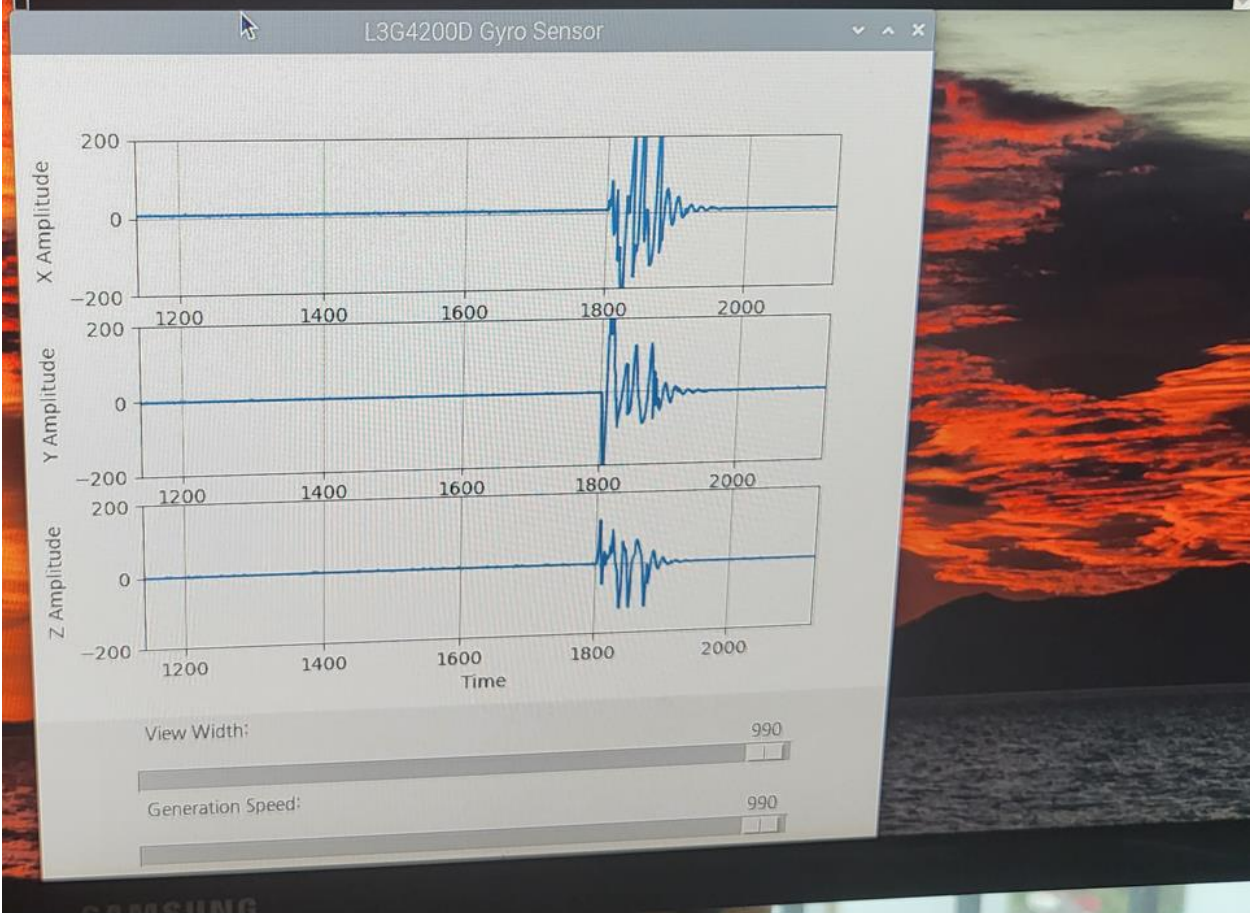
```
pi@raspberrypi:~/RaspberrypiwithIOT/ch9/imu $ sudo apt install python3-matplotlib python3-numpy
패키지 목록을 읽는 중입니다... 완료
의존성 트리를 만드는 중입니다... 완료
상태 정보를 읽는 중입니다... 완료
python3-numpy is already the newest version (1:1.19.5-1).
다음 패키지가 자동으로 설치되었지만 더 이상 필요하지 않습니다:
libfuse2
Use 'sudo apt autoremove' to remove it.
The following additional packages will be installed:
  fonts-lyx libjs-jquery-ui python-matplotlib-data python3-cycler python3-dateutil python3-kiwisolver
  python3-pyparsing ttf-bitstream-vera
제안하는 패키지:
  libjs-jquery-ui-docs python-cycler-doc dvipng inkscape ipython3 python-matplotlib-doc python3-cairocffi
  python3-gobject python3-nose python3-scipy python3-sip python3-tornado texlive-extra-utils
  texlive-latex-extra ttf-staypuft python-pyparsing-doc
다음 새 패키지를 설치할 것입니다:
  fonts-lyx libjs-jquery-ui python-matplotlib-data python3-cycler python3-dateutil python3-kiwisolver
  python3-matplotlib python3-pyparsing ttf-bitstream-vera
0개 업그레이드, 9개 새로 설치, 0개 제거 및 1개 업그레이드 안 함.
9,170 바이트 아카이브를 받아야 합니다.
이 작업 후 25.4 M바이트의 디스크 공간을 더 사용하게 됩니다.
계속 하시겠습니까? [Y/n]
```

