

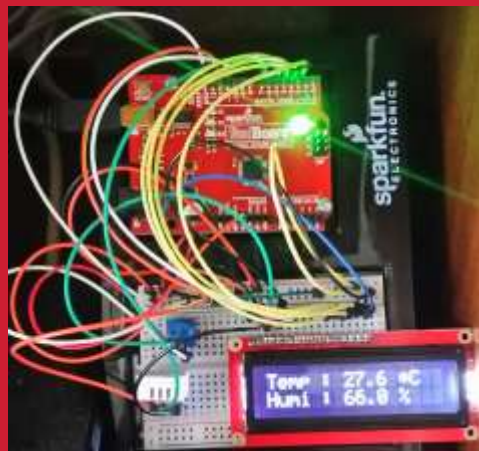


Arduino-IoT

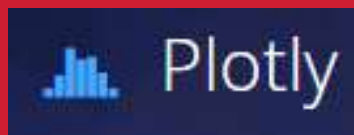
[wk14]

nano33 BLE sensor

IMU: acc, gyro, mag



Visualization of Signals using Arduino,
Node.js & storing signals in MongoDB
& mining iot data using Python



Drone-IoT-Comsi, INJE University

2nd semester, 2022

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My ID

ID를 확인하고 github에 repo 만들기

AA01	강대진	AA13	박제홍
		AA14	심준혁
AA03	김성우	AA15	이상혁
AA04	김정현	AA16	이승무
		AA17	이승준
AA06	김창연	AA18	이준희
AA07	김창욱	AA19	이현준
AA08	김태화	AA20	임태형
AA09	남승현	AA21	정동현
AA10	류재환		
AA11	박세훈	AA23	정희서
AA12	박신영	AA24	최재형

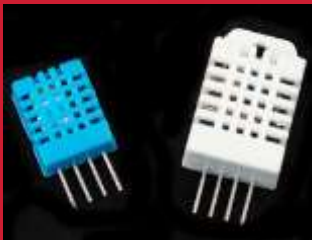
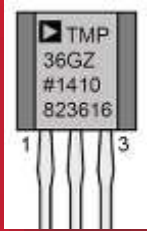
위의 id를 이용해서 github에 repo를 만드시오.

Option: 아두이노응용 실습 과제 - AAnn

Public, README.md check



[Practice]



◆ [wk13]

- IoT Project: nano33ble
- Multi-sensor circuits : IMU
- Complete your project
- Upload folder: aann-rpt13
- Use repo “aann” in github

wk13 : Practice : aann-rpt13

◆ [Target of this week]

- Complete your works
- Save your outcomes and upload outputs in github

제출폴더명 : **aann-rpt13**

제출할 파일들

- ① **gesture.ino**
- ② **LSM9DS1_Basic.ino**
- ③ **LSM9DS1_IoT.ino**

Purpose of AA

주요 수업 목표는 다음과 같다.

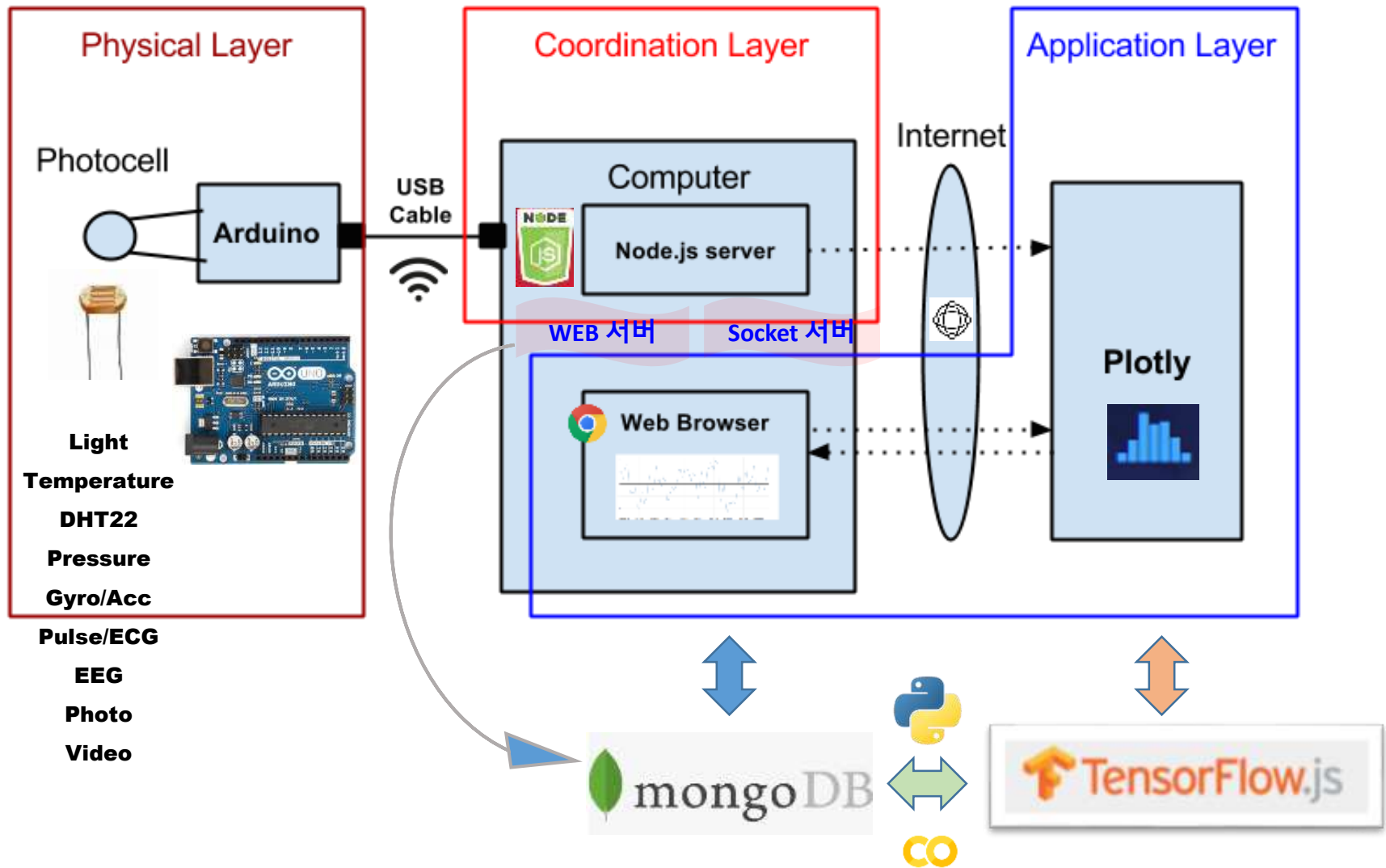
1. Node.js를 이용한 아두이노 센서 신호 처리
2. Plotly.js를 이용한 아두이노 센서 신호 시각화
3. MongoDB에 아두이노 센서 데이터 저장 및 처리

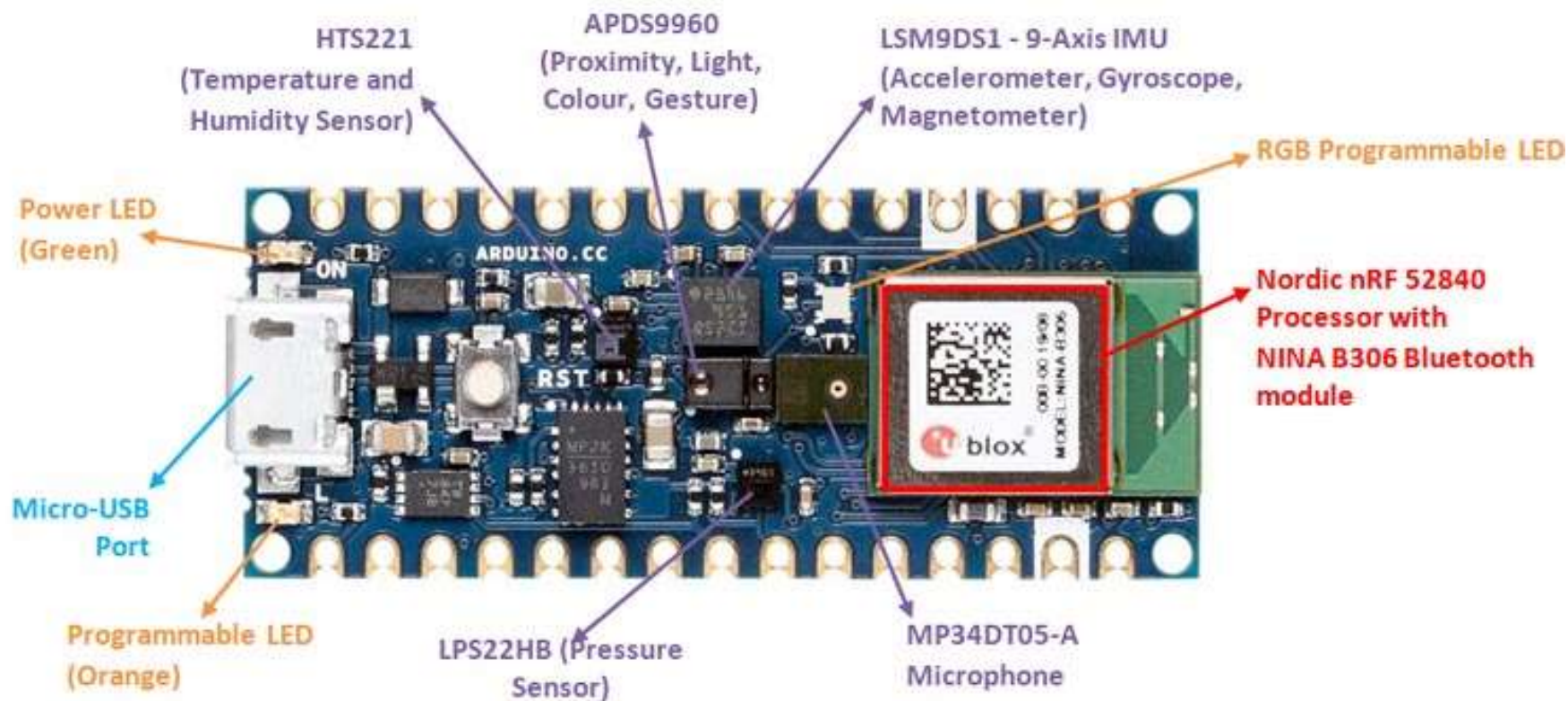


4. 저장된 IoT 데이터의 마이닝 (파이썬 코딩)

