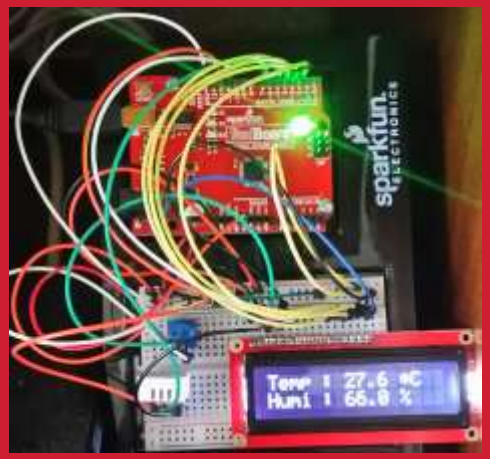


Arduino-IOT

[wk05]

Arduino Sensors + Node

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

Drone-IoT-Comsi, INJE University

2nd semester, 2022

Email : chaos21c@gmail.com

My ID

ID를 확인하고 github에 repo 만들기

AA01	강대진	AA13	박제홍
		AA14	심준혁
AA03	김성우	AA15	이상혁
AA04	김정헌	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

[Review]

- [wk04]
  - aann-rpt05
  - aann-rpt06

wk04 : Practice-05 : aann-rpt05

- [Target of this week]
  - Complete your works
  - Save your outcomes and upload figures in github

Upload folder : aann-rpt05

- 제출할 파일들
  1. **AAnn_AnalogVoltage.png**
  2. **AAnn_TMP36.png**
  3. **AAnn_LCD_lux.png**
  4. **All *.ino**

Email : chaos21c@gmail.com

wk04 : Practice : aann-rpt06

- [Target of this week]
  - Complete your works
  - Save your outcomes and upload outputs in github repo.

제출폴더명 : **aann-rpt06**

- 압축할 파일들

① AAnn_tmp36_message.png

② AAnn_tmp36_IOT_data.png

③ AAnn_tmp36_IOT_WEB.png

④ All *.ino

⑤ All *.js

⑥ NO node_modules folder

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)

IOT: HSC

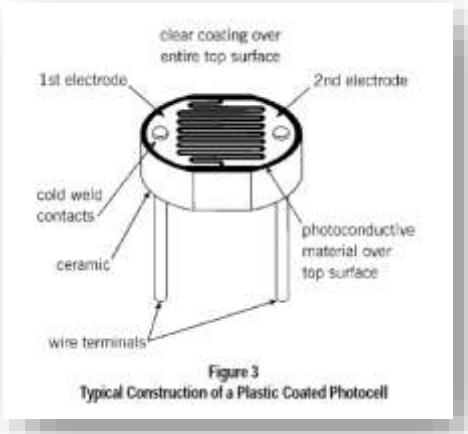
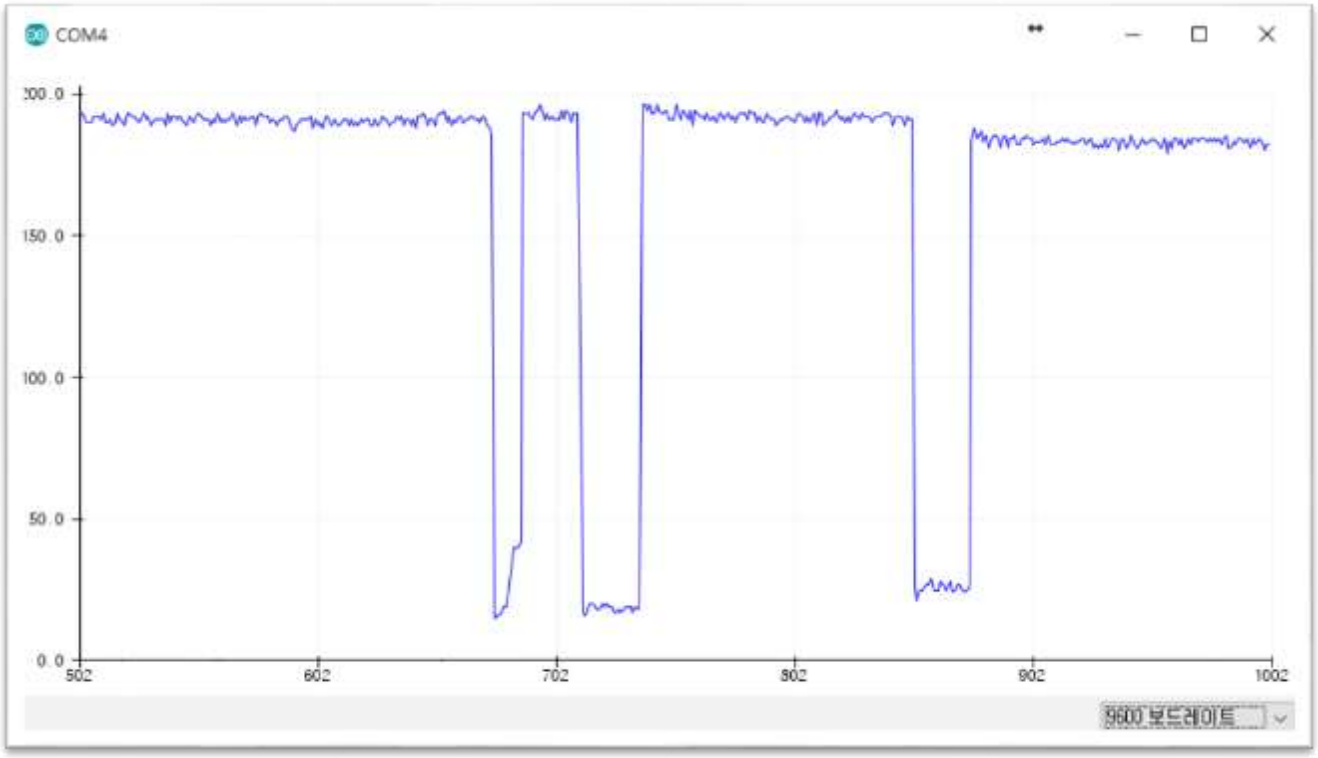
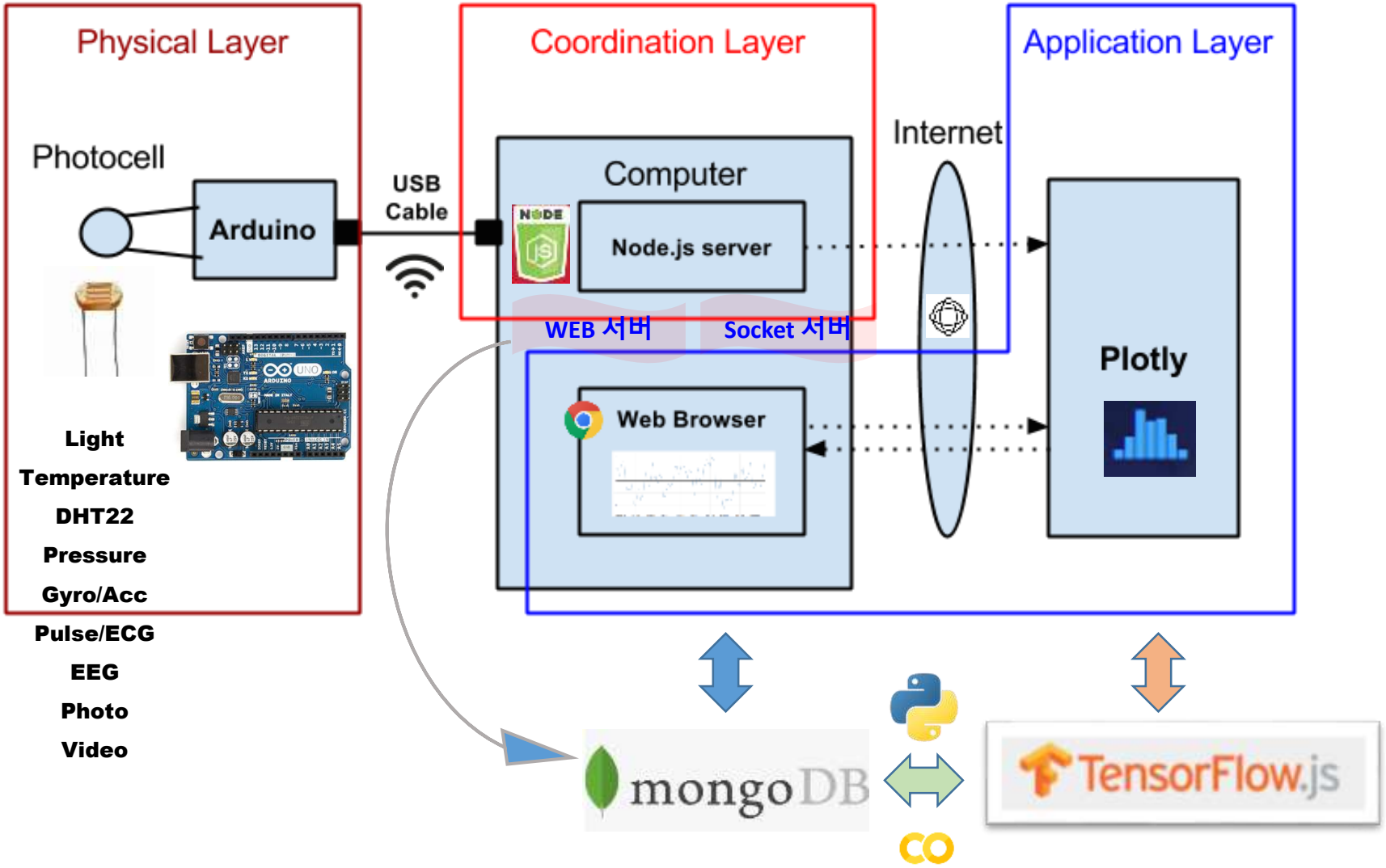