(중략)

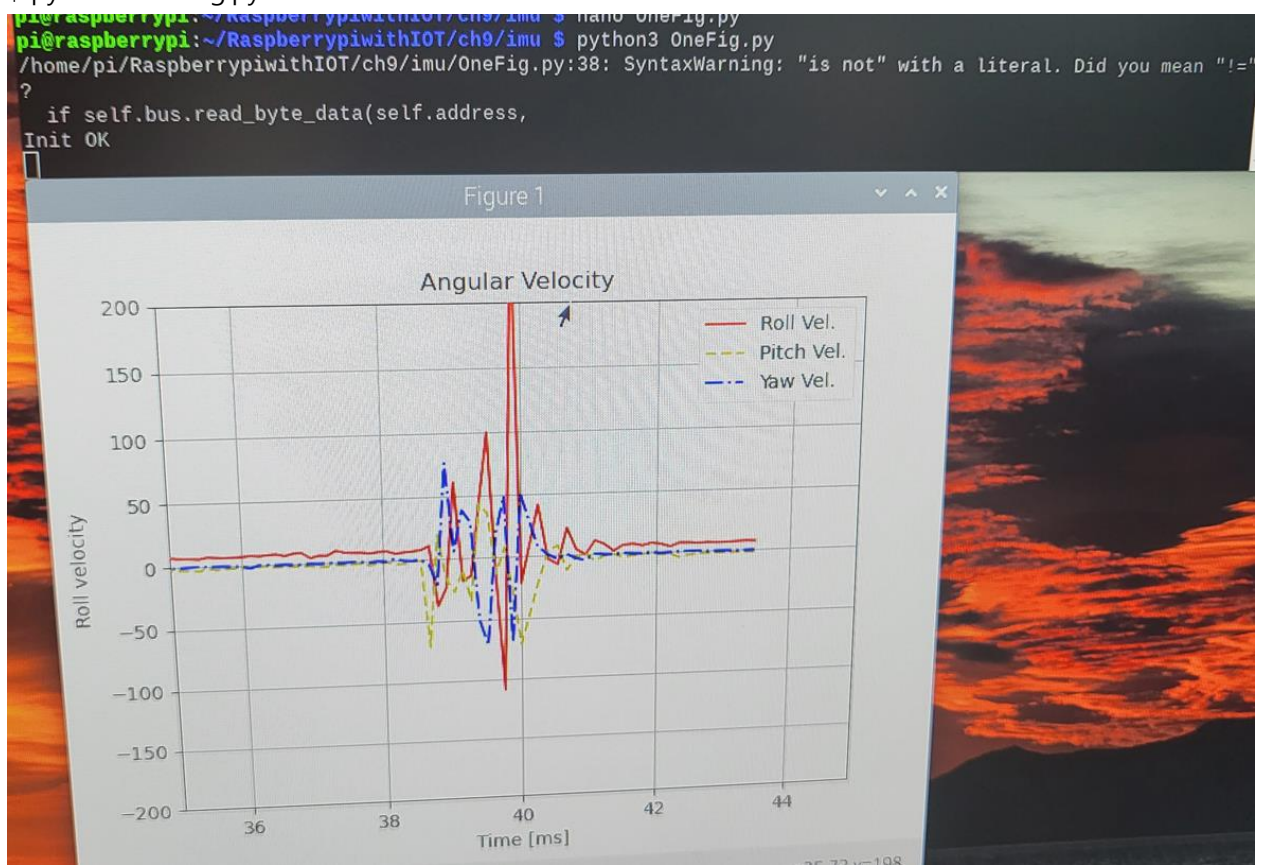
```
Unpacking python3-kiwisolver (1.3.1-1+b1) ...
Selecting previously unselected package python3-pyparsing.
Preparing to unpack .../7-python3-pyparsing_2.4.7-1_all.deb ...
Unpacking python3-pyparsing (2.4.7-1) ...
Selecting previously unselected package python3-matplotlib.
Preparing to unpack .../8-python3-matplotlib_3.3.4-1_arm64.deb ...
Unpacking python3-matplotlib (3.3.4-1) ...
ttf-bitstream-vera (1.10-8.1) 설정하는 중입니다 ...
fonts-lyx (2.3.6-1) 설정하는 중입니다 ...
libjs-jquery-ui (1.12.1+dfsg-8+deb11u1) 설정하는 중입니다 ...
python3-pyparsing (2.4.7-1) 설정하는 중입니다 ...
python3-cycler (0.10.0-3) 설정하는 중입니다 ...
python3-kiwisolver (1.3.1-1+b1) 설정하는 중입니다 ...
python3-dateutil (2.8.1-6) 설정하는 중입니다 ...
python-matplotlib-data (3.3.4-1) 설정하는 중입니다 ...
python3-matplotlib (3.3.4-1) 설정하는 중입니다 ...
Processing triggers for fontconfig (2.13.1-4.2) ...
pi@raspberrypi:~/RaspberrypiwithIOT/ch9/imu $
```