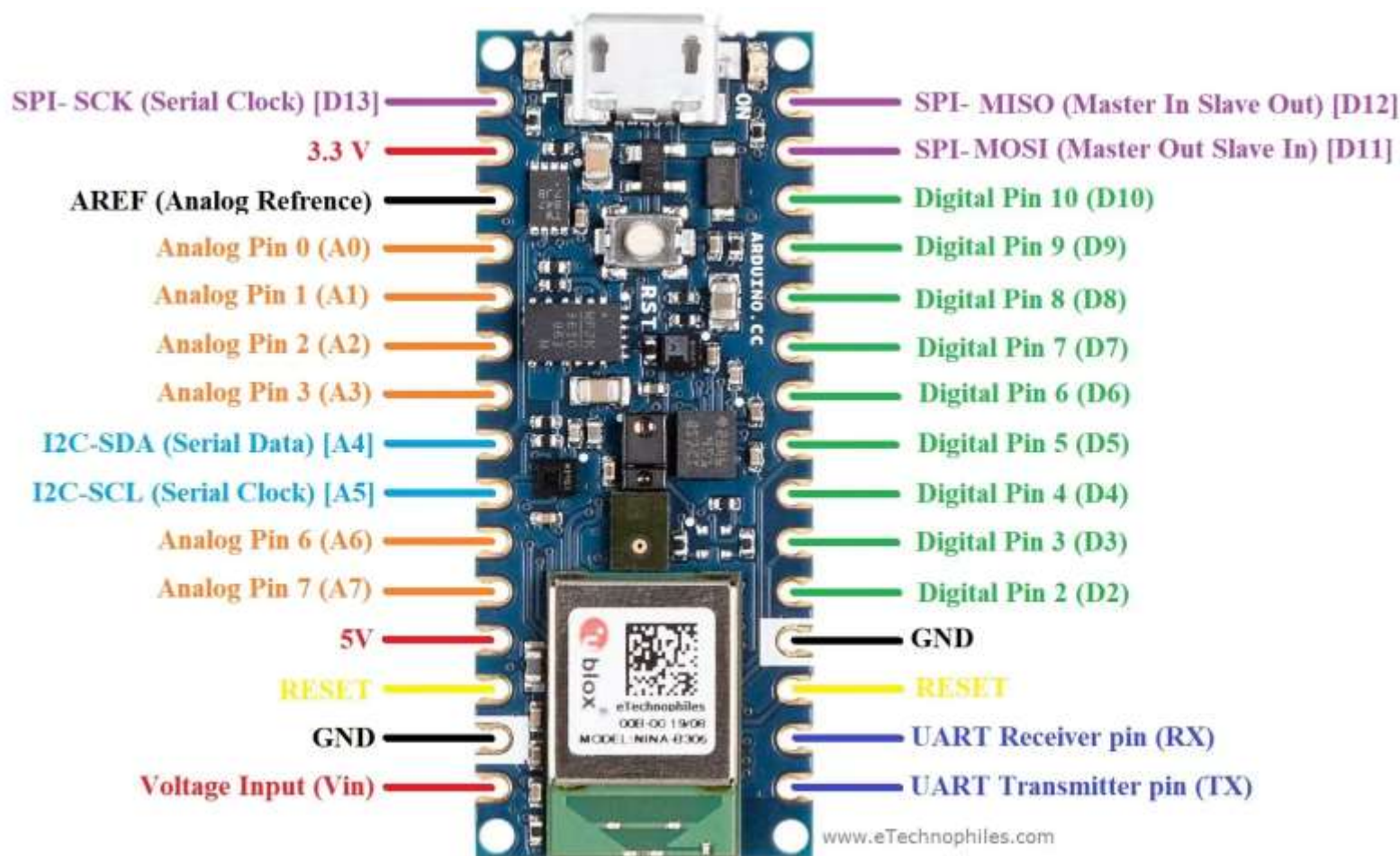


Layout [H S C]

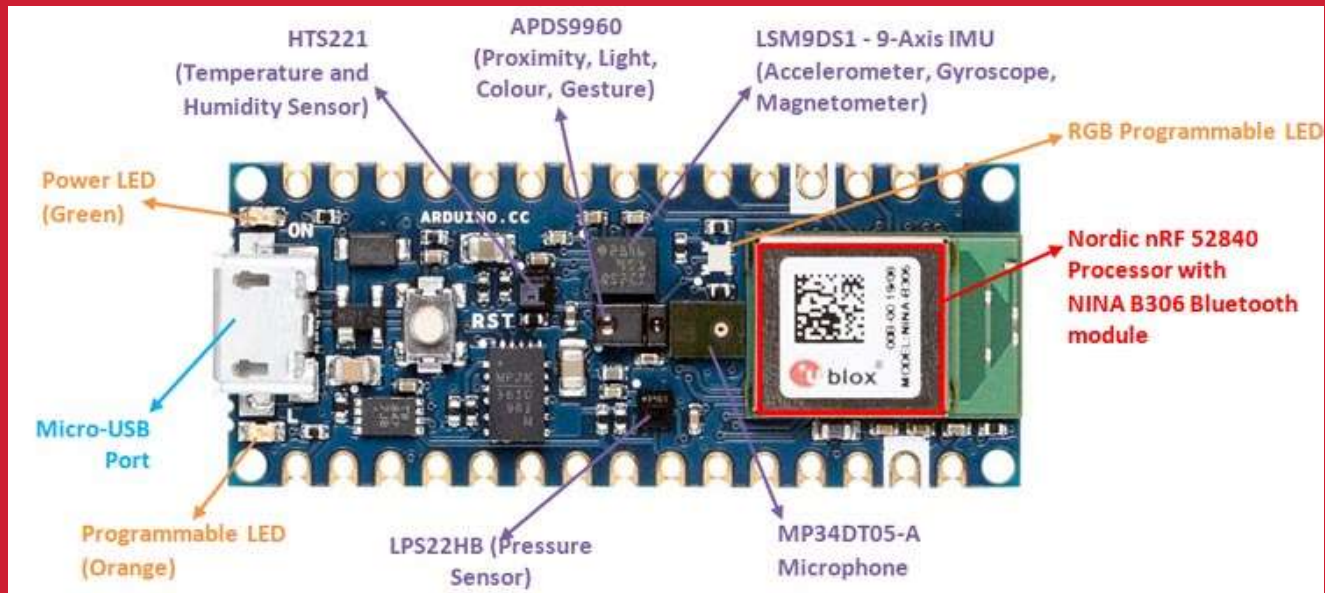




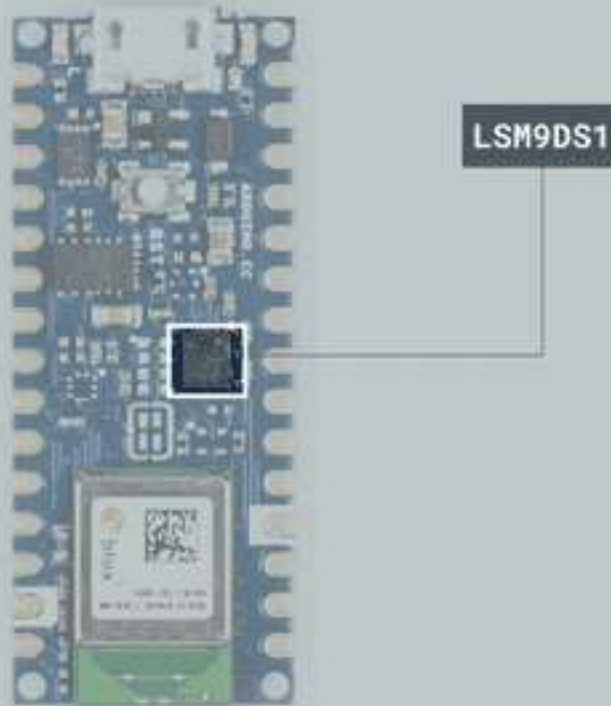
nano33BLE sensor - pins



2021/22 AA project nano33BLE sensor



LSM9DS1, 9축 IMU센서: acc, gyro, mag



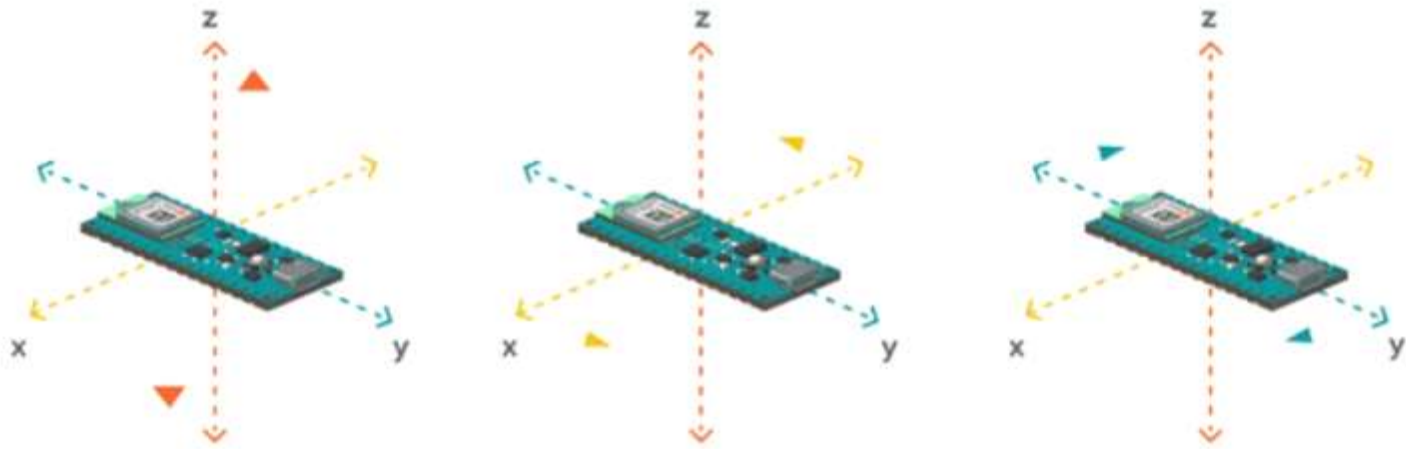
LSM9DS1, 9축 IMU센서: acc, gyro, mag

The LSM9DS1 Library

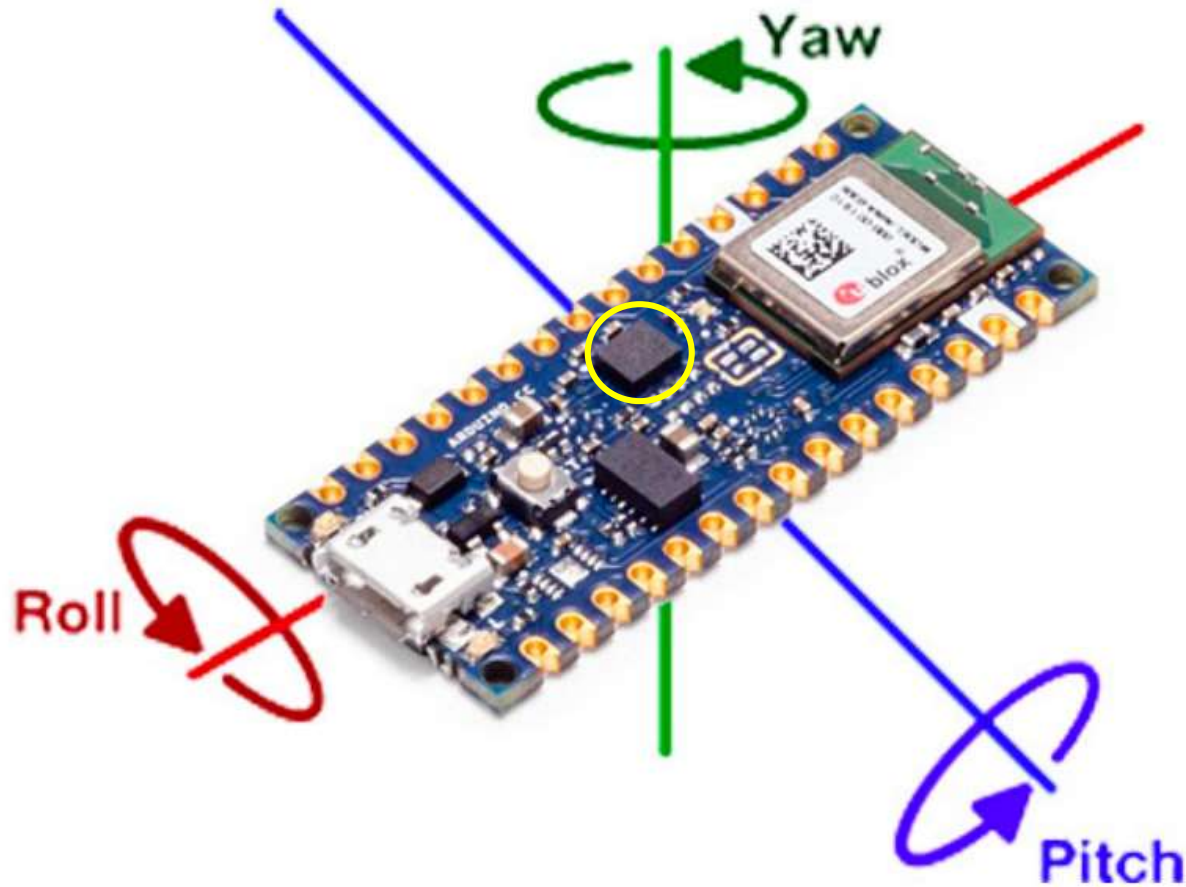
The Arduino LSM9DS1 library allows us to use the Arduino Nano 33 BLE IMU module without having to go into complicated programming. The library takes care of the sensor initialization and sets its values as follows:

- ◆ **Accelerometer** range is set at $[-4, +4]g$ ± 0.122 mg.
- ◆ **Gyroscope** range is set at $[-2000, +2000]$ dps ± 70 mdps.
- ◆ **Magnetometer** range is set at $[-400, +400]$ uT ± 0.014 uT.
- ◆ **Accelerometer** output data rate is fixed at 104 Hz.
- ◆ **Gyroscope** output data rate is fixed at 104 Hz.
- ◆ **Magnetometer** output data rate is fixed at 20 Hz.