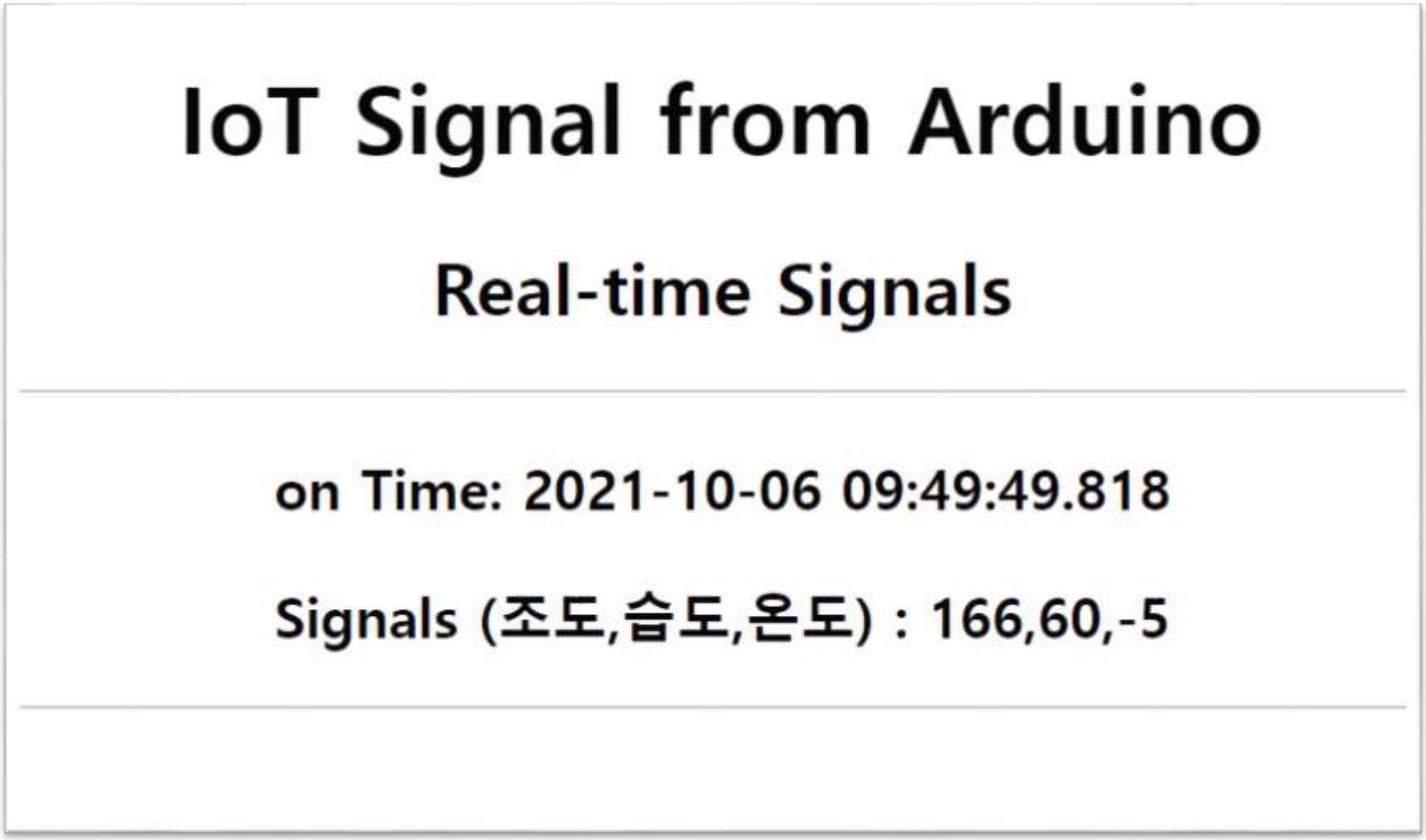
Figure 3
Typical Construction of a Plastic Coated Photocell



Layout [H S C]

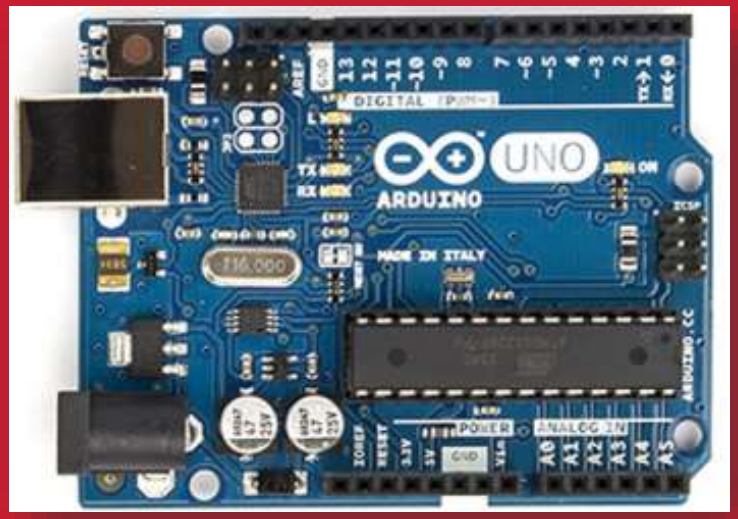

Physical Layer
Photocell
Arduino
USB Cable
Light
Temperature
DHT22
Pressure
Gyro/Acc
Pulse/ECG
EEG
Photo
Video
Coordination Layer
Computer
Node.js server
WEB 서버
Socket 서버
Web Browser
Internet
Application Layer
Plotly
mongoDB
TensorFlow.js

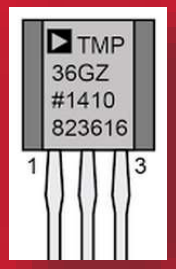
on WEB monitoring Arduino data

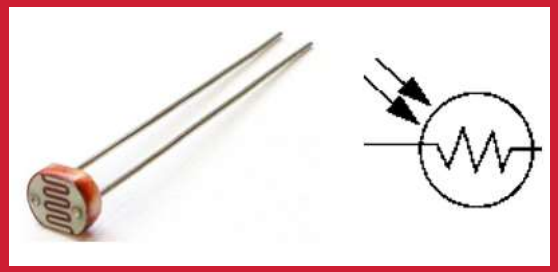


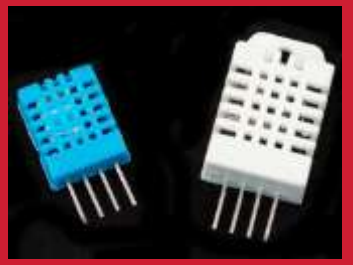
http://chaos.inje.ac.kr:3030/iot_multi.html

Arduino Sensors + Node.js

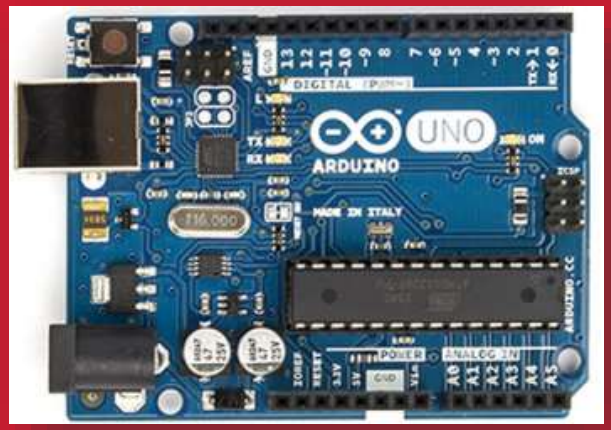








Single sensor: CdS

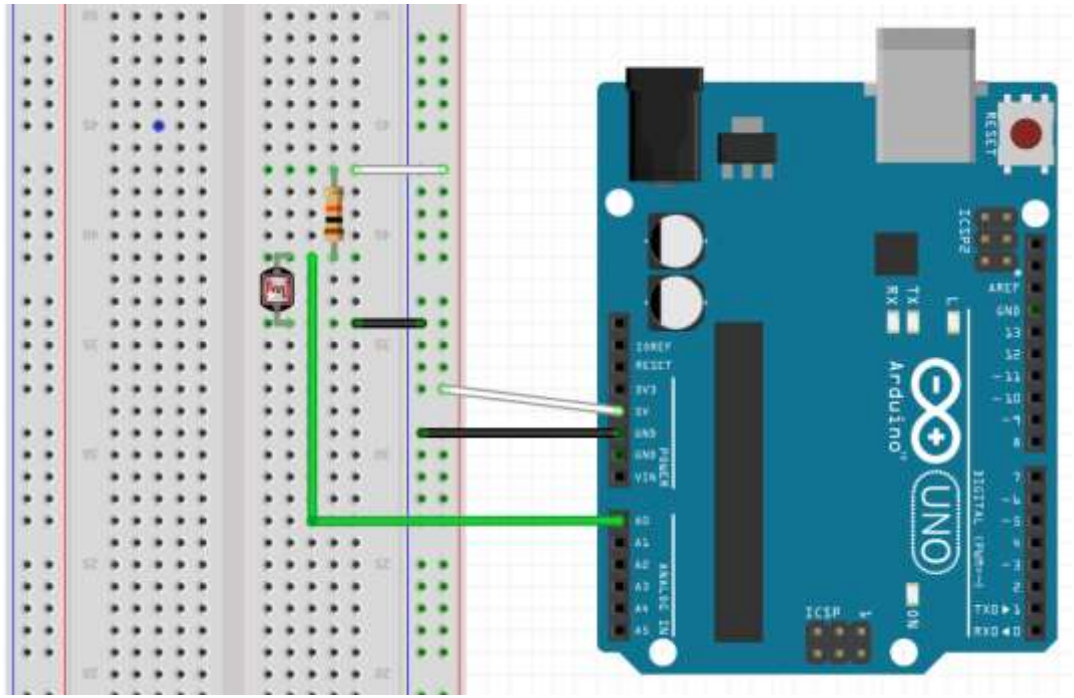


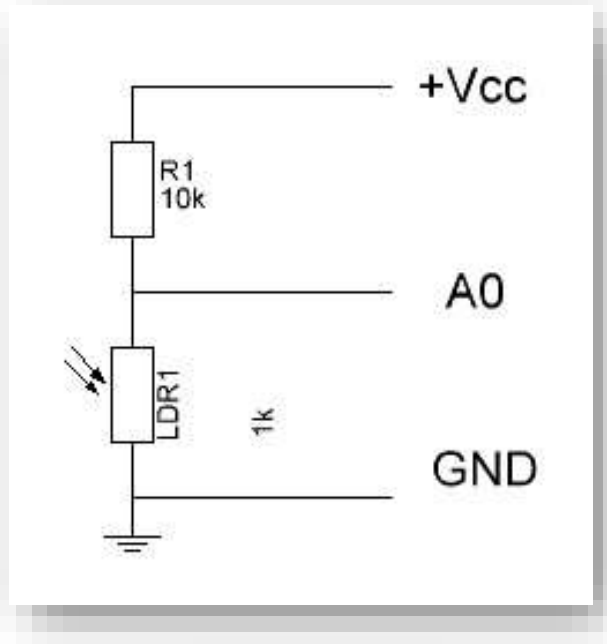
CdS (LDR)

Node project

A3.2.2 Luminosity sensor [Photocell LDR]

CdS 센서 회로





Parts : 20 mm photocell LDR, R (10 kΩ X 1)

광센서에서의 전압 강하 값을 **A0**로 측정

A3.2.6 Luminosity sensor [Photocell LDR]

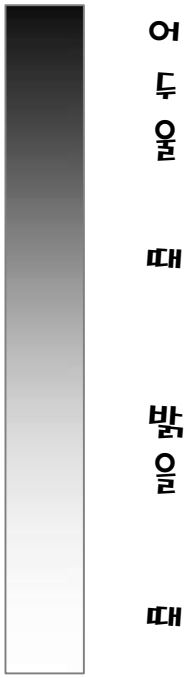
CdS 센서 회로 - 측정 2.

AAnn_cds_start.ino

```
1  //  lux
2  #define CDS_INPUT 0
3
4  void setup() {
5  Serial.begin(9600);
6  }
7  void loop() {
8    int value = analogRead(CDS_INPUT);
9    Serial.println(int(luminosity(value)));
10   delay(1000);
11 }
12
13 //Voltage to Lux
14 double luminosity (int RawADC0){
15   double Vout=RawADC0*5.0/1023;  // 5/1023 (Vin = 5 V)
16   double lux=(2500/Vout-500)/10;
17   // lux = 500 / Rldr, Vout = Ildr*Rldr = (5/(10 + Rldr))*Rldr
18   return lux;
19 }
```

COM11 (Arduino/Genuino Uno)

```
23
24
23
183
191
183
185
531
1169
1262
1198
1039
1063
```

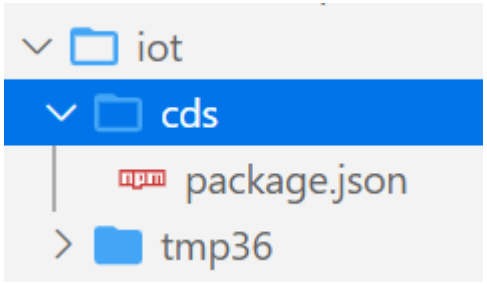


밝을수록 측정 값이 커지고
어두을수록 값이 작아진다 !!!