\$ python3 drawgyro.py

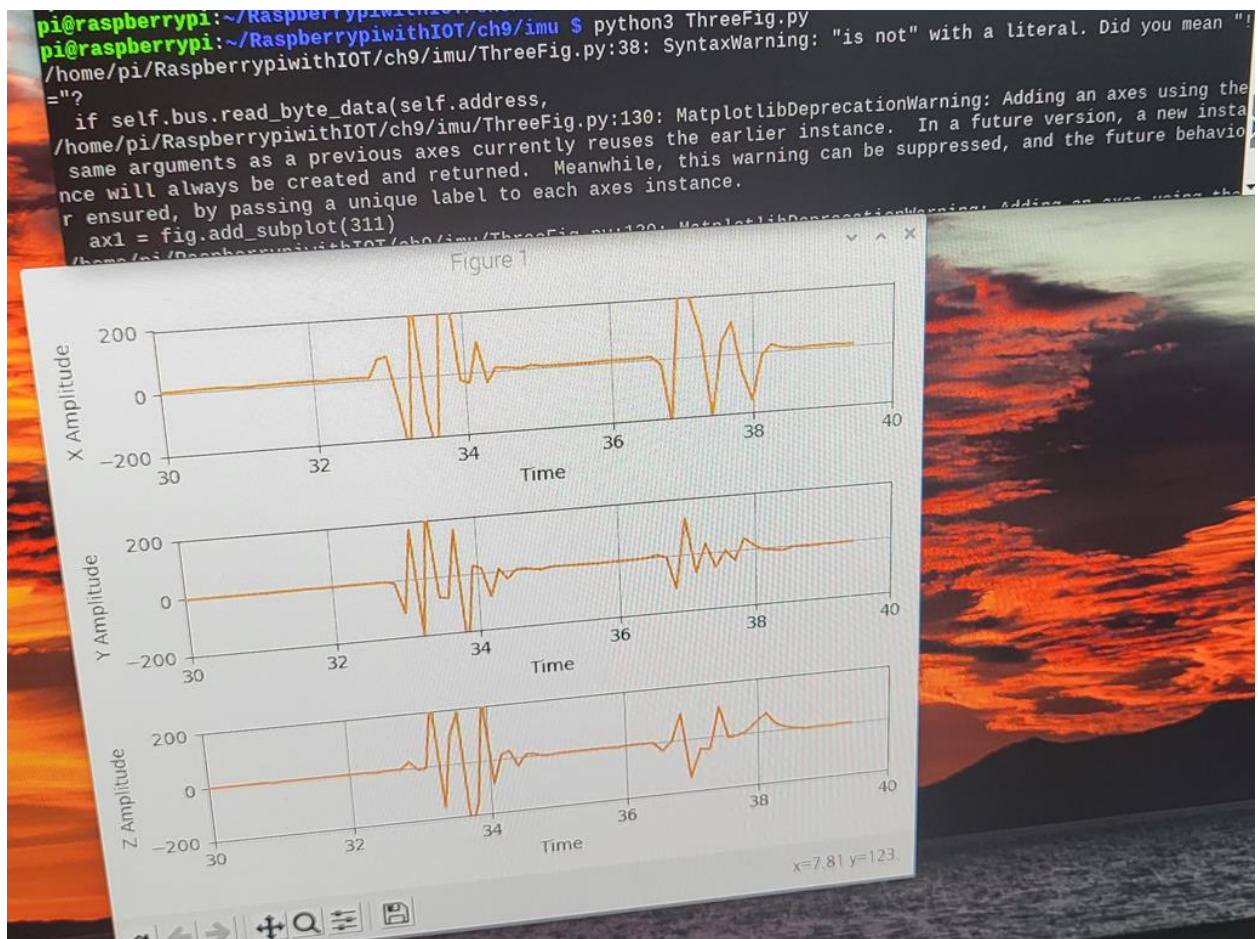

```
pi@raspberrypi:~/RaspberrypiwithIOT/ch9/imu $ python3 drawgyro.py
/home/pi/RaspberrypiwithIOT/ch9/imu/L3G4200D.py:31: SyntaxWarning: "is not" with a literal. Did you mean "!="?
if self.bus.read_byte_data(self.address,
```



```
$ python3 OneFig.py
```