LSM9DS1, 9축 IMU센서: **acc** , gyro, mag



LSM9DS1, 9축 IMU 센서: acc, gyro, mag



자이로 스코프 측정, 이미지 출처 <https://www.mauroalfieri.it/elettronica/arduino-nano-33-ble-giroscopio-lsm9ds1.html>

LSM9DS1, 9축 IMU센서: acc, gyro, mag

LSM9DS1_IoT.ino

```
1  #include <Arduino_LSM9DS1.h>
2
3  void setup() {
4      Serial.begin(9600);    // 19200
5      while (!Serial);
6
7      if (!IMU.begin()) { // IMU센서를 초기화합니다. 초기화중 문제가 발생하면 오류를 발생시킵니다.
8          Serial.println("Failed to initialize IMU!");
9          while (1);
10     }
11
12 }
13
```


LSM9DS1, 9축 IMU센서: acc, gyro, mag

```
14 float aX, aY, aZ, gX, gY, gZ, mX, mY, mZ;
15
16 void loop() {
17
18     delay(500);
19     // 가속도, 자이로, 지자기 센서의 값이 모두 정상 출력되면 데이터 수집 시작.
20     if (IMU.accelerationAvailable() && IMU.gyroscopeAvailable() && IMU.magneticFieldAvailable()) {
21         // read the acceleration, gyroscope, and magnetic data
22         IMU.readAcceleration(aX, aY, aZ);
23         IMU.readGyroscope(gX, gY, gZ);
24         IMU.readMagneticField(mX, mY, mZ);
25
26         Serial.print("AA00,");    // Change to your ID
27         Serial.print(aX);
28         Serial.print(',');
29         Serial.print(aY);
30         Serial.print(',');
31         Serial.print(aZ);
32         Serial.print(',');
33         Serial.print(gX);
34         Serial.print(',');
35         Serial.print(gY);
36         Serial.print(',');
37         Serial.print(gZ);
38         Serial.print(',');
39         Serial.print(mX);
40         Serial.print(',');
41         Serial.print(mY);
42         Serial.print(',');
43         Serial.println(mZ);
44     }
45 }
```

LSM9DS1, 9축 IMU센서: acc, gyro, mag
IoT 데이터 수집 형태로 출력을 변경하시오.

ax,ay,az,gx,gy,gz,mx,my,mz

```
0.17,-0.60,1.43,17.70,134.40,-209.05,12.52,12.59,0.34
0.53,0.40,0.88,-52.73,-38.51,-230.77,16.10,11.32,3.06
0.91,1.58,1.04,-62.19,-116.94,-66.41,18.52,11.22,8.23
-0.18,0.82,-0.29,77.21,-88.44,190.61,16.74,11.05,8.46
-0.55,-1.39,0.99,5.43,-71.72,180.30,14.15,16.38,2.43
-0.39,-0.68,0.75,-19.96,-192.44,-118.53,14.09,13.23,4.27
0.31,0.30,-0.75,-47.55,10.56,-24.17,16.70,-1.49,29.46
-0.75,-0.89,-0.06,65.55,-186.58,-158.57,6.42,20.53,2.88
-0.59,0.44,0.48,-338.13,159.85,-424.26,8.85,-13.66,15.32
0.75,0.37,0.46,288.39,-52.19,-362.00,20.43,7.52,11.69
0.47,0.77,1.98,-304.93,353.21,-110.60,8.02,-2.36,-4.66
-0.24,2.32,-0.79,192.26,-132.08,-271.85,22.35,-6.70,18.77
-0.65,-0.02,0.51,-0.79,-47.85,-60.00,8.63,9.52,0.02
0.30,-0.40,1.47,35.83,-155.82,-67.26,10.94,10.00,-3.55
-0.75,-0.39,3.63,-34.73,-219.54,6.53,9.24,11.16,-3.72
0.61,0.08,3.10,-125.43,118.04,-36.44,11.18,14.27,-1.40
-0.74,-0.47,0.50,688.78,-650.76,-144.29,19.58,-2.94,17.32
-0.12,-1.01,0.68,-319.52,398.25,761.60,13.33,19.10,2.84
0.13,-0.12,1.05,5.31,-0.92,13.18,15.00,8.51,-0.85
```

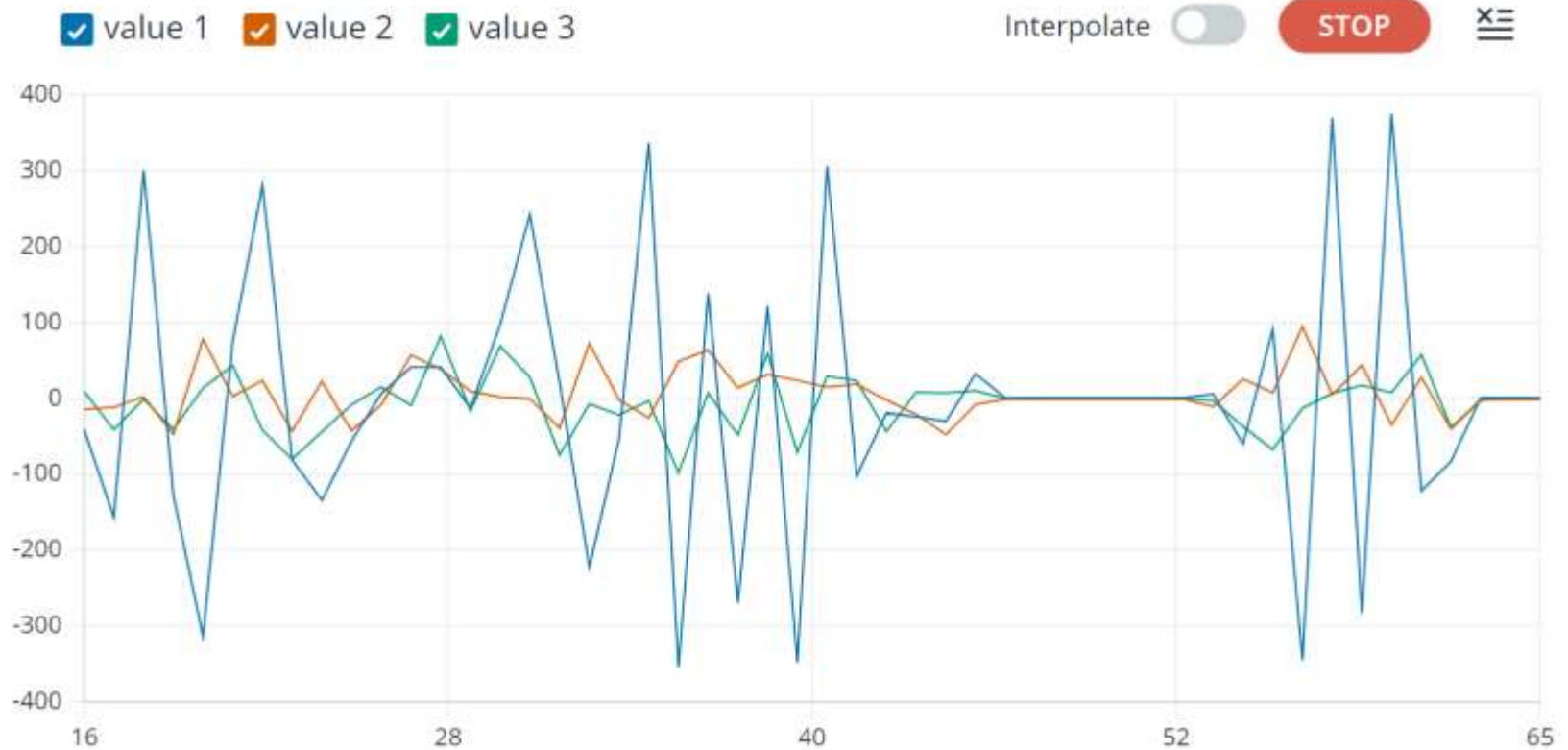
LSM9DS1, 9축 IMU센서: **acc**, gyro, mag

Accelerometer range is set at $[-4, +4]g$ $-/+0.122$ mg.



LSM9DS1, 9축 IMU센서: acc, gyro, mag

Gyroscope range is set at [-2000, +2000] dps +/- 70 mdps.



LSM9DS1, 9축 IMU센서: acc, gyro, mag

Magnetometer range is set at $[-400, +400]$ μT ± 0.014 μT .



LSM9DS1, 9축 IMU센서: acc, gyro, mag

* 9축 IMU 센서 신호 마이닝

1. MongoDB

2. Express server

- 실시간 모니터링
- DB 모니터링

3. data mining using Colab

4. Deep learning ?

LSM9DS1, 9축 IMU센서: MongoDB

```
> show dbs
admin          0.000GB
config         0.000GB
iot            0.000GB
iot00          0.000GB
iot10          0.000GB
iot33          0.000GB
iot33imu       0.001GB
```

mongo ×

+ ▾ □ ▢ ...

```
{ "_id" : ObjectId("6387452617a1bb6323ccfa4d"), "date" : "2022-11-30 20:57:26.179", "accel_x" : "-0.01", "accel_y" : "-0.05", "accel_z" : "0.97", "gyro_x" : "1.40", "gyro_y" : "-0.79", "gyro_z" : "-0.49", "mag_x" : "1.32", "mag_y" : "-3.17", "mag_z" : "4.50", "__v" : 0 }
{ "_id" : ObjectId("6387452617a1bb6323ccfa4f"), "date" : "2022-11-30 20:57:26.690", "accel_x" : "-0.01", "accel_y" : "-0.05", "accel_z" : "0.97", "gyro_x" : "1.46", "gyro_y" : "-0.67", "gyro_z" : "-0.37", "mag_x" : "1.44", "mag_y" : "-3.12", "mag_z" : "5.60", "__v" : 0 }
{ "_id" : ObjectId("6387452717a1bb6323ccfa51"), "date" : "2022-11-30 20:57:27.204", "accel_x" : "-0.01", "accel_y" : "-0.05", "accel_z" : "0.97", "gyro_x" : "1.53", "gyro_y" : "-0.67", "gyro_z" : "-0.43", "mag_x" : "1.82", "mag_y" : "-2.78", "mag_z" : "4.59", "__v" : 0 }
{ "_id" : ObjectId("6387452717a1bb6323ccfa53"), "date" : "2022-11-30 20:57:27.714", "accel_x" : "-0.01", "accel_y" : "-0.05", "accel_z" : "0.98", "gyro_x" : "1.46", "gyro_y" : "-0.61", "gyro_z" : "-0.18", "mag_x" : "1.42", "mag_y" : "-3.33", "mag_z" : "4.94", "__v" : 0 }
{ "_id" : ObjectId("6387452817a1bb6323ccfa55"), "date" : "2022-11-30 20:57:28.225", "accel_x" : "-0.00", "accel_y" : "-0.03", "accel_z" : "0.96", "gyro_x" : "1.40", "gyro_y" : "-0.43", "gyro_z" : "-0.37", "mag_x" : "1.31", "mag_y" : "-3.19", "mag_z" : "5.20", "__v" : 0 }
{ "_id" : ObjectId("6387452817a1bb6323ccfa57"), "date" : "2022-11-30 20:57:28.735", "accel_x" : "-0.00", "accel_y" : "-0.05", "accel_z" : "0.97", "gyro_x" : "1.71", "gyro_y" : "-0.49", "gyro_z" : "-0.37", "mag_x" : "1.39", "mag_y" : "-2.58", "mag_z" : "4.94", "__v" : 0 }
Type "it" for more
>
```