A4.2.1 Luminosity sensor [npm init]

Start cds-node project

1. **Go to my working folder**
2. **Go to iot folder**
3. **md cds**
4. **cd cds**
5. **Open terminal in cds**
6. **npm init**



"main": "cds_node.js"
"author": “aann"

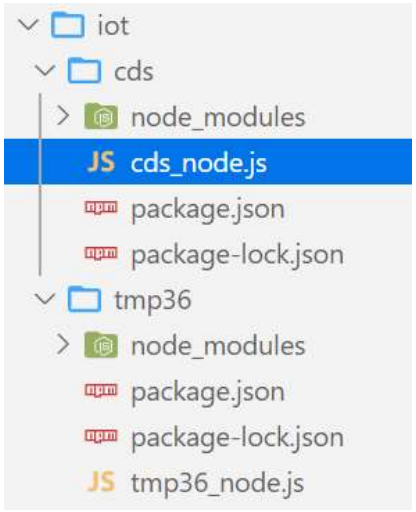
A4.2.2 Luminosity sensor [install node modules]

npm install --save serialport@9.2.4

npm install --save socket.io@2.4.1

```
{
  "name": "cds",
  "version": "1.0.0",
  "description": "cds node project",
  "main": "cds_node.js",
  ▷ Debug
  "scripts": {
    "test": "echo \"Error: no test specified\" && exit 1"
  },
  "keywords": [
    "cds",
    "node"
  ],
  "author": "aa00",
  "license": "MIT",
  "dependencies": {
    "serialport": "^9.2.4",
    "socket.io": "^2.4.1"
  }
}
```

A4.2.3 Luminosity sensor [node code]

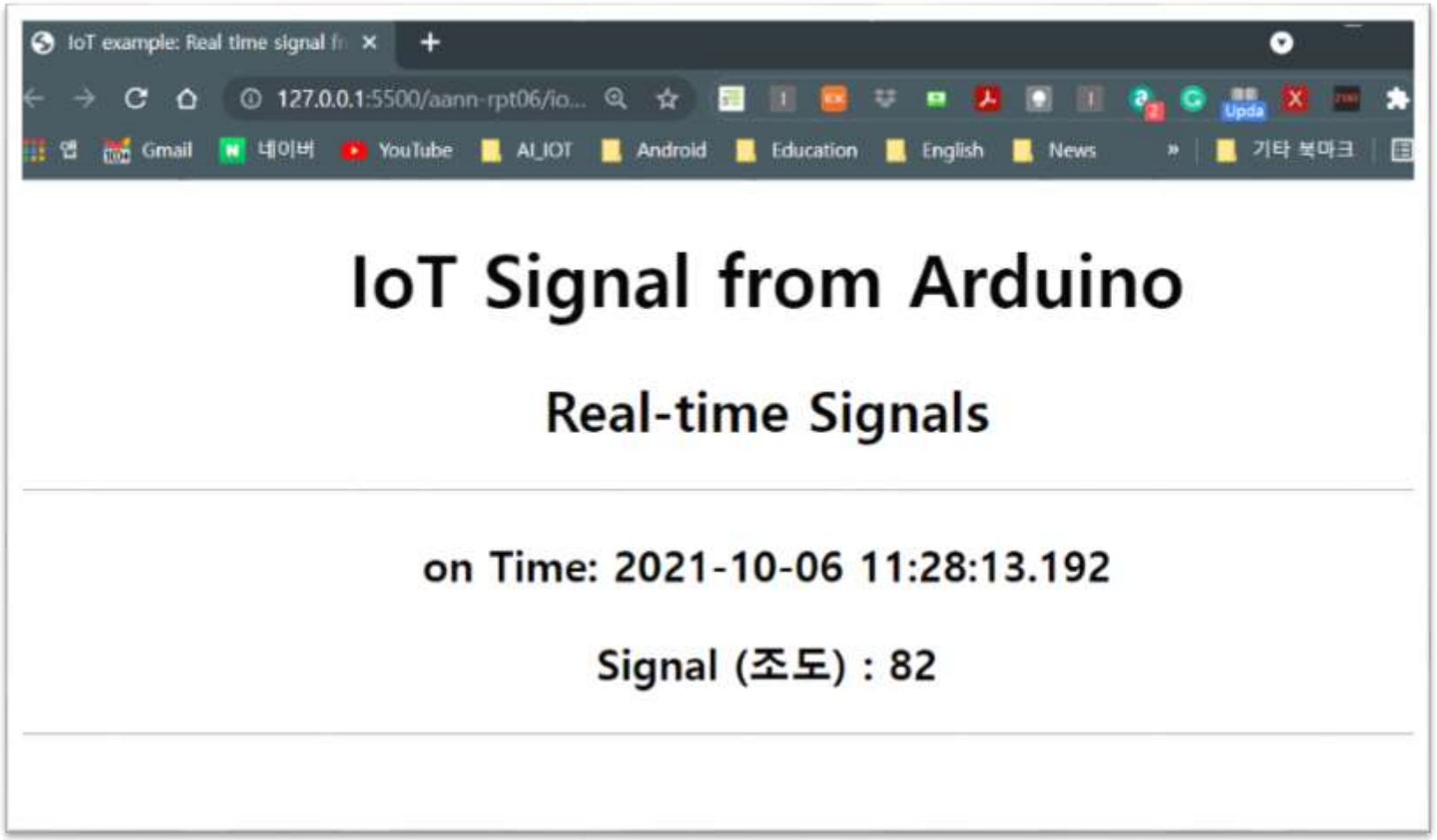


Save tmp36_node.js as cds_node.js in cds folder
(code 재활용)

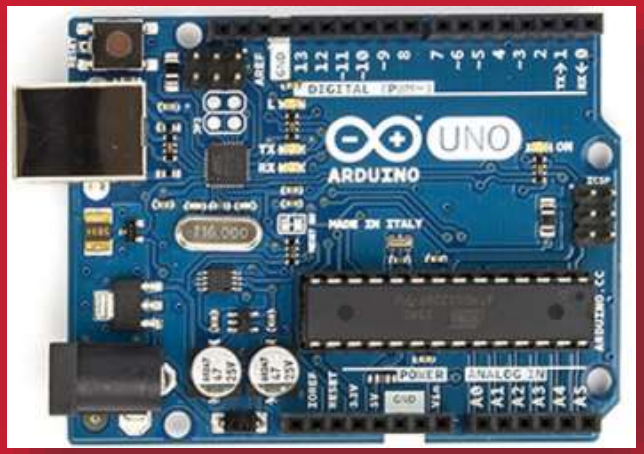
```
D:\aann\aann-rpt06\iot\cds>node cds_node
serial port open
AA00,2021-10-06 11:22:58.665,82
AA00,2021-10-06 11:22:59.669,83
AA00,2021-10-06 11:23:00.668,82
AA00,2021-10-06 11:23:01.672,83
AA00,2021-10-06 11:23:02.672,82
AA00,2021-10-06 11:23:03.675,82
AA00,2021-10-06 11:23:04.675,82
AA00,2021-10-06 11:23:05.678,82
AA00,2021-10-06 11:23:06.678,83
```

A4.2.4 CdS node project (web monitoring)

