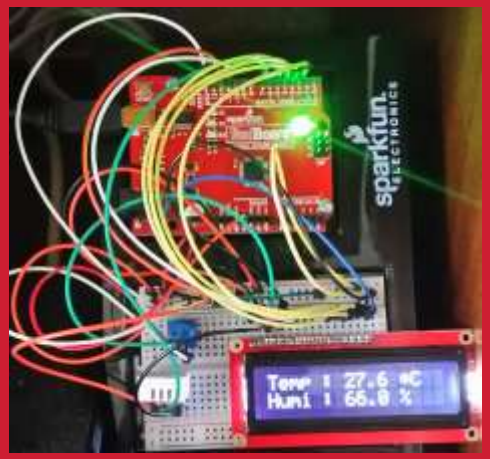
Arduino-IOT

[wk09]



Data Visualization II

- plotly.js + node

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

Drone-IoT-Comsi, INJE University

2nd semester, 2023

Email : chaos21c@gmail.com

My ID

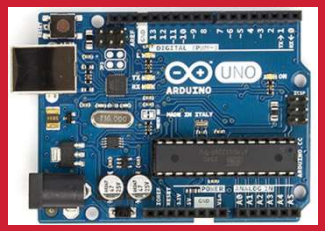
ID를 확인하고 github에 repo 만들기

ID	성명
AA01	강동하
AA02	고서진
AA03	김민재
AA04	김예원
AA05	김주호
AA06	김창욱
AA07	김현서
AA08	박종혁
AA09	서명진
AA10	유동기
AA11	
AA12	이근보
AA13	정호기

위의 id를 이용해서 github에 repo를 만드시오.

Option: 아두이노응용 실습 과제 – AAnn

Public, README.md check



[Review]

- [wk08]
  - charts by plotly
  - Complete your project
  - Upload folder: aann-rpt08
  - Use repo “aann” in github