LSM9DS1, 9축 IMU센서: Express server

```
D:\aann\aann-rpt14\nano33imu>node nano33imu_ex_0
Express_IOT is running at port:3030, CORS powered!
mongo db connection OK.
```



LSM9DS1, 9축 IMU센서: All servers

문제 출력 디버그 콘솔 터미널 JUPYTER

```
1, accel_y : -0.06, accel_z : 0.97, gyro_x : 1.16, gyro_y : -0.98, gyro_z : -0.37, mag_x : 7.46, mag_y : 3.23, mag_z : -3.00
iotInfo: Current date: 2022-11-30 21:49:49.532, accel_x : 0.02, accel_y : -0.06, accel_z : 0.97, gyro_x : 1.34, gyro_y : -0.79, gyro_z : -0.31, mag_x : 7.07, mag_y : 3.17, mag_z : -2.43
iotInfo: Current date: 2022-11-30 21:49:50.042, accel_x : 0.02, accel_y : -0.06, accel_z : 0.97, gyro_x : 1.22, gyro_y : -0.92, gyro_z : -0.37, mag_x : 6.82, mag_y : 3.50, mag_z : -1.11

```

```
c
6개 파일 222,746 바이트
4개 디렉터리 406,823,346,176 바이트 남음
D:\aann\aaann-rpt14\nano33imu>node nano33imu_ex_0
Express_IOT is running at port:3030, CORS powered!
mongo db connection OK.

```

```
> show dbs
admin 0.000GB
config 0.000GB
iot 0.000GB
iot00 0.000GB
iot10 0.000GB
iot33 0.000GB
iot33imu 0.001GB
iot33rgb211119 0.000GB
local 0.000GB
test2 0.000GB
>

```

+ v ^ x

- node
- node
- mongo

LSM9DS1, 9축 IMU센서:

express server routing: localhost:3030

IoT example: Real time signal from nano33ble IMU sensor

127.0.0.1:5500/wk14_src/nano33imu/public/client_signal.html

IoT Signals from nano33ble IMU sensor

Real-time Signals

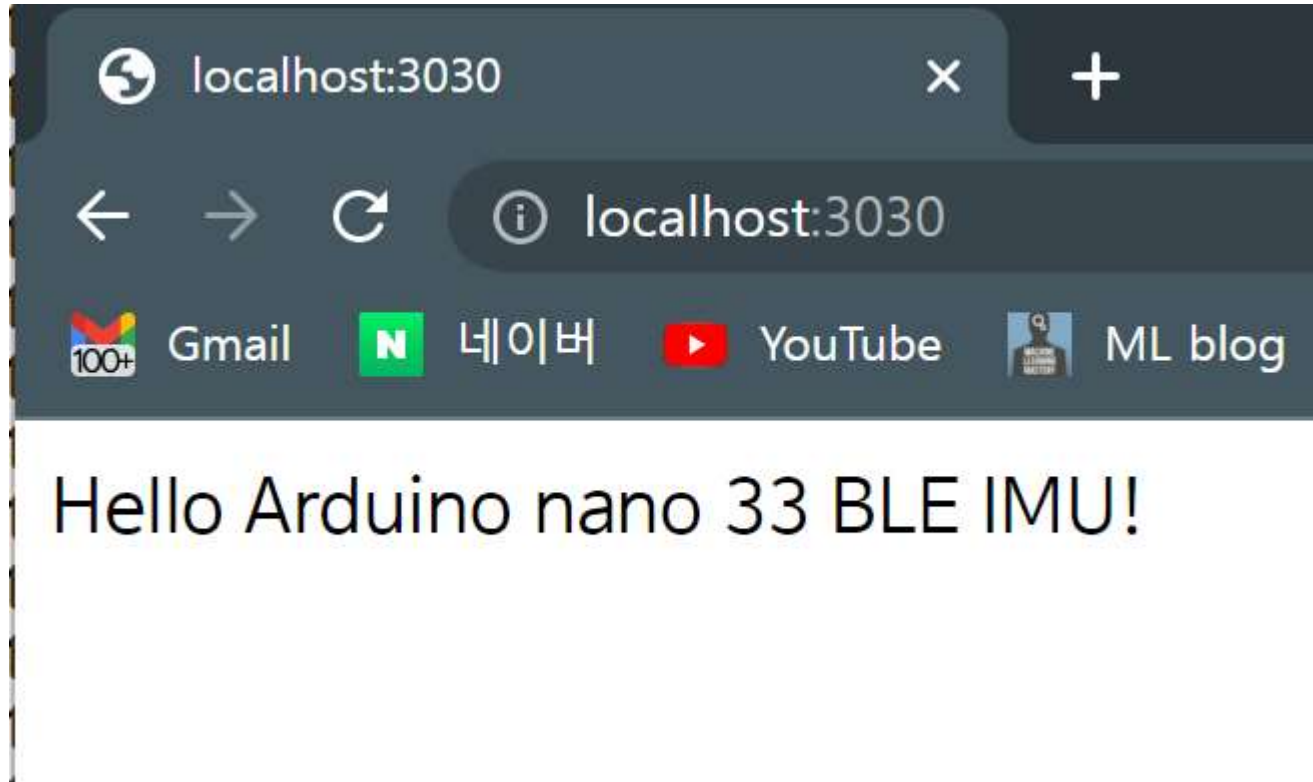
on Time: 2022-12-01 15:22:05.912

IMU signals (ax,ay,az),(gx,gy,gz),(mx,my,mz) : (0.04,0.25,0.95) , (-0.31,-3.30,-0.24) , (26.57,-3.42,-21.85)

RMS of IMU signals (ma, mg, mm) : 0.98,3.32,34.57

LSM9DS1, 9축 IMU센서:

express server routing: localhost:3030



LSM9DS1, 9축 IMU센서:

express server routing: localhost:3030/iot

localhost:3030/iot

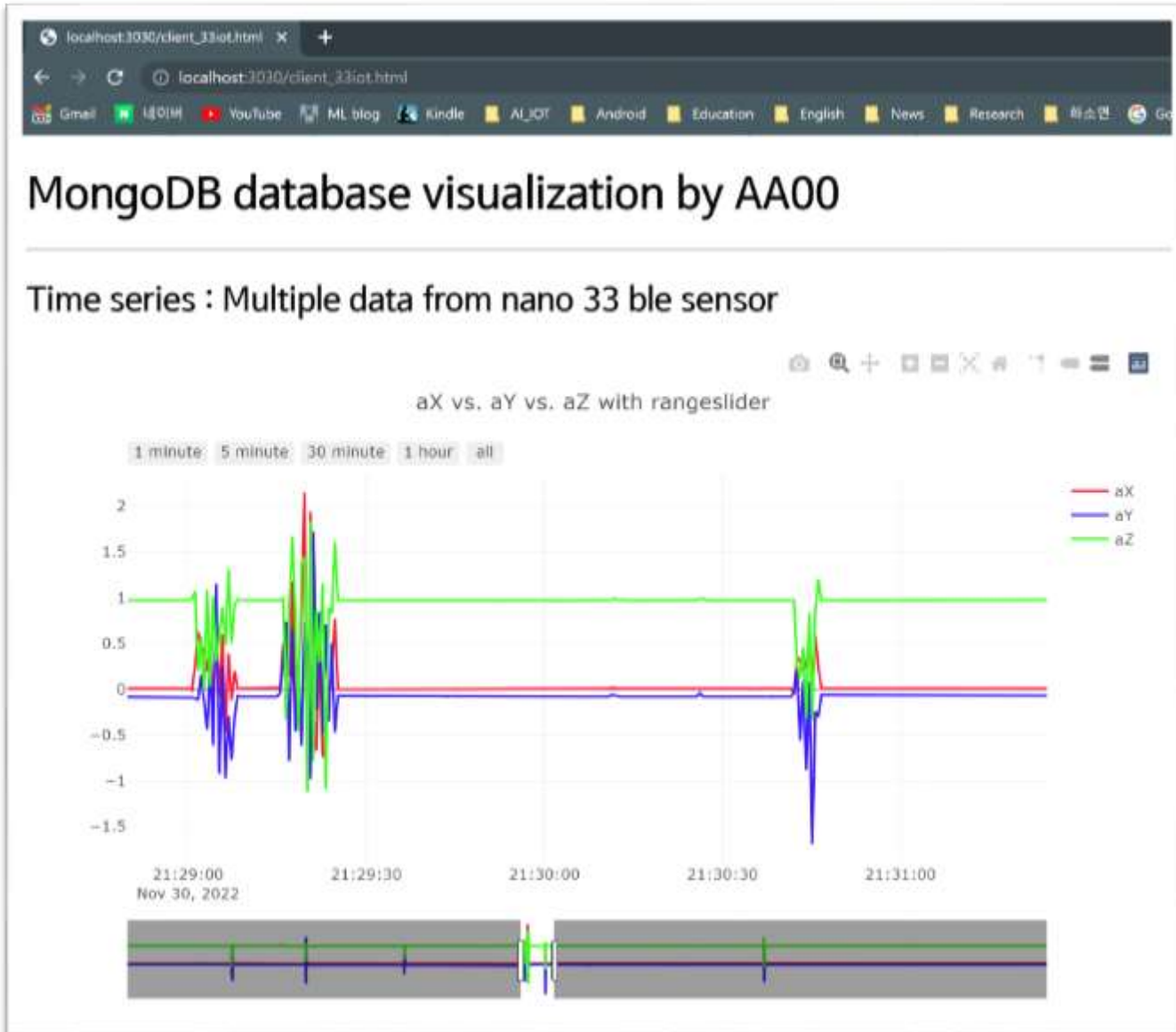
localhost:3030/iot

Gmail 네이버 YouTube ML blog Kindle AI_IOT Android Education English News Research 하소문 Google Google Scholar Life21c 네이버 영어사전 TechCrunch 네이버 블로그...

```
[{"_id":"6387456517a1bb6323ccfb43","date":"2022-11-30 20:58:29.197","accel_x":"-0.01","accel_y":"-0.05","accel_z":"0.97","gyro_x":"1.40","gyro_y":"-0.61","gyro_z":"-0.37","mag_x":"2.10","mag_y":"-3.22","mag_z":"5.33","_v":0},
{"_id":"6387456517a1bb6323ccfb45","date":"2022-11-30 20:58:29.710","accel_x":"-0.00","accel_y":"-0.05","accel_z":"0.98","gyro_x":"1.71","gyro_y":"-0.55","gyro_z":"-0.31","mag_x":"1.64","mag_y":"-3.39","mag_z":"5.24","_v":0},
{"_id":"6387456617a1bb6323ccfb47","date":"2022-11-30 20:58:30.224","accel_x":"-0.01","accel_y":"-0.05","accel_z":"0.97","gyro_x":"1.40","gyro_y":"-0.79","gyro_z":"-0.31","mag_x":"1.70","mag_y":"-2.88","mag_z":"5.92","_v":0},
{"_id":"6387456617a1bb6323ccfb49","date":"2022-11-30 20:58:30.736","accel_x":"-0.01","accel_y":"-0.05","accel_z":"0.97","gyro_x":"1.46","gyro_y":"-0.92","gyro_z":"-0.24","mag_x":"1.87","mag_y":"-2.93","mag_z":"5.66","_v":0},
{"_id":"6387456717a1bb6323ccfb4b","date":"2022-11-30 20:58:31.247","accel_x":"-0.01","accel_y":"-0.05","accel_z":"0.97","gyro_x":"1.53","gyro_y":"-0.73","gyro_z":"-0.31","mag_x":"1.38","mag_y":"-2.29","mag_z":"5.20","_v":0},
{"_id":"6387456717a1bb6323ccfb4d","date":"2022-11-30 20:58:31.756","accel_x":"-0.01","accel_y":"-0.05","accel_z":"0.97","gyro_x":"1.34","gyro_y":"-0.85","gyro_z":"-0.31","mag_x":"1.83","mag_y":"-2.87","mag_z":"5.98","_v":0},
{"_id":"6387456817a1bb6323ccfb4f","date":"2022-11-30 20:58:32.266","accel_x":"-0.01","accel_y":"-0.05","accel_z":"0.97","gyro_x":"1.40","gyro_y":"-0.61","gyro_z":"-0.43","mag_x":"1.18","mag_y":"-2.59","mag_z":"5.43","_v":0},
{"_id":"6387456817a1bb6323ccfb51","date":"2022-11-30 20:58:32.779","accel_x":"-0.01","accel_y":"-0.05","accel_z":"0.97","gyro_x":"1.34","gyro_y":"-0.85","gyro_z":"-0.49","mag_x":"1.72","mag_y":"-2.97","mag_z":"6.12","_v":0},
{"_id":"6387456917a1bb6323ccfb53","date":"2022-11-30 20:58:33.295","accel_x":"-0.01","accel_y":"-0.05","accel_z":"0.98","gyro_x":"1.34","gyro_y":"-0.92","gyro_z":"-0.37","mag_x":"1.66","mag_y":"-3.27","mag_z":"5.91","_v":0},
{"_id":"6387456917a1bb6323ccfb55","date":"2022-11-30 20:58:33.804","accel_x":"-0.01","accel_y":"-0.05","accel_z":"0.97","gyro_x":"1.53","gyro_y":"-0.79","gyro_z":"-0.43","mag_x":"1.45","mag_y":"-2.67","mag_z":"5.37","_v":0},
{"_id":"6387456a17a1bb6323ccfb57","date":"2022-11-30 20:58:34.313","accel_x":"-0.01","accel_y":"-0.05","accel_z":"0.97","gyro_x":"1.40","gyro_y":"-0.79","gyro_z":"-0.43","mag_x":"1.15","mag_y":"-2.48","mag_z":"5.74","_v":0},
{"_id":"6387456a17a1bb6323ccfb59","date":"2022-11-30 20:58:34.823","accel_x":"-0.01","accel_y":"-0.05","accel_z":"0.97","gyro_x":"1.46","gyro_y":"-0.85","gyro_z":"-0.31","mag_x":"1.17","mag_y":"-3.25","mag_z":"5.90","_v":0},
{"_id":"6387456b17a1bb6323ccfb5b","date":"2022-11-30 20:58:35.337","accel_x":"-0.01","accel_y":"-0.05","accel_z":"0.97","gyro_x":"1.34","gyro_y":"-0.67","gyro_z":"-0.31","mag_x":"1.60","mag_y":"-2.83","mag_z":"4.25","_v":0},
{"_id":"6387456b17a1bb6323ccfb5d","date":"2022-11-30 20:58:35.847","accel_x":"-0.01","accel_y":"-0.05","accel_z":"0.97","gyro_x":"1.46","gyro_y":"-0.85","gyro_z":"-0.37","mag_x":"1.06","mag_y":"-3.26","mag_z":"4.97","_v":0},
{"_id":"6387456c17a1bb6323ccfb5f","date":"2022-11-30 20:58:36.362","accel_x":"-0.01","accel_y":"-0.05","accel_z":"0.98","gyro_x":"1.46","gyro_y":"-0.85","gyro_z":"-0.31","mag_x":"1.15","mag_y":"-2.72","mag_z":"5.72","_v":0},
{"_id":"6387456c17a1bb6323ccfb61","date":"2022-11-30 20:58:36.872","accel_x":"-0.01","accel_y":"-0.05","accel_z":"0.97","gyro_x":"1.16","gyro_y":"-1.04","gyro_z":"-0.55","mag_x":"1.76","mag_y":"-3.10","mag_z":"5.63","_v":0},
{"_id":"6387456d17a1bb6323ccfb63","date":"2022-11-30 20:58:37.384","accel_x":"-0.01","accel_y":"-0.05","accel_z":"0.97","gyro_x":"1.34","gyro_y":"-1.04","gyro_z":"-0.43","mag_x":"1.42","mag_y":"-3.04","mag_z":"4.85","_v":0},
{"_id":"6387456d17a1bb6323ccfb65","date":"2022-11-30 20:58:37.897","accel_x":"-0.01","accel_y":"-0.05","accel_z":"0.97","gyro_x":"1.65","gyro_y":"-0.67","gyro_z":"-0.24","mag_x":"1.64","mag_y":"-2.92","mag_z":"4.91","_v":0},
{"_id":"6387456e17a1bb6323ccfb67","date":"2022-11-30 20:58:38.408","accel_x":"-0.01","accel_y":"-0.05","accel_z":"0.97","gyro_x":"1.34","gyro_y":"-0.79","gyro_z":"-0.43","mag_x":"1.86","mag_y":"-2.81","mag_z":"5.41","_v":0},
{"_id":"6387456e17a1bb6323ccfb69","date":"2022-11-30 20:58:38.919","accel_x":"-0.01","accel_y":"-0.05","accel_z":"0.97","gyro_x":"1.34","gyro_y":"-0.67","gyro_z":"-0.24","mag_x":"2.34","mag_y":"-2.65","mag_z":"5.40","_v":0},
{"_id":"6387456f17a1bb6323ccfb6b","date":"2022-11-30 20:58:39.432","accel_x":"-0.01","accel_y":"-0.05","accel_z":"0.97","gyro_x":"1.28","gyro_y":"-0.73","gyro_z":"-0.31","mag_x":"1.76","mag_y":"-3.16","mag_z":"4.98","_v":0},
{"_id":"6387456f17a1bb6323ccfb6d","date":"2022-11-30 20:58:39.942","accel_x":"-0.01","accel_y":"-0.05","accel_z":"0.97","gyro_x":"1.40","gyro_y":"-0.73","gyro_z":"-0.49","mag_x":"1.40","mag_y":"-3.34","mag_z":"6.49","_v":0},
{"_id":"6387457017a1bb6323ccfb6f","date":"2022-11-30 20:58:40.456","accel_x":"-0.01","accel_y":"-0.05","accel_z":"0.97","gyro_x":"1.40","gyro_y":"-0.61","gyro_z":"-0.43","mag_x":"1.31","mag_y":"-2.89","mag_z":"5.36","_v":0},
{"_id":"6387457017a1bb6323ccfb71","date":"2022-11-30 20:58:40.968","accel_x":"-0.01","accel_y":"-0.05","accel_z":"0.97","gyro_x":"1.28","gyro_y":"-0.79","gyro_z":"-0.43","mag_x":"1.07","mag_y":"-3.05","mag_z":"4.99","_v":0},
{"_id":"6387457117a1bb6323ccfb73","date":"2022-11-30 20:58:41.483","accel_x":"-0.00","accel_y":"-0.05","accel_z":"0.97","gyro_x":"1.59","gyro_y":"-0.85","gyro_z":"-0.12","mag_x":"1.53","mag_y":"-2.95","mag_z":"5.13","_v":0},
{"_id":"6387457117a1bb6323ccfb75","date":"2022-11-30 20:58:41.997","accel_x":"-0.01","accel_y":"-0.05","accel_z":"0.97","gyro_x":"1.40","gyro_y":"-0.73","gyro_z":"-0.31","mag_x":"2.31","mag_y":"-3.09","mag_z":"5.41","_v":0},
{"_id":"6387457217a1bb6323ccfb77","date":"2022-11-30 20:58:42.510","accel_x":"-0.01","accel_y":"-0.05","accel_z":"0.97","gyro_x":"1.22","gyro_y":"-0.79","gyro_z":"-0.31","mag_x":"1.97","mag_y":"-3.34","mag_z":"4.85","_v":0},
{"_id":"6387457317a1bb6323ccfb79","date":"2022-11-30 20:58:43.024","accel_x":"-0.01","accel_y":"-0.05","accel_z":"0.97","gyro_x":"1.53","gyro_y":"-0.61","gyro_z":"-0.31","mag_x":"2.12","mag_y":"-3.78","mag_z":"4.99","_v":0},
{"_id":"6387457317a1bb6323ccfb7b","date":"2022-11-30 20:58:43.537","accel_x":"-0.01","accel_y":"-0.05","accel_z":"0.97","gyro_x":"1.40","gyro_y":"-0.67","gyro_z":"-0.37","mag_x":"1.49","mag_y":"-2.51","mag_z":"5.36","_v":0},
{"_id":"6387457417a1bb6323ccfb7d","date":"2022-11-30 20:58:44.050","accel_x":"-0.00","accel_y":"-0.05","accel_z":"0.97","gyro_x":"1.40","gyro_y":"-0.73","gyro_z":"-0.43","mag_x":"1.90","mag_y":"-3.17","mag_z":"5.43","_v":0},
{"_id":"6387457417a1bb6323ccfb7f","date":"2022-11-30 20:58:44.562","accel_x":"-0.01","accel_y":"-0.05","accel_z":"0.97","gyro_x":"1.40","gyro_y":"-0.67","gyro_z":"-0.43","mag_x":"1.73","mag_y":"-4.02","mag_z":"6.60","_v":0},
{"_id":"6387457517a1bb6323ccfb81","date":"2022-11-30 20:58:45.075","accel_x":"-0.01","accel_y":"-0.05","accel_z":"0.97","gyro_x":"1.40","gyro_y":"-0.85","gyro_z":"-0.43","mag_x":"1.84","mag_y":"-3.04","mag_z":"6.45","_v":0},
{"_id":"6387457517a1bb6323ccfb83","date":"2022-11-30 20:58:45.584","accel_x":"-0.01","accel_y":"-0.05","accel_z":"0.97","gyro_x":"1.59","gyro_y":"-0.73","gyro_z":"-0.18","mag_x":"1.05","mag_y":"-3.12","mag_z":"5.88","_v":0},
{"_id":"6387457617a1bb6323ccfb85","date":"2022-11-30 20:58:46.094","accel_x":"-0.01","accel_y":"-0.05","accel_z":"0.97","gyro_x":"1.46","gyro_y":"-0.67","gyro_z":"-0.37","mag_x":"1.48","mag_y":"-3.09","mag_z":"4.06","_v":0},
{"_id":"6387457617a1bb6323ccfb87","date":"2022-11-30 20:58:46.606","accel_x":"-0.01","accel_y":"-0.05","accel_z":"0.97","gyro_x":"1.46","gyro_y":"-0.92","gyro_z":"-0.37","mag_x":"1.48","mag_y":"-2.95","mag_z":"5.31","_v":0},
{"_id":"6387457717a1bb6323ccfb89","date":"2022-11-30 20:58:47.116","accel_x":"-0.01","accel_y":"-0.05","accel_z":"0.97","gyro_x":"1.53","gyro_y":"-0.67","gyro_z":"-0.43","mag_x":"1.25","mag_y":"-3.37","mag_z":"5.54","_v":0},
{"_id":"6387457717a1bb6323ccfb8b","date":"2022-11-30 20:58:47.626","accel_x":"-0.01","accel_y":"-0.05","accel_z":"0.97","gyro_x":"1.65","gyro_y":"-0.61","gyro_z":"-0.37","mag_x":"1.35","mag_y":"-3.04","mag_z":"5.94","_v":0},
{"_id":"6387457817a1bb6323ccfb8d","date":"2022-11-30 20:58:48.136","accel_x":"-0.01","accel_y":"-0.05","accel_z":"0.97","gyro_x":"1.53","gyro_y":"-0.85","gyro_z":"-0.31","mag_x":"1.62","mag_y":"-3.47","mag_z":"4.59","_v":0},
{"_id":"6387457817a1bb6323ccfb8f","date":"2022-11-30 20:58:48.646","accel_x":"-0.01","accel_y":"-0.05","accel_z":"0.97","gyro_x":"1.34","gyro_y":"-0.73","gyro_z":"-0.31","mag_x":"0.88","mag_y":"-3.41","mag_z":"5.65","_v":0},
{"_id":"6387457917a1bb6323ccfb91","date":"2022-11-30 20:58:49.156","accel_x":"-0.01","accel_y":"-0.05","accel_z":"0.97","gyro_x":"1.40","gyro_y":"-0.79","gyro_z":"-0.31","mag_x":"0.82","mag_y":"-3.22","mag_z":"5.69","_v":0}]
```