[Web monitoring] client_signal_cds.html

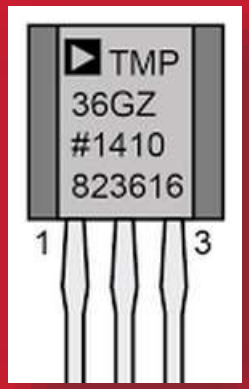


Multiple sensors

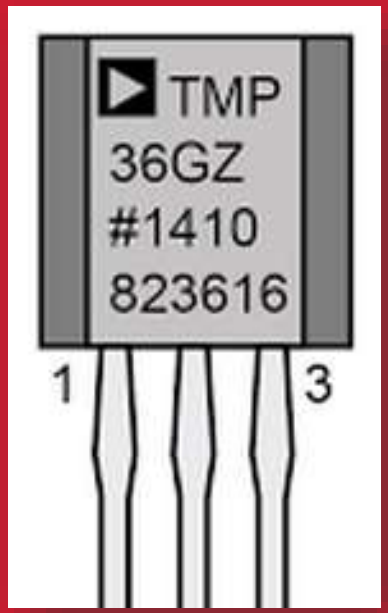


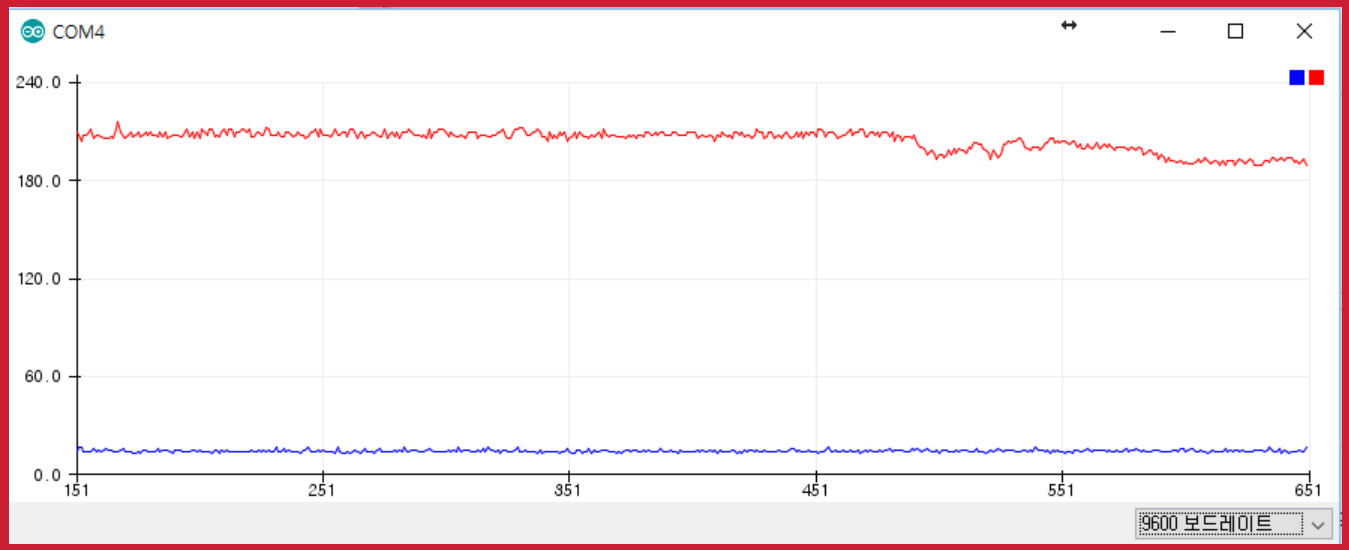
Arduino

+ Node.js

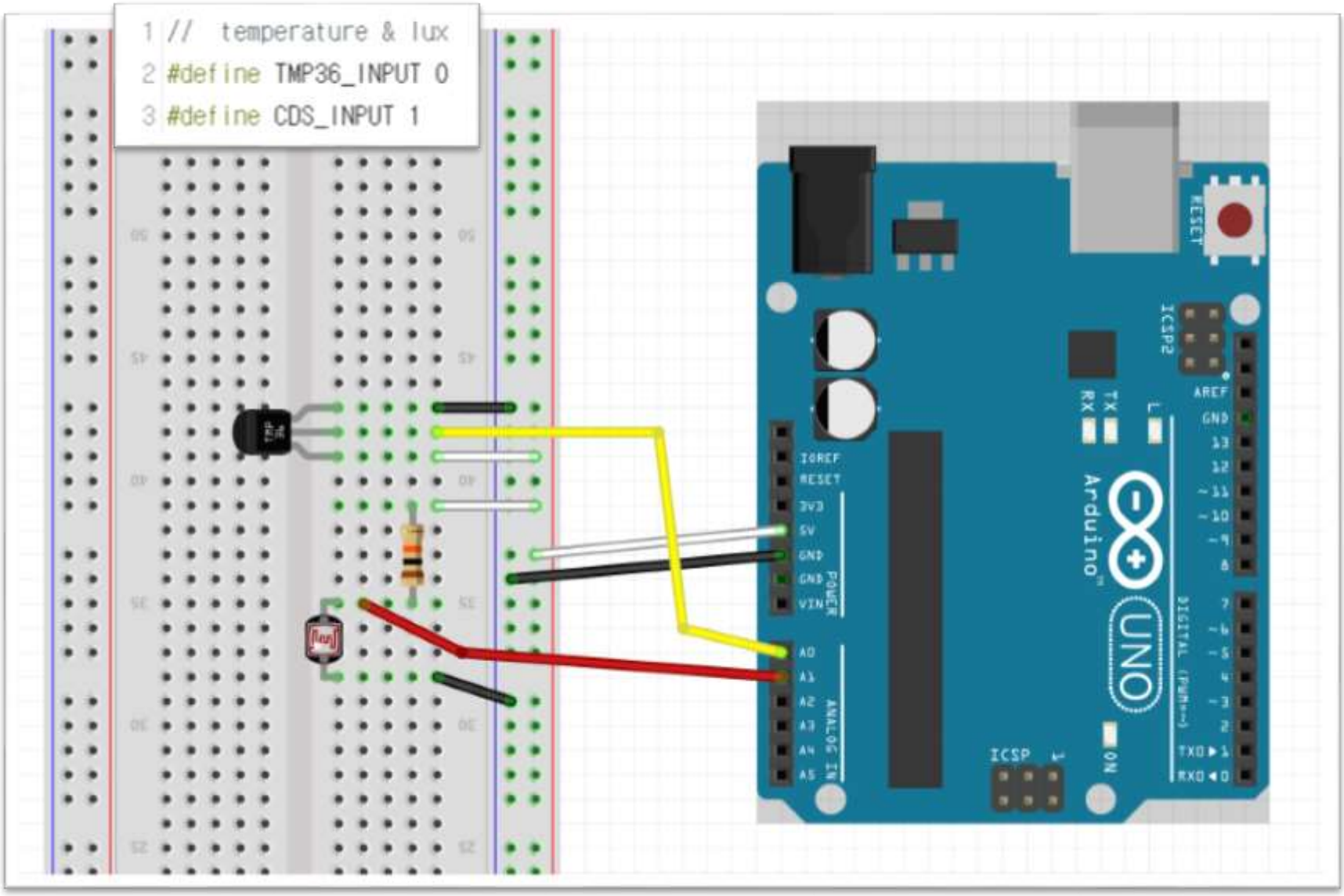


Monitoring via Serial monitor & LCD


TMP
36GZ
#1410
823616
1
3


COM4
240.0
180.0
120.0
60.0
0.0
151
251
351
451
551
651
9600 보드레이트

A4.3.1 TMP36 + CdS : circuit



A4.3.2 TMP36 + CdS : code

AAnn_TMP36_CdS§

```
1  //  temperature & lux
2  #define TMP36_INPUT 0
3  #define CDS_INPUT 1
4
5  void setup() {
6    Serial.begin(9600);
7  }
```

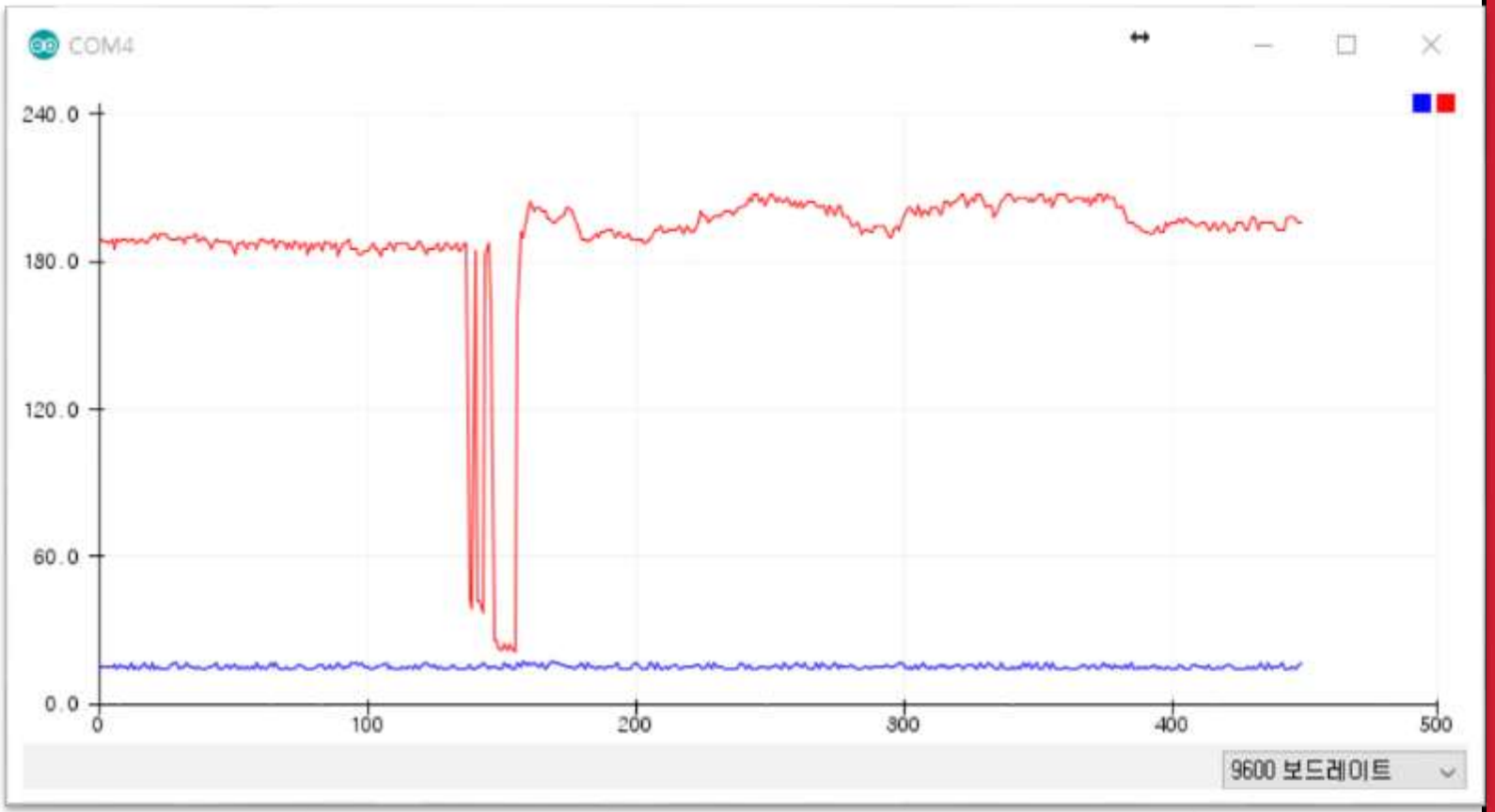
AAnn_tmp36_cds.ino

```
8  void loop() {
9    // Temperature from TMP36
10   int temp_value = analogRead(TMP36_INPUT);
11   // converting that reading to voltage
12   float voltage = temp_value * 5.0 * 1000;  // in mV
13   voltage /= 1023.0;
14   float tempC = (voltage - 500) / 10 ;
15
16   // Lux from CdS (LDR)
17   int cds_value = analogRead(CDS_INPUT);
18   int lux = int(luminosity(cds_value));
19 //
20   Serial.print(tempC);
21   Serial.print(",");
22   Serial.println(lux);
23
24   delay(1000);
25 }
26
27 //Voltage to Lux
28 double luminosity (int RawADC0){
29   double Vout=RawADC0*5.0/1023.0;  // 5/1023 (Vin = 5 V)
30   int lux=(2500/Vout-500)/10;
31   // lux = 500 / Rldr, Vout = Ildr*Rldr = (5/(10 + Rldr))*Rldr
32   return lux;
33 }
```

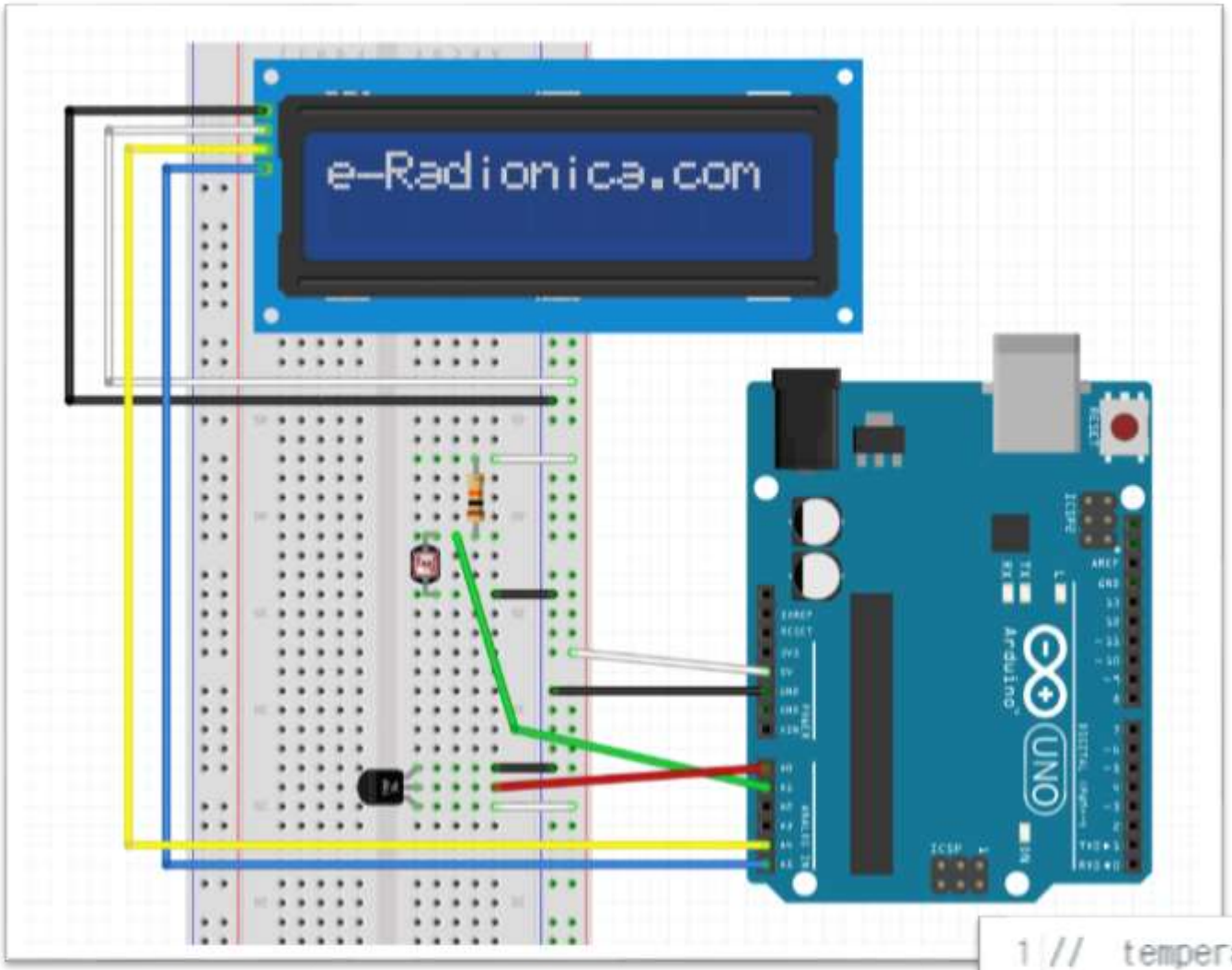
A4.3.3 TMP36 + CdS : Monitoring

COM4

15.98,192
14.52,194
14.52,193
14.52,193
15.00,180
14.03,18
14.52,17
14.52,16
13.54,15
14.52,191
16.47,188
15.00,188
14.52,190
14.52,190