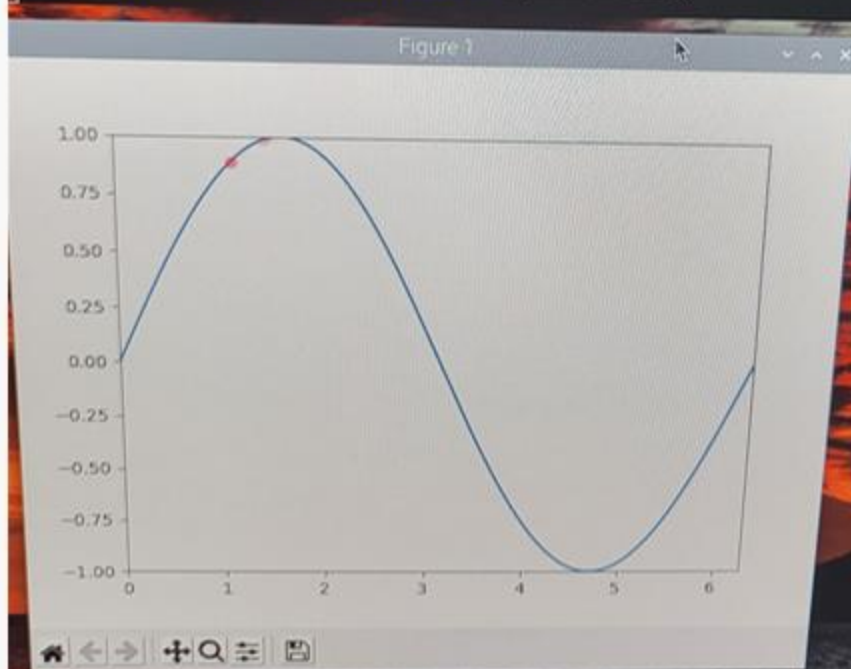


```
$ python3 ThreeFig.py
```



\$ python3 aniSin.py


```
lsmb30ENC.py OneFig.py _pycache_ drawaccmag.py pedometer.py
364200D.py LSM303DLHC.pyc RTIMULib.ini ahrs.py drawgyro.py
364200D_spi.py MPU6050.py ThreeFig.py aniSin.py ecompass.py
pi@raspberrypi:~/RaspberrypiwithIOT/ch0/imu $ python3 aniSin.py
```



SAMSUNG