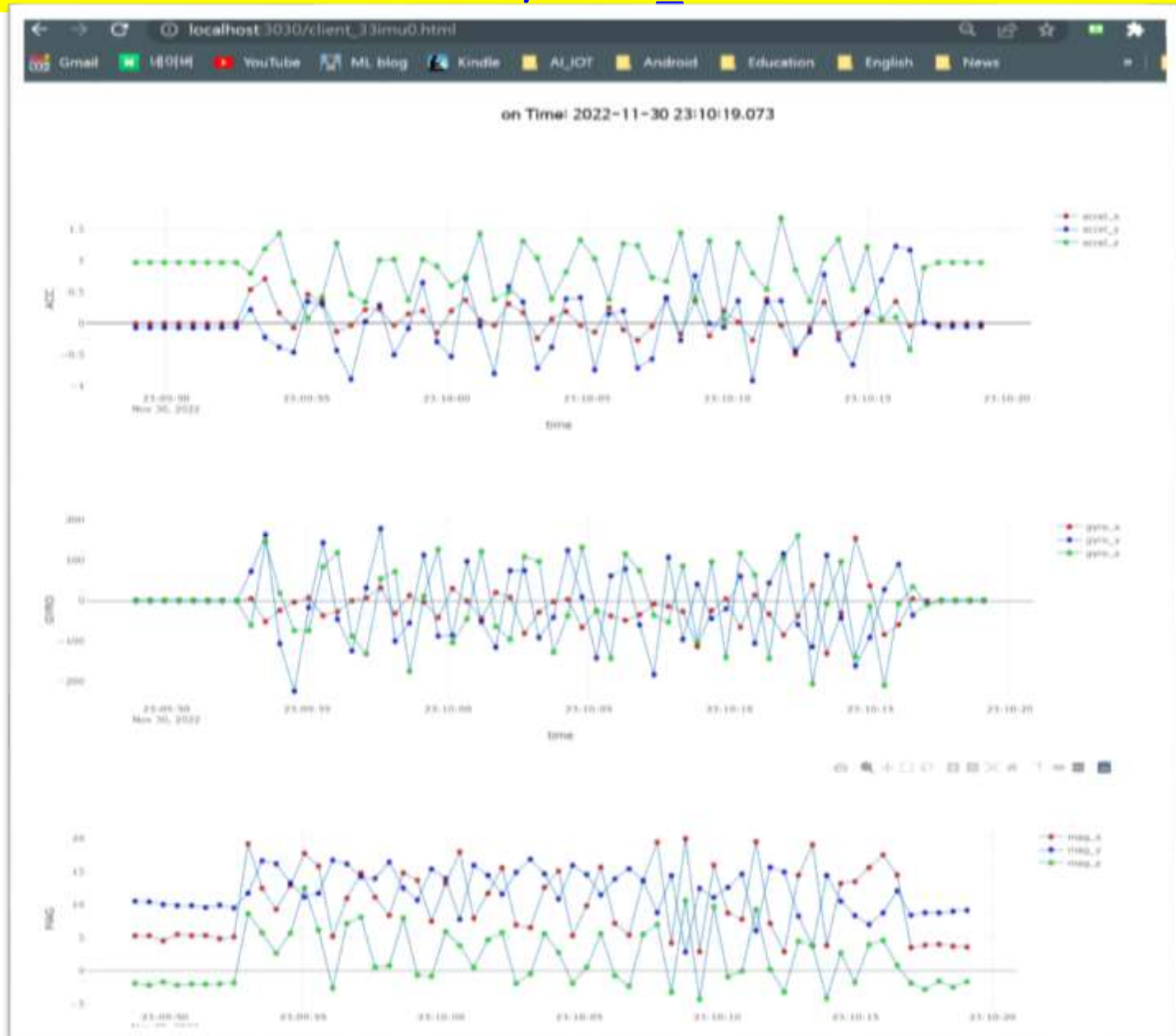

LSM9DS1, 9축 IMU센서:

localhost:3030/client_33iot.html



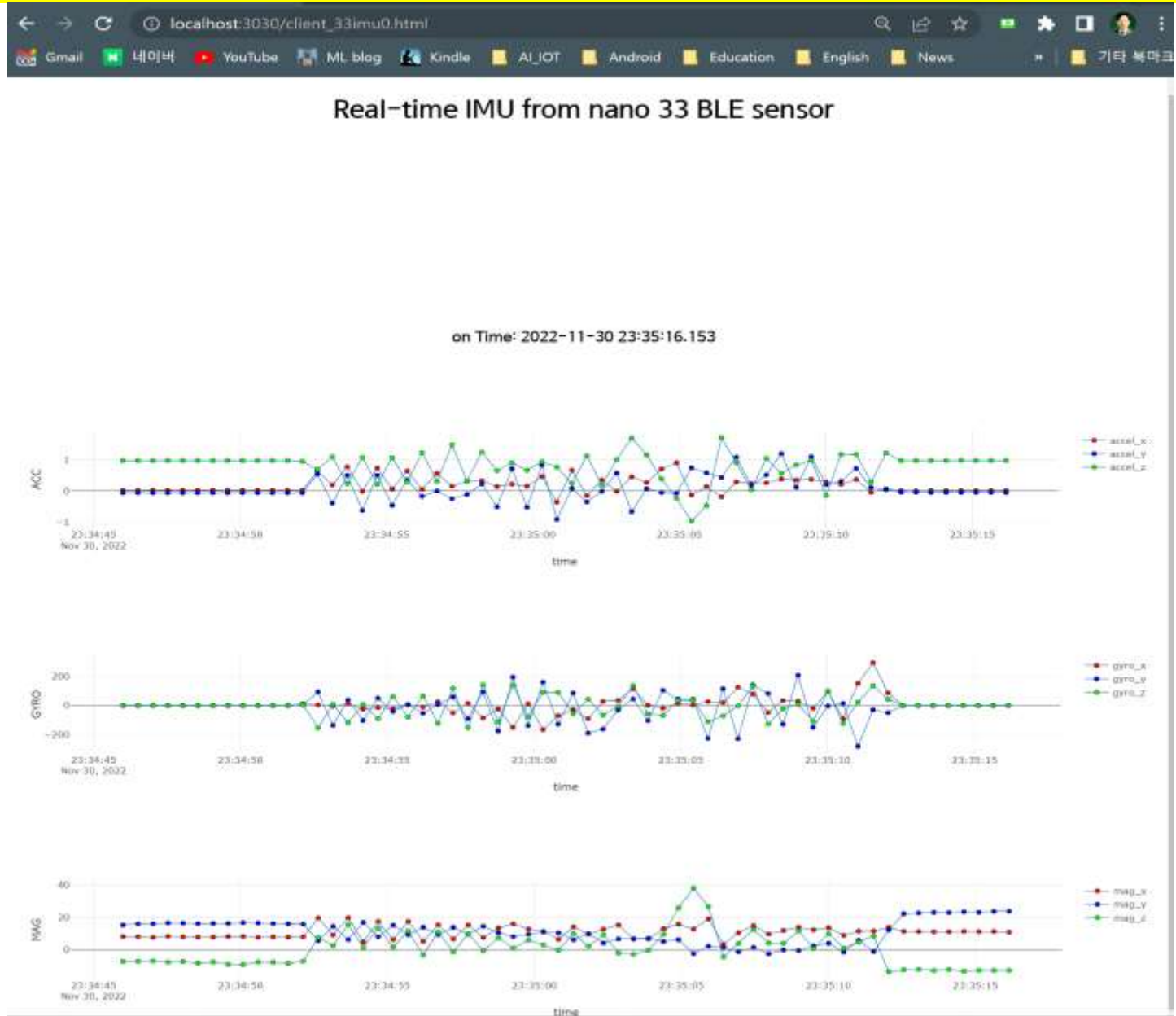
LSM9DS1, 9축 IMU센서:

localhost:3030/client_33imu.html



LSM9DS1, 9축 IMU센서:

localhost:3030/client_33imu.html



LSM9DS1, 9축 IMU센서:

iot_nano33imu_json.ipynb

co iot_nano33imu_json.ipynb ☆

파일 수정 보기 삽입 런타임 도구 도움말 모든 변경사항이 저장됨

+ 코드 + 텍스트

▼ Pandas: access to the remote json from MongoDB

- The json file is generated on the fly from the express server of Node.js.
- The data stored in MongoDB are saved in the json file.
- The data are composed of three time series; temperature, humidity, and luminosity.

[1] 03

```
1 import pandas as pd
2 import numpy as np
3 import matplotlib.pyplot as plt
4 from matplotlib import animation, rc
```

▼ [데이터 로드 1.]

- loading real-time json file from MongoDB via web
- http://life21c.inje.ac.kr:3030/client_33imu_gauge.html

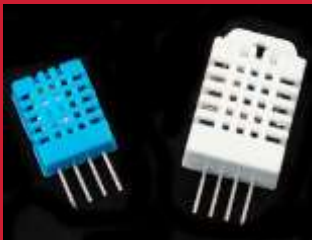
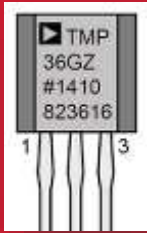
[2] 16

```
1 # loading real-time json file from MongoDB via web (CORS, port=3030)
2 url="http://life21c.inje.ac.kr:3030/iot"
3 df=pd.read_json(url)
4 print("Large IoT data was retrieved successfully from MongoDB!")
```

Large IoT data was retrieved successfully from MongoDB!