A4.4.1 TMP36 + CdS + LCD : circuit




```
1 //  temperature & lux
2 #define TMP36_INPUT 0
3 #define CDS_INPUT 1
```

A4.4.2 TMP36 + CdS + LCD : code-1

AAnn_tmp36_cds_lcd.ino

```
/*
 온도, 빛 입력 LCD 모니터링 및 제어
*/
 // LCD 라이브러리 설정
#include <LiquidCrystal_I2C.h>
#include<Wire.h>
// LCD 설정
LiquidCrystal_I2C lcd(0x27,16,2); // 0x3F
// 0번 아날로그핀을 TMP36 온도 입력으로 설정한다.
// 1번 아날로그핀을 CdS 조도 입력으로 설정한다.
#define TMP36_INPUT 0   // A0
#define CDS_INPUT 1     // A1

void setup() {
  Serial.begin(9600);
// 16X2 LCD 모듈 설정하고 백라이트를 켠다.
  lcd.init();
  lcd.backlight();
// 모든 메세지를 삭제한 뒤
// 숫자를 제외한 부분들을 미리 출력시킨다.
  lcd.clear();
  lcd.setCursor(0,0);
  lcd.print("AA00,Temp: ");
  lcd.setCursor(0,1);
  lcd.print("Light:  ");
  lcd.setCursor(13,1);
  lcd.print("lux");  //
}
```

A4.4.3 TMP36 + CdS + LCD : code-2

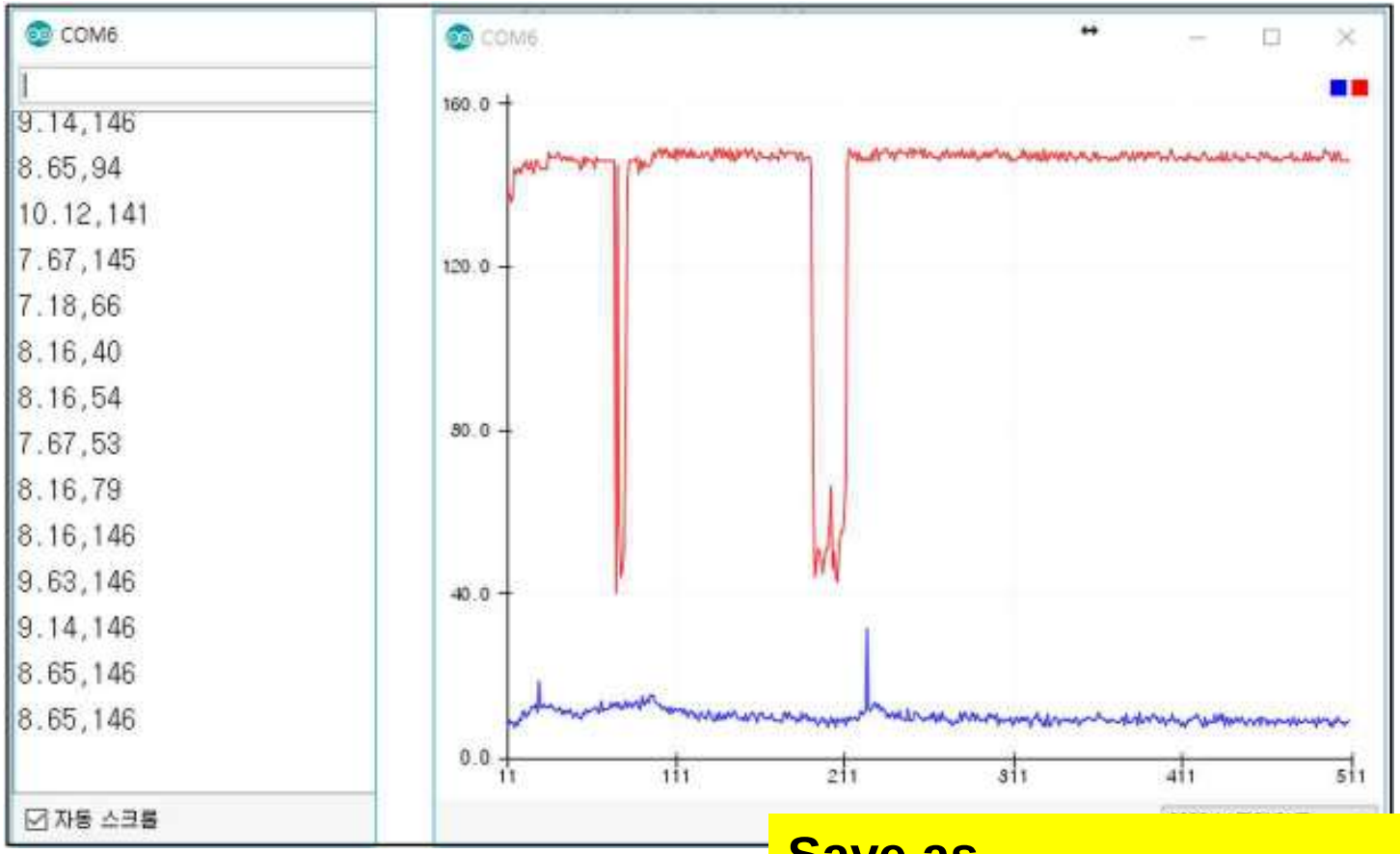
```
29 void loop(){
30   // Temperature from TMP36
31   int temp_value = analogRead(TMP36_INPUT);
32   // converting that reading to voltage
33   float voltage = temp_value * 5.0 * 1000;  // in mV
34   voltage /= 1023.0;
35   float tempC = (voltage - 500) / 10 ;
36
37   // Lux from CdS (LDR)
38   int cds_value = analogRead(CDS_INPUT);
39   int lux = int(luminosity(cds_value));
40
41   // 전에 표시했던 내용을 지운다.
42   lcd.setCursor(12,0);
43   lcd.print("    ");
44   // 온도를 표시한다
45   lcd.setCursor(12,0);
46   lcd.print(tempC);
47   // 전에 표시했던 내용을 지운다
48   lcd.setCursor(9,1);
49   lcd.print("    ");
50   // 조도를 표시한다
51   lcd.setCursor(9,1);
52   lcd.print(lux);
```

LCD output

```
56   // Serial output --> 온도,조도
57   Serial.print(tempC);
58   Serial.print(",");
59   Serial.println(lux);
60   delay(1000);
61 }
62
63 //Voltage to Lux
64 double luminosity (int RawADC0){
65   double Vout=RawADC0*5.0/1023;  // 5/1023 (Vin = 5 V)
66   double lux=(2500/Vout-500)/10;
67   // lux = 500 / Rldr,
68   // Vout = Ildr*Rldr = (5/(10 + Rldr))*Rldr
69   return lux;
70 }
```