[Practice]



◆ [wk14]

- IoT Project: nano33ble
- Multi-sensor circuits : IMU
- Complete your project
- Upload folder: aann-rpt14
- Use repo “aann” in github

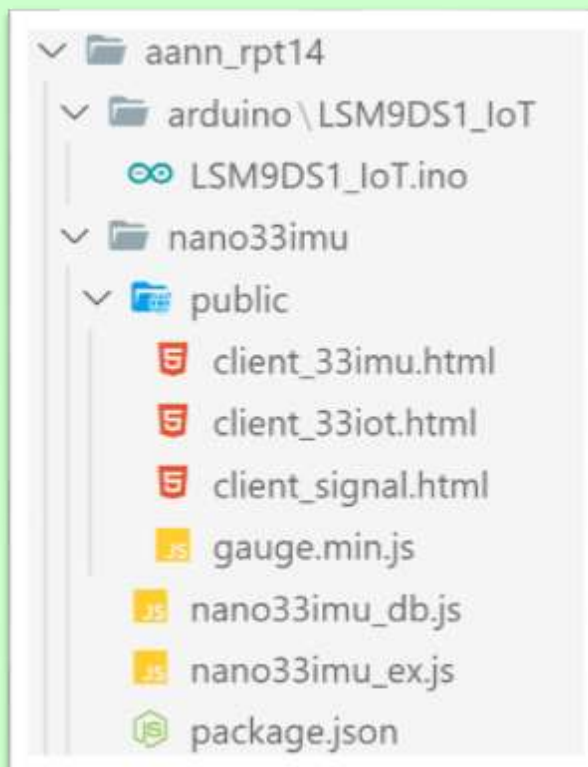
wk14 : Practice : aann-rpt14

◆ [Target of this week]

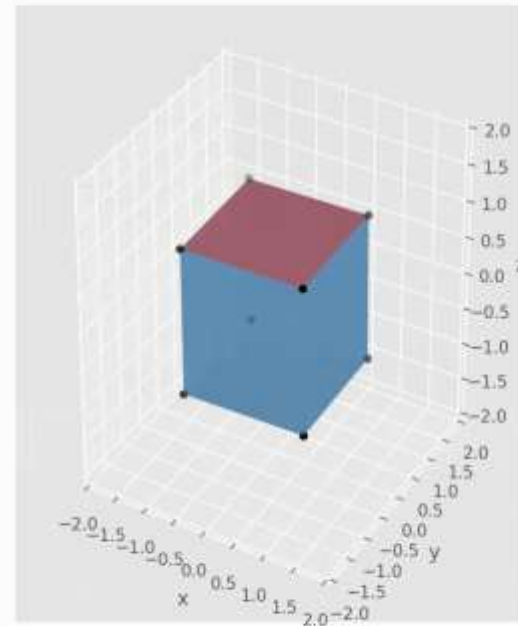
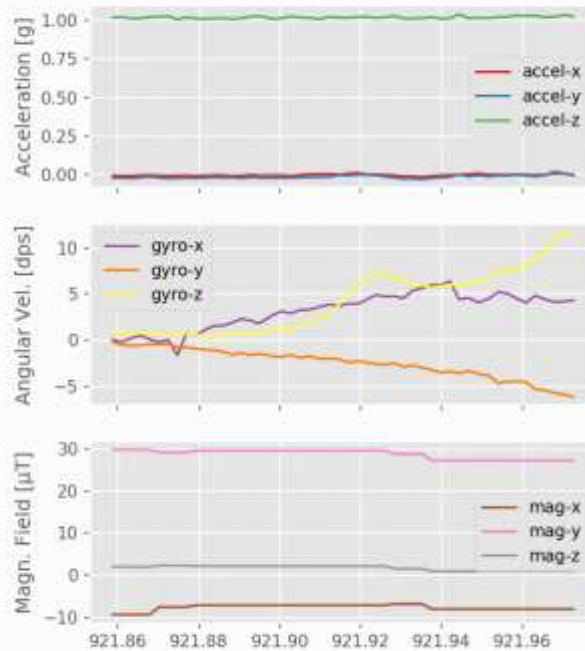
- Complete your works
- Save your outcomes and upload outputs in github

제출폴더명 : **aann-rpt14**

- 제출할 파일들



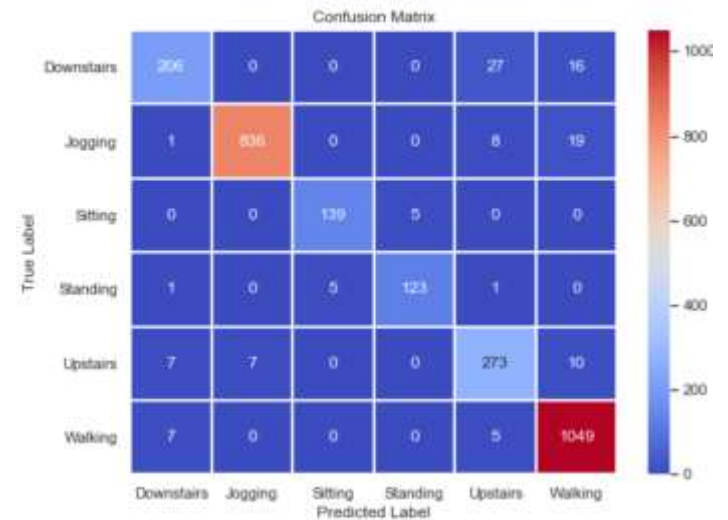
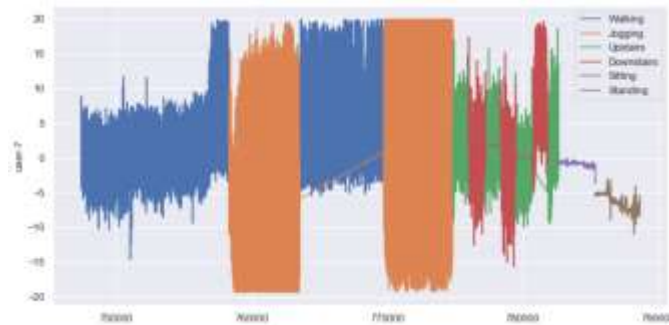
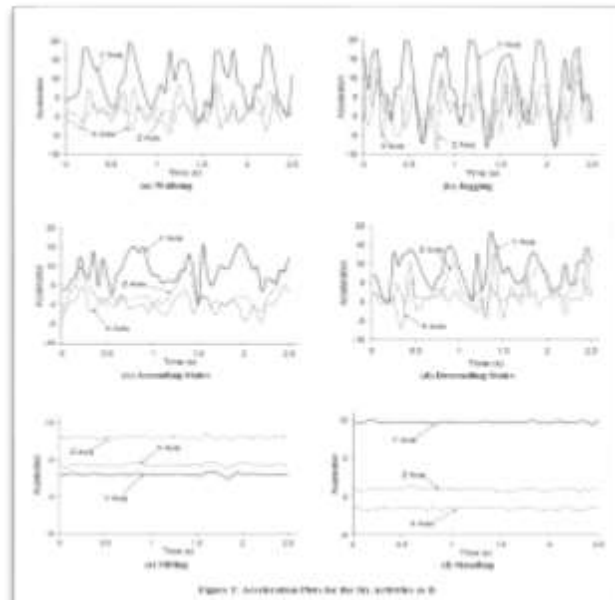
모션 인식(9-축 IMU)



https://images.squarespace-cdn.com/content/v1/59b037304c0dbfb092f8e894/1573836927118-IS5CS61OW9XH9HSRCMA1/ke17ZwdGBToddI8pDm48kGbFogdxZzB1B7PQq3zm9xl7gQa3H78H3Y0txjaiv_0fDoOvxcdMmMKkDs yUqMSsMWxHk725yiiHCClfrh8O1z5QPQohDlalelJMHgDF5CVlOqpeNLcl80NK65_fv7S1UQupMlr7Z9cq9PZkRytzEu3SbZmkCxOj ksrEup4_K2kPH3bqxw7fF48mhrq5Ulr0Hg/mpu9250_cube_rotation_compressed.gif

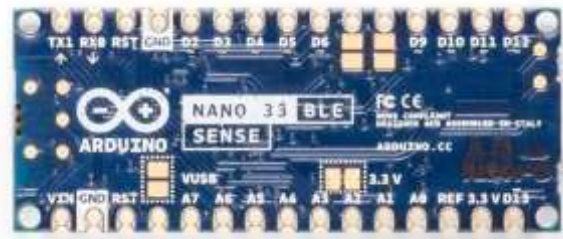
일상활동 인식(3축 가속도)

['Downstairs',
'Jogging',
'Sitting',
'Standing',
'Upstairs',
'Walking']



--- ACC_XYZ, 4s: classification report for test data ---

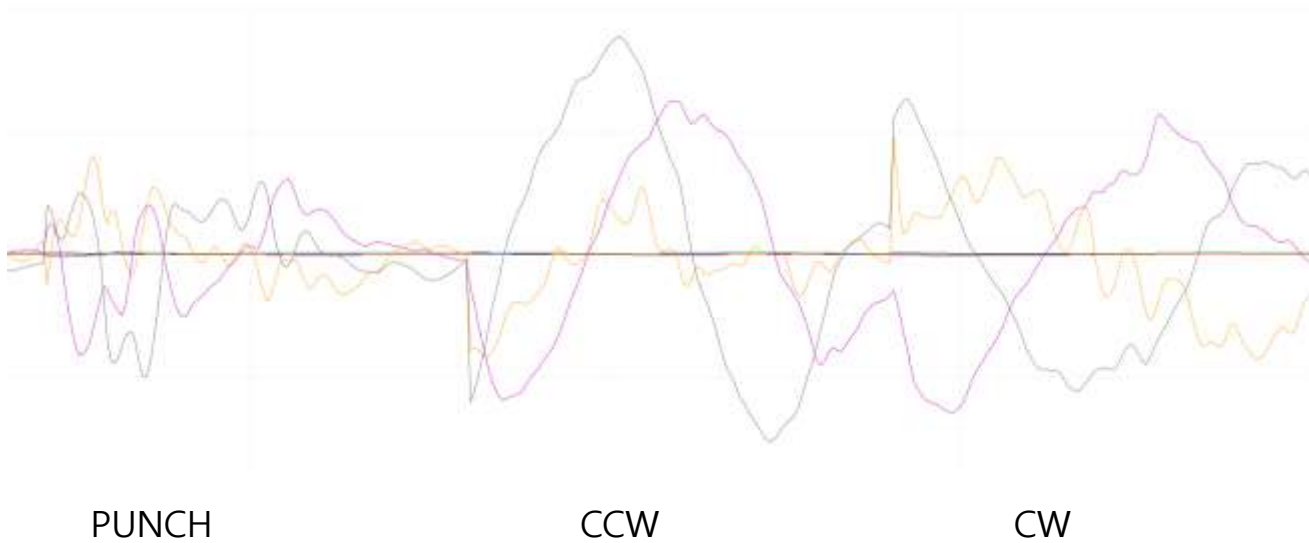
	precision	recall	f1-score	support
0	0.93	0.83	0.87	249
1	0.99	0.97	0.98	864
2	0.97	0.97	0.97	144
3	0.96	0.95	0.95	138
4	0.87	0.92	0.89	297
5	0.96	0.99	0.97	1061
accuracy			0.96	2745
macro avg	0.95	0.94	0.94	2745
weighted avg	0.96	0.96	0.96	2745



Arduino nano33 BLE

Classification of gestures
using ACC
in Tensorflow 2.x
& TinyML/TF-Lite

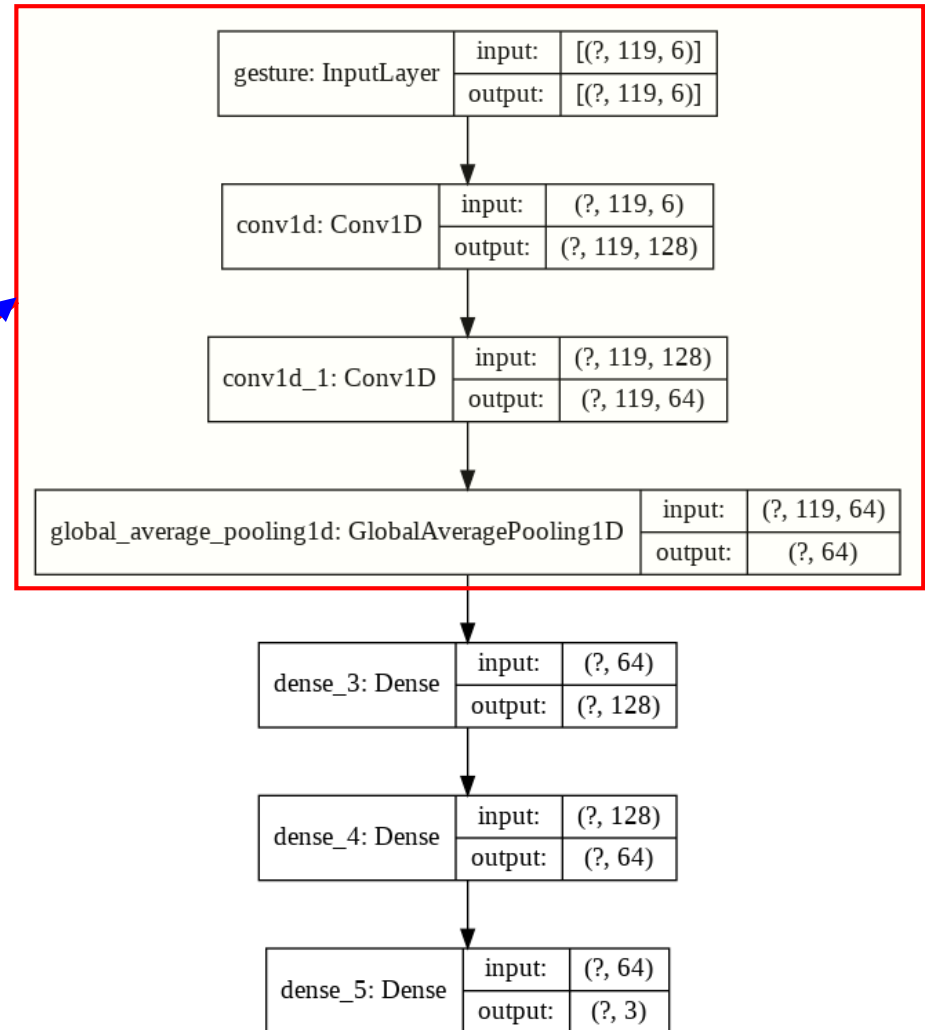
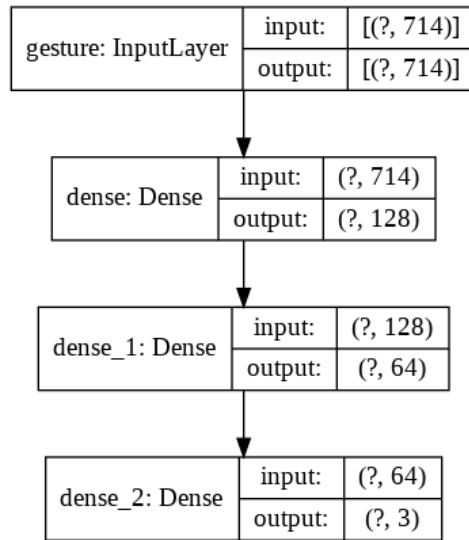
Data 모으기



119 X 6 (ax,ay,az, gx,gy,gz)

DL architecture

MLP \rightarrow Conv1D + MLP
(714,) \rightarrow (119,6) + (64,)



DL-model

```
from tensorflow.keras import layers
```

```
# TF2 functional API
```

```
# CONV1D & MLP
```

```
inputs = keras.Input(shape=(119,6), name='gesture')
```

```
x = layers.Conv1D(128, 3, padding='causal', activation='relu')(inputs) # 32,
```

```
x = layers.Conv1D(64, 3, padding='causal', activation='relu')(x) # 16
```

```
x = layers.GlobalAveragePooling1D()(x) # New features (714 => 16 or 64)
```

```
x = layers.Dense(128, activation='relu')(x)
```

```
x = layers.Dense(64, activation='relu')(x)
```

```
outputs = layers.Dense(NUM_GESTURES, activation='softmax')(x)
```

```
model_conv = keras.Model(inputs=inputs, outputs=outputs, name='gesture_model2')
```

```
model_conv.compile(optimizer='rmsprop', loss='mse', metrics=['accuracy'])
```

```
# train the model
```

```
history = model_conv.fit(inputs_train2, outputs_train, epochs=500, batch_size=16  
| | | | | validation_data=(inputs_validate2, outputs_validate))
```



```
model_conv.summary()
```

Model: "gesture_model2"

Layer (type)	Output Shape	Param #
gesture (InputLayer)	[(None, 119, 6)]	0
conv1d (Conv1D)	(None, 119, 128)	2432
conv1d_1 (Conv1D)	(None, 119, 64)	24640
global_average_pooling1d (Gl	(None, 64)	0
dense_3 (Dense)	(None, 128)	8320
dense_4 (Dense)	(None, 64)	8256
dense_5 (Dense)	(None, 3)	195

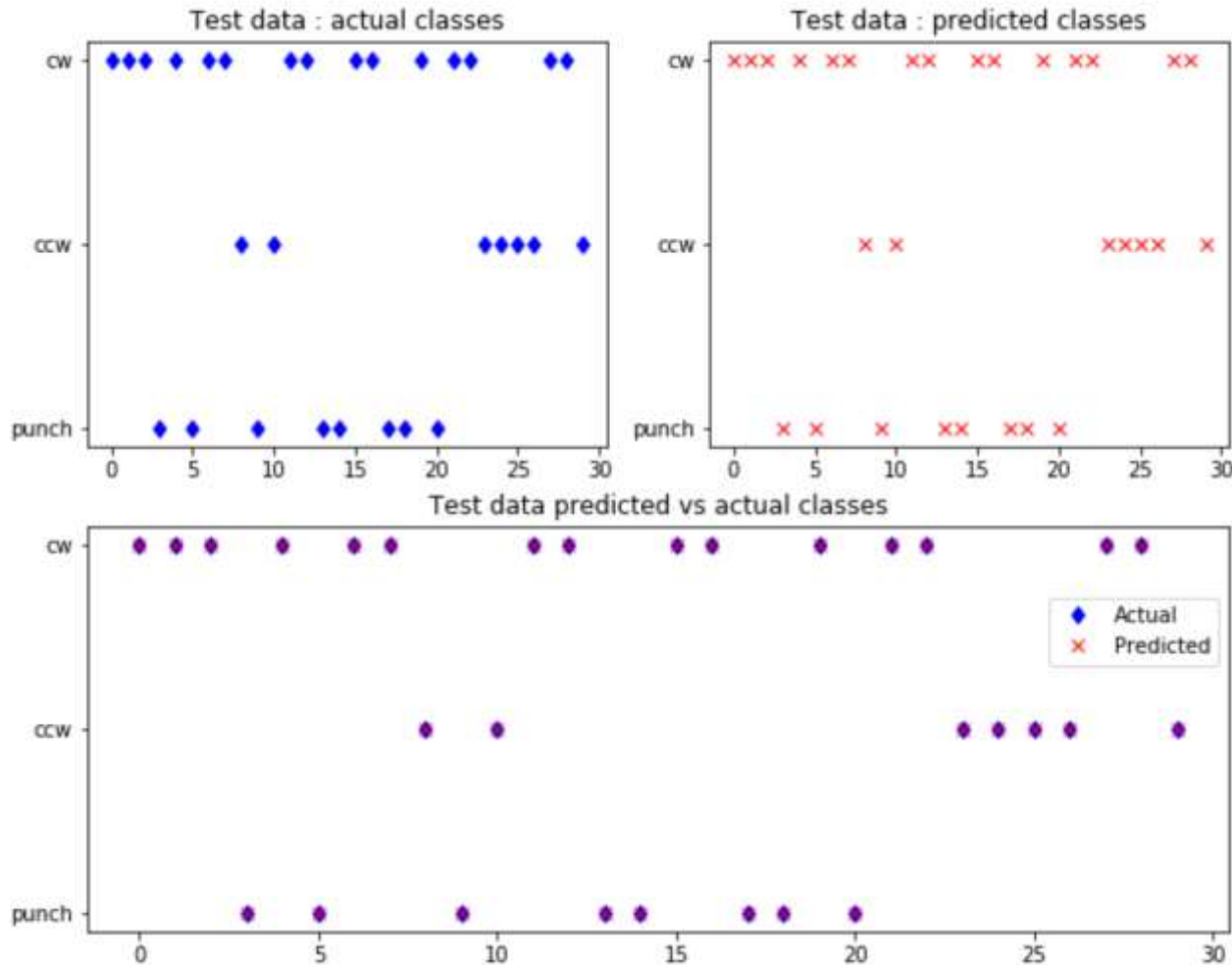
Total params: 43,843

Trainable params: 43,843

Non-trainable params: 0

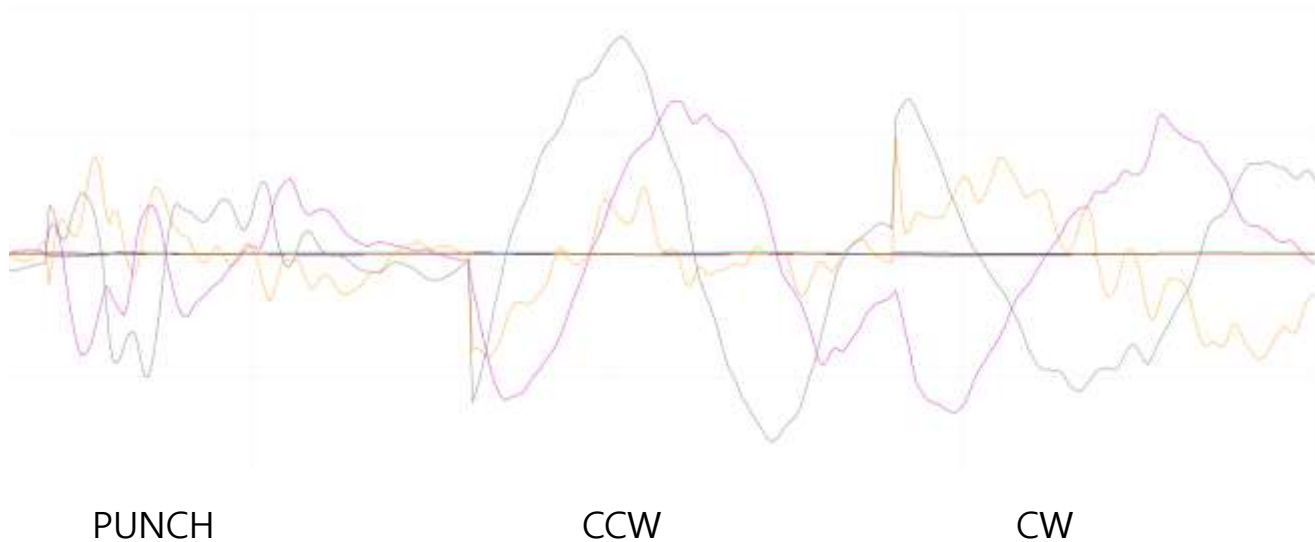
DL-model testing

actual =
[[0. 0. 1.]
[0. 0. 1.]
[0. 0. 1.]
[1. 0. 0.]
[0. 0. 1.]
[1. 0. 0.]
[0. 0. 1.]
[0. 0. 1.]
[0. 1. 0.]
[1. 0. 0.]
[0. 1. 0.]
[0. 0. 1.]
[0. 0. 1.]
[1. 0. 0.]



predictions =
[[0. 0.001 0.999]
[0.001 0.001 0.998]
[0.005 0.001 0.994]
[0.999 0. 0.001]
[0. 0.001 0.999]
[1. 0. 0.]
[0. 0.001 0.999]
[0.002 0.001 0.997]
[0. 1. 0.]
[1. 0. 0.]
[0. 1. 0.]
[0. 0.001 0.999]
[0.001 0. 0.999]
[0.997 0. 0.003]

Real-time testing



```
COM8
13:24:06.140 -> punch: 0.996470
13:24:06.140 -> ccw: 0.000000
13:24:06.140 -> cw: 0.003530
13:24:06.140 ->
13:24:10.197 -> punch: 0.000095
13:24:10.197 -> ccw: 0.000000
13:24:10.197 -> cw: 0.999905
13:24:10.197 ->
13:24:13.193 -> punch: 0.000000
13:24:13.193 -> ccw: 1.000000
13:24:13.193 -> cw: 0.000000
```

● References & good sites

- ✓ <http://www.arduino.cc> Arduino Homepage
- ✓ <http://www.nodejs.org/ko> Node.js
- ✓ <https://plot.ly/> plotly
- ✓ <https://www.mongodb.com/> MongoDB
- ✓ <http://www.w3schools.com> By w3schools
- ✓ <http://www.github.com> GitHub

Target of this class

Real-time Weather Station from nano 33 BLE sensors



on Time: 2022-11-15 09:48:56.577