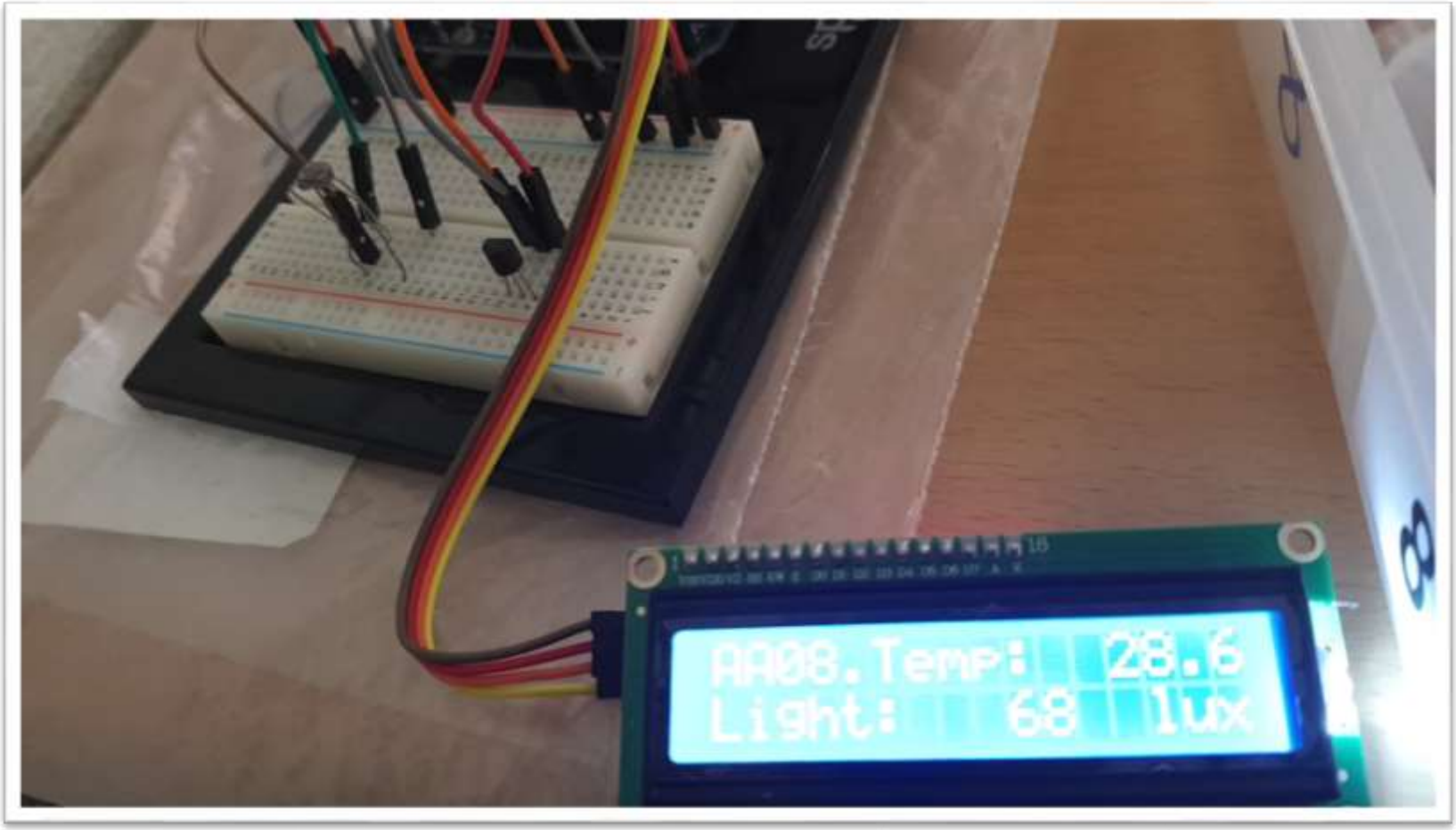
Serial output

A4.4.4 TMP36 + CdS + LCD : result-1



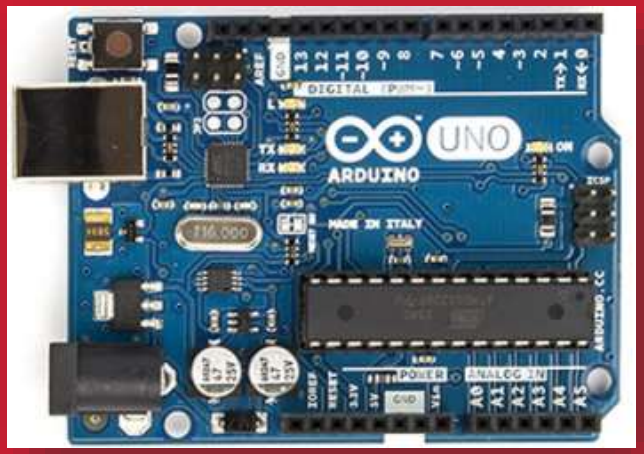
Save as
AAnn_cds_tmp36_serial.png

A4.4.5 TMP36 + CdS + LCD : result-2



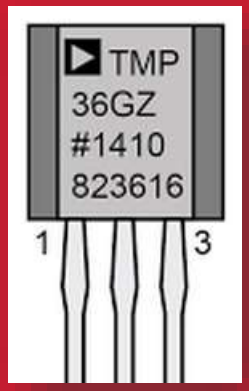
Save as
AAnn_cds_tmp36_lcd.png

Multiple sensors



CdS + TMP36

Node project



A4.5.1 CdS + TMP36 + Node project

1. Make cds_tmp36 node project
   - md cds_tmp36 in iot folder
2. Go to cds_tmp36 subfolder
   - Start terminal
   - npm init

"main": "cds_tmp36_node.js"
"author": “aann"

name : cds_tmp36

description : cds-tmp36-node project

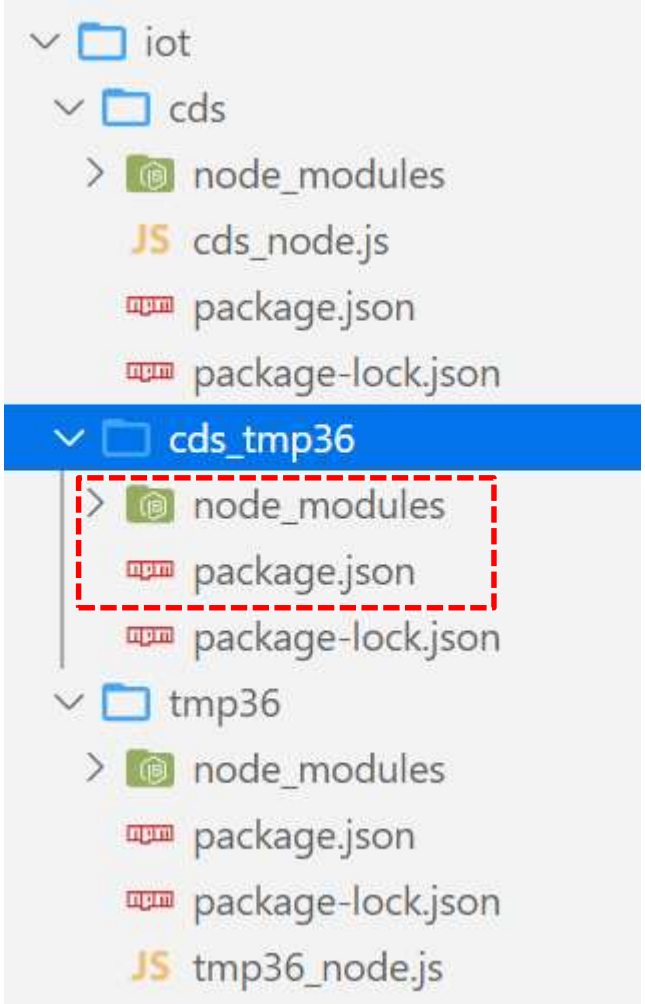
entry point : cds_tmp36_node.js

author : aann

A4.5.2 CdS + TMP36 + Node project

- **npm install –save serialport@9.2.4**
- **npm install –save socket.io@2.4.1**
- **npm Error 발생하면,**
- **npm update**

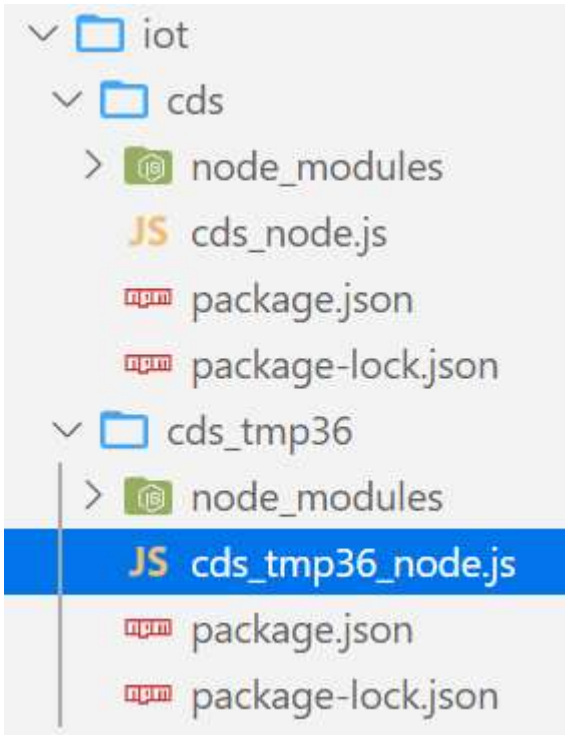
```
"keywords": [
  "cds",
  "tmp36",
  "node"
],
"author": "aa00",
"license": "MIT",
"dependencies": {
  "serialport": "^9.2.4",
  "socket.io": "^2.4.1"
}
```



A4.5.3 CdS + TMP36 + Node project

Recycling code:
코드 재활용

Save cds_node.js as
cds_tmp36_node.js



A4.5.4.1 CdS + TMP36 + Node project : code-1

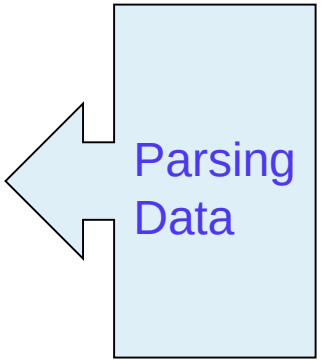
cds_tmp36_node.js

```
1   // cds_tmp36_node.js
2
3   var serialport = require("serialport");
4   var portName = "COM3"; // check your COM port!!
5   var port = process.env.PORT || 3000;
6
7   var io = require("socket.io").listen(port);
8
9   const Readline = require("@serialport/parser-readline");
10  // serial port object
11  var sp = new serialport(portName, {
12    baudRate: 9600, // 9600  38400
13    dataBits: 8,
14    parity: "none",
15    stopBits: 1,
16    flowControl: false,
17    parser: new Readline("\r\n"),
18  });
19
20  const parser = sp.pipe(new Readline({ delimiter: "\r\n" }));
21
22  // Read the port data
23  sp.on("open", () => {
24    console.log("serial port open");
25  });
```

A4.5.4.2 CdS + TMP36 + Node project : code-2

cds_tmp36_node.js – parsing data

```
27  var dStr = "";
28  var readData = "";
29  var temp = "";
30  var lux = "";
31  var mdata = [];
32  var firstcommaidx = 0;
33
34  parser.on("data", (data) => {
35    // call back when data is received
36    readData = data.toString();
37    firstcommaidx = readData.indexOf(",");
38    if (firstcommaidx > 0) {
39      temp = readData.substring(0, firstcommaidx);
40      lux = readData.substring(firstcommaidx + 1);
41      readData = "";
42
43      dStr = getDateString();
44      mdata[0] = dStr; //date
45      mdata[1] = temp; //data
46      mdata[2] = lux;
47      console.log("AA00," + mdata.toString());
48      io.sockets.emit("message", mdata); // send data to all clients
49    } else {
50      console.log(readData);
51    }
52  });
```



A4.5.4.3 CdS + TMP36 + Node project : code-3

cds_tmp36_node.js

```
54  io.sockets.on("connection", function (socket) {
55    // If socket.io receives message from the client browser then
56    // this call back will be executed.
57    socket.on("message", function (msg) {
58      console.log(msg);
59    });
60    // If a web browser disconnects from Socket.IO then this callback is called.
61    socket.on("disconnect", function () {
62      console.log("disconnected");
63    });
64  });
65
66  // helper function to get a nicely formatted date string for IOT
67  function getDateString() {
68    var time = new Date().getTime();
69    // 32400000 is (GMT+9 Korea, GimHae)
70    // for your timezone just multiply +/-GMT by 3600000
71    var datestr = new Date(time + 32400000)
72      .toISOString()
73      .replace(/T/, " ")
74      .replace(/Z/, "");
75    return datestr;
76  }
```

A4.5.5 CdS + TMP36 + Node project : result

Terminal에서 실행

```
D:\aann\aann-rpt06\iot\cds_tmp36>node cds_tmp36_node
serial port open
AA00,2021-10-05 13:57:38.119,25.27,84
AA00,2021-10-05 13:57:39.119,25.27,84
AA00,2021-10-05 13:57:40.122,24.78,83
AA00,2021-10-05 13:57:41.125,24.78,84
AA00,2021-10-05 13:57:42.125,24.78,84
AA00,2021-10-05 13:57:43.129,25.27,84
AA00,2021-10-05 13:57:44.132,25.27,83
AA00,2021-10-05 13:57:45.132,25.76,83
AA00,2021-10-05 13:57:46.135,24.78,84
```

IOT data format

시간, 온도,조도

Save as
AAnn_cds_tmp36_IOT.png

A4.5.6 CdS + TMP36 + Node project : WEB

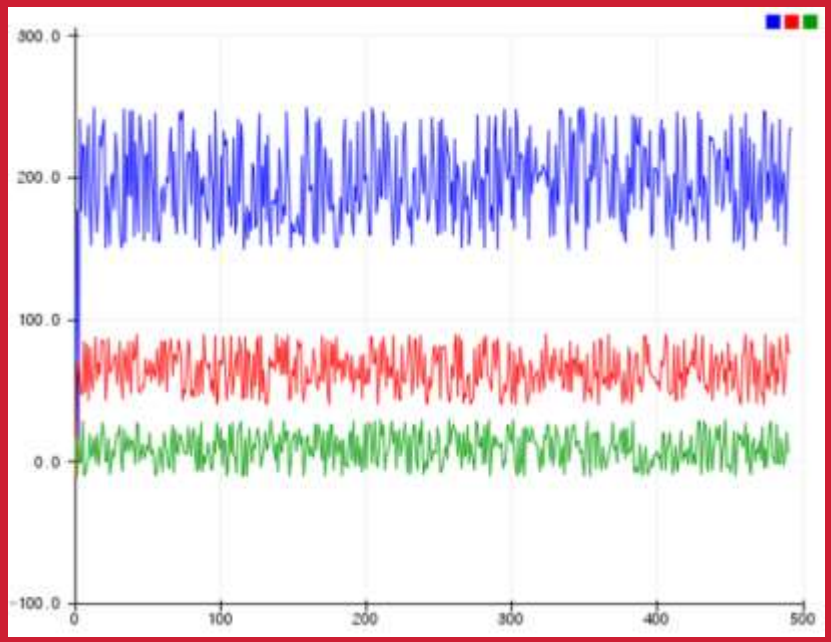
[Web monitoring] client_signal_cds_tmp36.html

Save as
AAnn_cds_tmp36_WEB.png

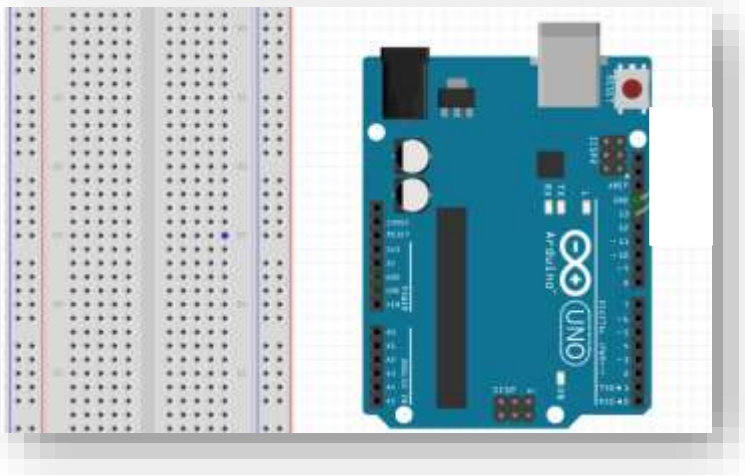
[DIY] Multi-signals

다중신호 시뮬레이션

+ node.js



DIY - 스케치



아두이노에서 **LED**와 저항을 모두 제거하고 **USB**만 컴퓨터와 연결한다.

전자 소자 연결 없이 마구잡이 수 생성 함수를 이용해서 조도, 습도, 온도에 해당되는 **3**개의 신호를 만든다.

온도는 값의 범위를 **–10 ~ 30,** 습도는 **40 ~ 90,** 그리고 조도는 **150 ~ 250** 으로 가상적 으로 설정한다.

직렬통신 모니터링을 이용해서 세 개의 신호의 변화를 모니터링 하는 코드를 만들어 결과를 확인한다.

▶ 스케치 구성

1. 3 개의 신호를 담을 변수를 초기화한다.
2. setup()에서 직렬 통신 속도를 9600 bps 로 설정하고 컴퓨터와 연결한다.
3. loop()에서 마구잡이 수를 세 개 발생시켜서 직렬 통신으로 3 개의 pwm 값을 각각 컴퓨터로 전송한다.

DIY - code

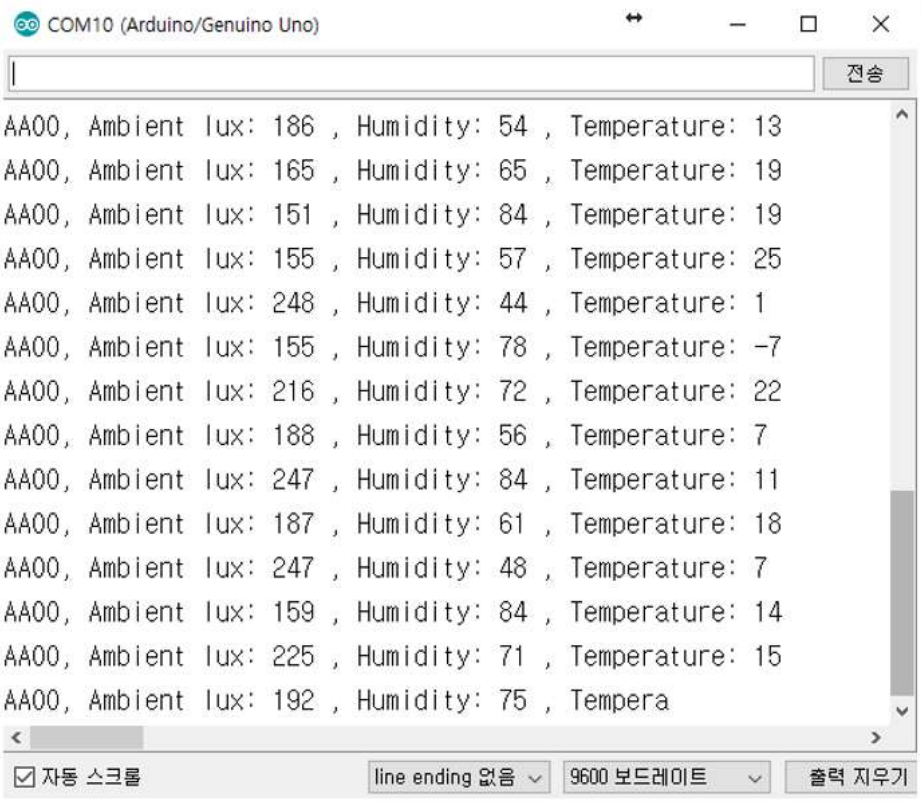
sketch05_multi_signals

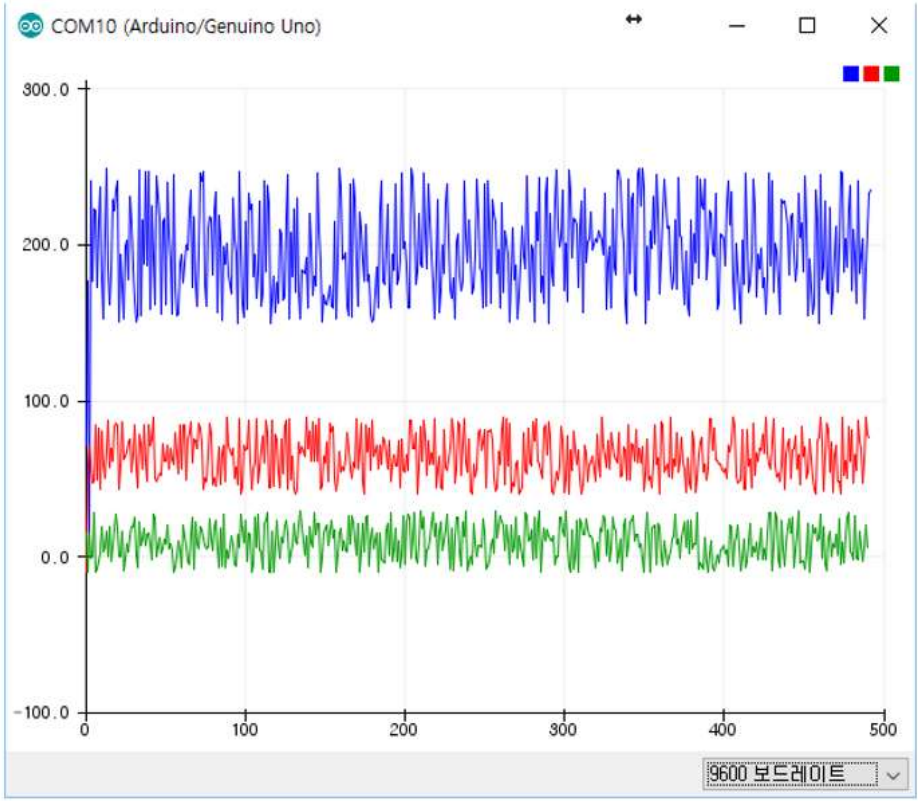
```
/*
  Multi Signals
  Simulation of multiple random signals
*/
// signals
int humi=0;
int temp=0;
int lux=0;

// the setup routine runs once when you press reset:
void setup() {
  // initialize serial communication at 9600 bits per second:
  Serial.begin(9600);
}

// the loop routine runs over and over again forever:
void loop() {
  // Multi signals
  humi = random(40,90);
  temp = random(-10, 30);
  lux = random(150,250);
  Serial.print("AA00, Ambient lux: ");
  Serial.print(lux);
  Serial.print(" , Humidity: ");
  Serial.print(humi);
  Serial.print(" , Temperature: ");
  Serial.println(temp);
  delay(500);          // delay in between reads for stability
}
```

DIY - result

DIY 결과

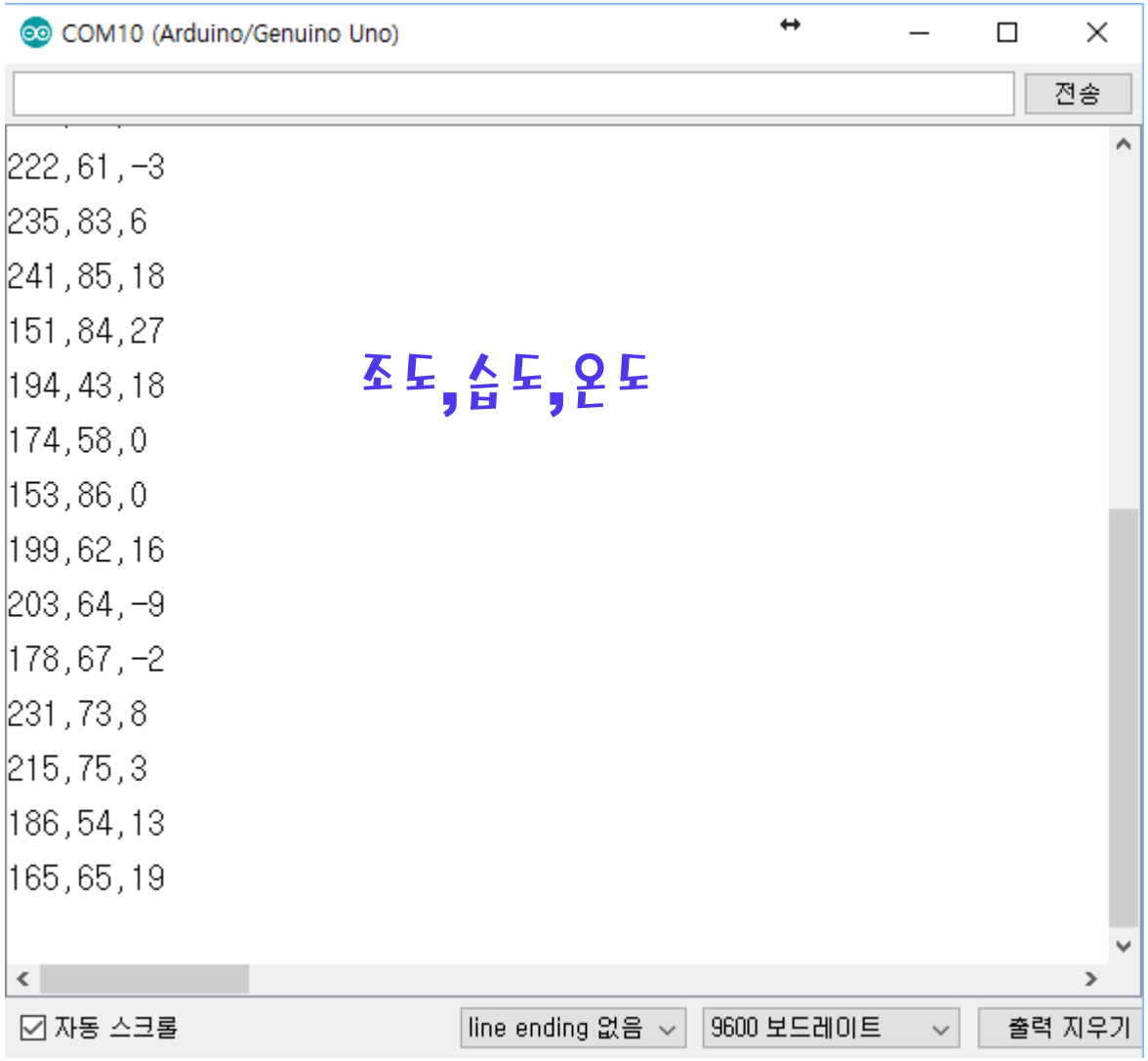
가상적인 세 개의 센서신호 시뮬레이션:조도(위), 습도(중간), 온도(아래).





DIY – New result 1

DIY 결과 [1] : 가상적인 세 개의 센서신호 시뮬레이션 → 조도,습도,온도



DIY – New result 2-1

DIY 결과 [2]: 가상적인 세 개의 센서신호 시뮬레이션 → 조도,습도,온도를 Node.js로 처리

[1 단계] Node cmd

1. Make multi_signals node project

- md multi_signals in iot folder
- cd multi_signals

2. Go to multi_signals subfolder

- npm init

  name : multi_signals

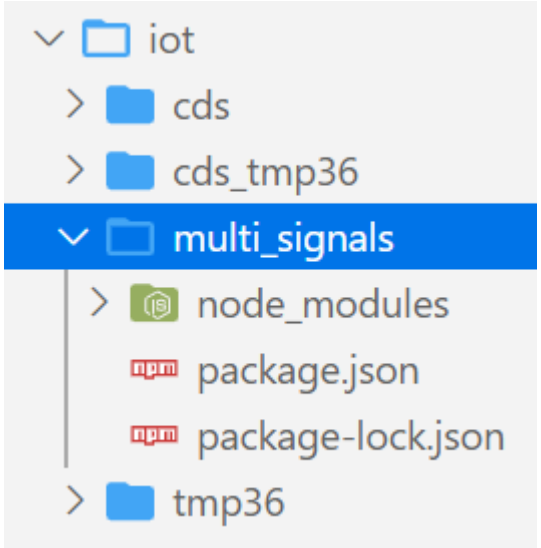
  description : multi-signals-node project

  entry point : aann_multi_signals.js

  author : aann

3. Install node modules

- npm install –save serialport@9.2.4
- npm install –save socket.io@2.4.1



DIY – New result 2-2

DIY 결과 [2]: 가상적인 세 개의 센서신호 시뮬레이션 → 조도,습도,온도를 Node.js로 처리

Recycling code:
Save cds_tmp36_node.js as
aann_multi_signals.js in multi_signals subfolder
Update code

```
var dStr ='';
var readData='';
var temp='';
var humi='';
var lux='';
var mdata=[];
var firstcommaidx = 0;
var secondcommaidx= 0;
```

DIY – New result 2-3

DIY 결과 [2]: 가상적인 세 개의 센서신호 시뮬레이션 → 조도,습도,온도를 Node.js로 처리

```
parser.on("data", (data) => {
  // call back when data is received
  readData = data.toString();
  firstcommaidx = readData.indexOf(",");
  secondcommaidx = readData.indexOf(",", firstcommaidx + 1);
  if (firstcommaidx > 0) {
    console.log("AA00," + mdata);
    io.sockets.emit("message", mdata); // send data to all clients
  } else {
    console.log(readData);
  }
});
```

아두이노가 직렬통신으로 전송하는 2 개의 comma (,)로 구분된

조도,습도,온도 데이터 메시지를 **parsing**하여 **mdata** 배열에 담는 코드를 완성하시오.

substring() 함수에서 firstcommaidx, secondcommaidx를 잘 이용하시오.

DIY – New result 2-3

DIY 결과 [2]: 가상적인 세 개의 센서신호 시뮬레이션 → 조도,습도,온도를 Node.js로 처리

```
parser.on("data", (data) => {
  // call back when data is received
  readData = data.toString();
  firstcommaidx = readData.indexOf(",");
  secondcommaidx = readData.indexOf(",", firstcommaidx + 1);
  if (firstcommaidx > 0) {
    lux = readData.substring(0, firstcommaidx);
    humi = readData.substring(firstcommaidx + 1, secondcommaidx);
    temp = readData.substring(secondcommaidx + 1);
    readData = "";

    dStr = getDateString();
    mdata[0] = dStr; //date
    mdata[1] = lux; //data
    mdata[2] = humi;
    mdata[3] = temp;
    console.log("AA00," + mdata.toString());
    io.sockets.emit("message", mdata); // send data to all clients
  } else {
    console.log(readData);
  }
});
```

DIY – New result 2-4 : js functions

DIY 결과 [2]: 가상적인 세 개의 센서신호 시뮬레이션 → 조도,습도,온도를 Node.js로 처리

Hint:

javascript function : indexOf()

https://www.w3schools.com/jsref/jsref_indexof.asp

Syntax

```
string.indexOf(searchvalue, start)
```

Parameter Values

Parameter	Description
searchvalue	Required. The string to search for
start	Optional. Default 0. At which position to start the search

javascript function : substring()

```
string.substring(start, end)
```

Parameter Values

Parameter	Description
start	Required. The position where to start the extraction. First character is at index 0
end	Optional. The position (up to, but not including) where to end the extraction. If omitted, it extracts the rest of the string

DIY – New result 2-5

DIY 결과 [2]: 가상적인 세 개의 센서신호 시뮬레이션 → 조도,습도,온도를 Node.js로 처리

```
D:\aann\aann-rpt06\iot\multi_signals>node aann_multi_signals
serial port open
AA00,2021-10-05 14:21:10.805,223,47,-1
AA00,2021-10-05 14:21:11.804,222,48,0
AA00,2021-10-05 14:21:12.808,173,84,28
AA00,2021-10-05 14:21:13.811,215,49,-10
AA00,2021-10-05 14:21:14.811,237,82,-8
AA00,2021-10-05 14:21:15.815,179,43,-3
AA00,2021-10-05 14:21:16.814,153,80,2
AA00,2021-10-05 14:21:17.818,207,59,19
AA00,2021-10-05 14:21:18.817,249,50,3
AA00,2021-10-05 14:21:19.821,185,68,6
AA00,2021-10-05 14:21:20.820,162,87,16
```

ID,시간,조도,습도,온도

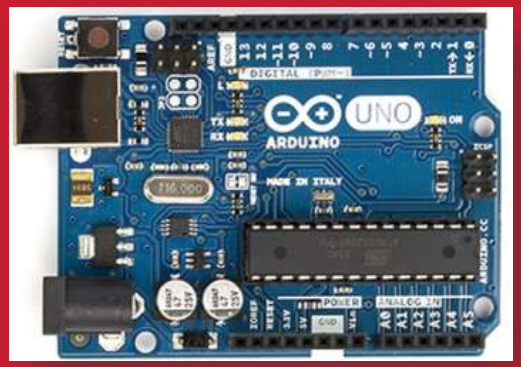
Save this result as AAnn_multi_signals_node .png

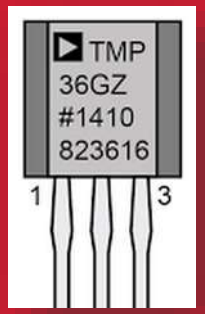
A4.5.6 multi-signals + Node project : WEB

[Web monitoring] client_multi_signals.html

Save as
AAnn_multi_signals_WEB.png

Next week

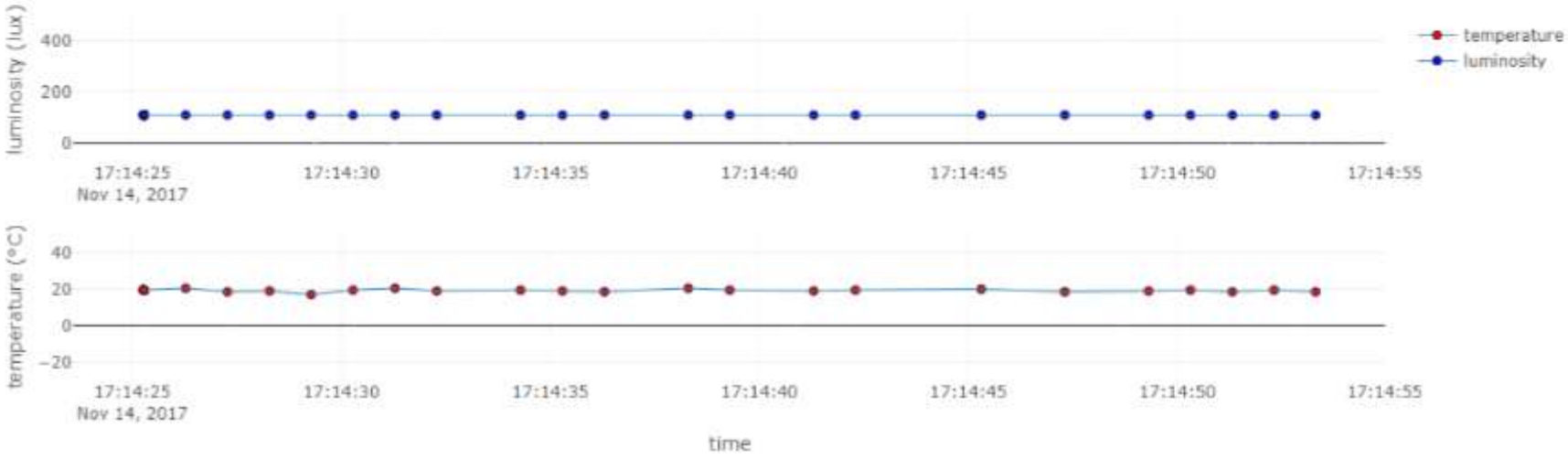


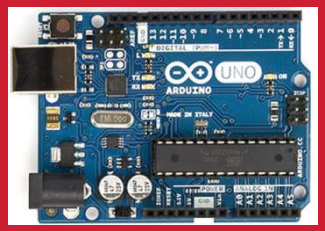


Data visualization using ploy.ly

Real-time Temperature(°C) and Luminosity(lux) from sensors

on Time: 2017-11-14 17:14:53.321





[Practice]

- [wk05]
  - Arduino sensors + Node.js
  - Complete your project
  - Upload folder: aann-rpt06
  - Use repo “aann” in github

wk06 : Practice : aann-rpt06

- [Target of this week]
  - Complete your works & update your repo.
  - Save your outcomes and upload outputs in github repo.

제출폴더명 : **aann-rpt06**

- 압축할 파일들

① AAnn_cds_tmp36_serial.png

② AAnn_cds_tmp36_lcd.png

③ AAnn_cds_tmp36_IOT.png

④ AAnn_cds_tmp36_WEB.png

⑤ AAnn_multi_signals_node.png

⑥ AAnn_multi_signals_WEB.png

⑦ All *.ino

⑧ All *.js

⑨ NO node_modules folder

Lecture materials

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