wk08 : Practice : aann-rpt08

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

제출폴더명 : **aann-rpt08**

- 압축할 파일들

① AAnn_Chart_Layout.png

② AAnn_Axis_Title.png

③ AAnn_Line_Dash_Dot.png

④ AAnn_lux_Time_Series.png

⑤ AAnn_lux_Rangeslider.png

⑥ All *.html in data_charts folder

Email : chaos21c@gmail.com

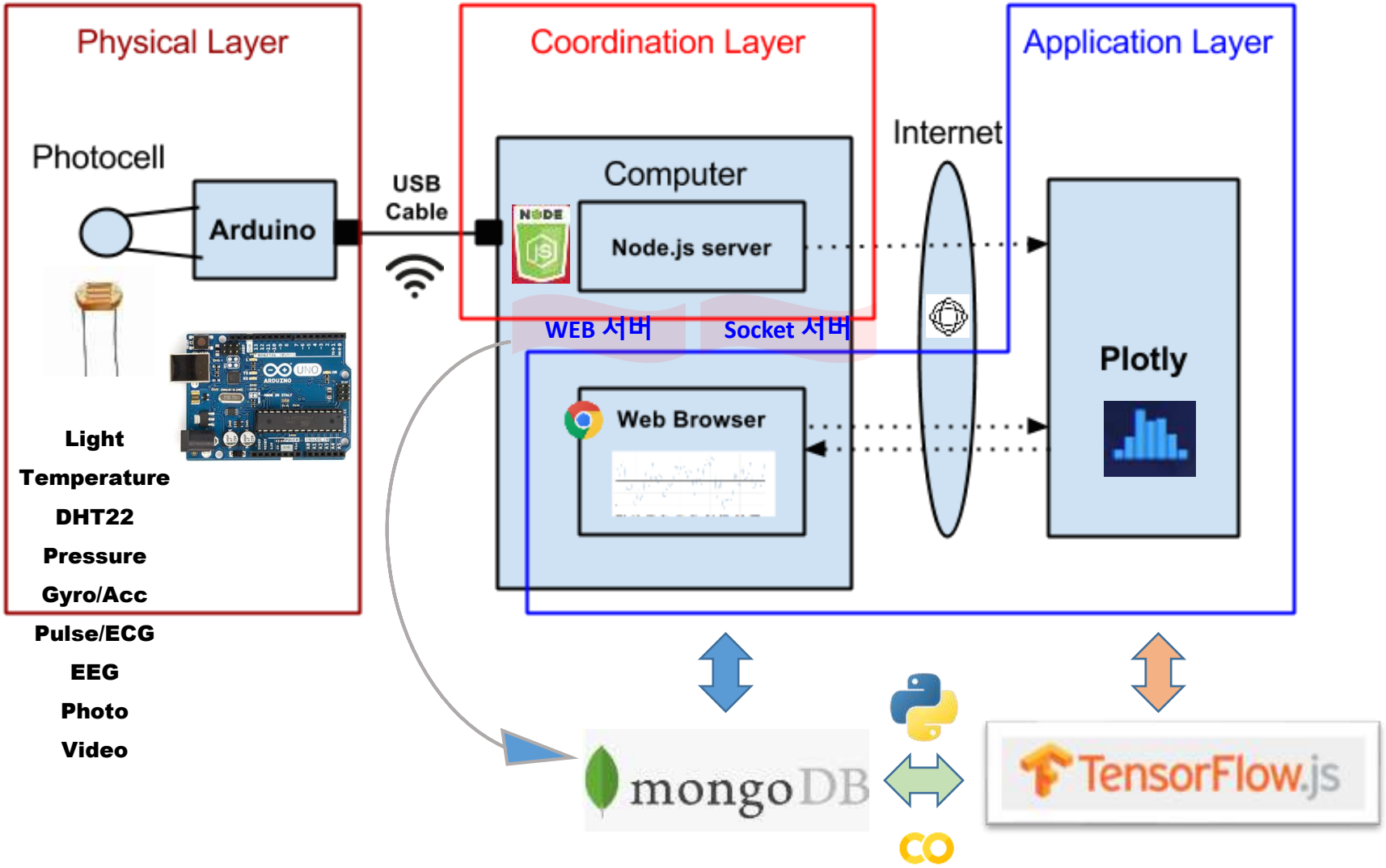
Purpose of AA

주요 수업 목표는 다음과 같다.

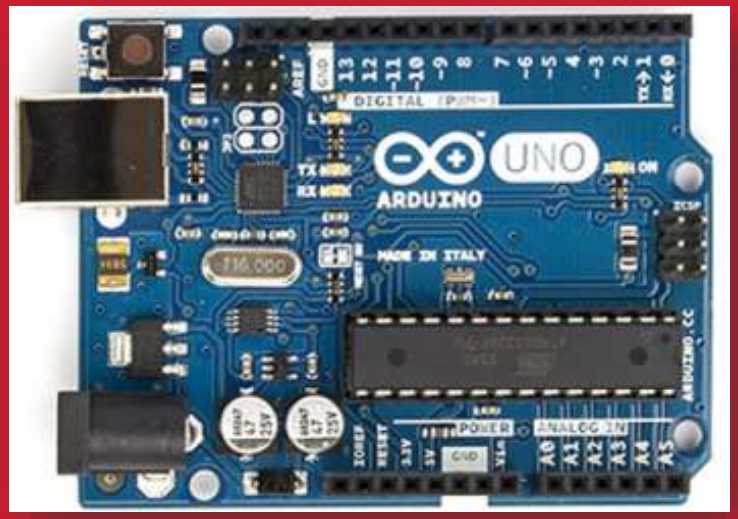
1. Node.js를 이용한 아두이노 센서 신호 처리
2. Plotly.js를 이용한 아두이노 센서 신호 시각화
3. MongoDB에 아두이노 센서 데이터 저장 및 처리

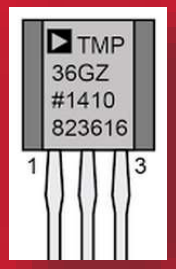
4. 저장된 IoT 데이터의 마이닝 (파이썬 코딩)

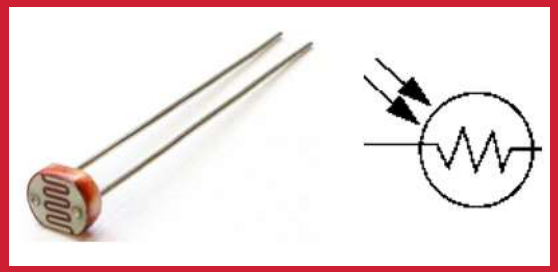
Layout [H S C]

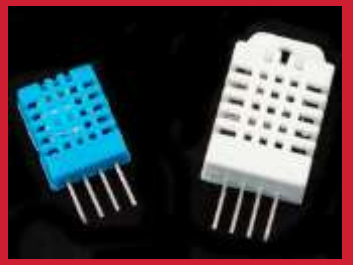

Physical Layer
Photocell
Arduino
USB Cable
Light
Temperature
DHT22
Pressure
Gyro/Acc
Pulse/ECG
EEG
Photo
Video
Coordination Layer
Computer
Node.js server
WEB 서버
Socket 서버
Web Browser
Internet
Application Layer
Plotly
mongoDB
TensorFlow.js

Arduino Sensors + Node.js

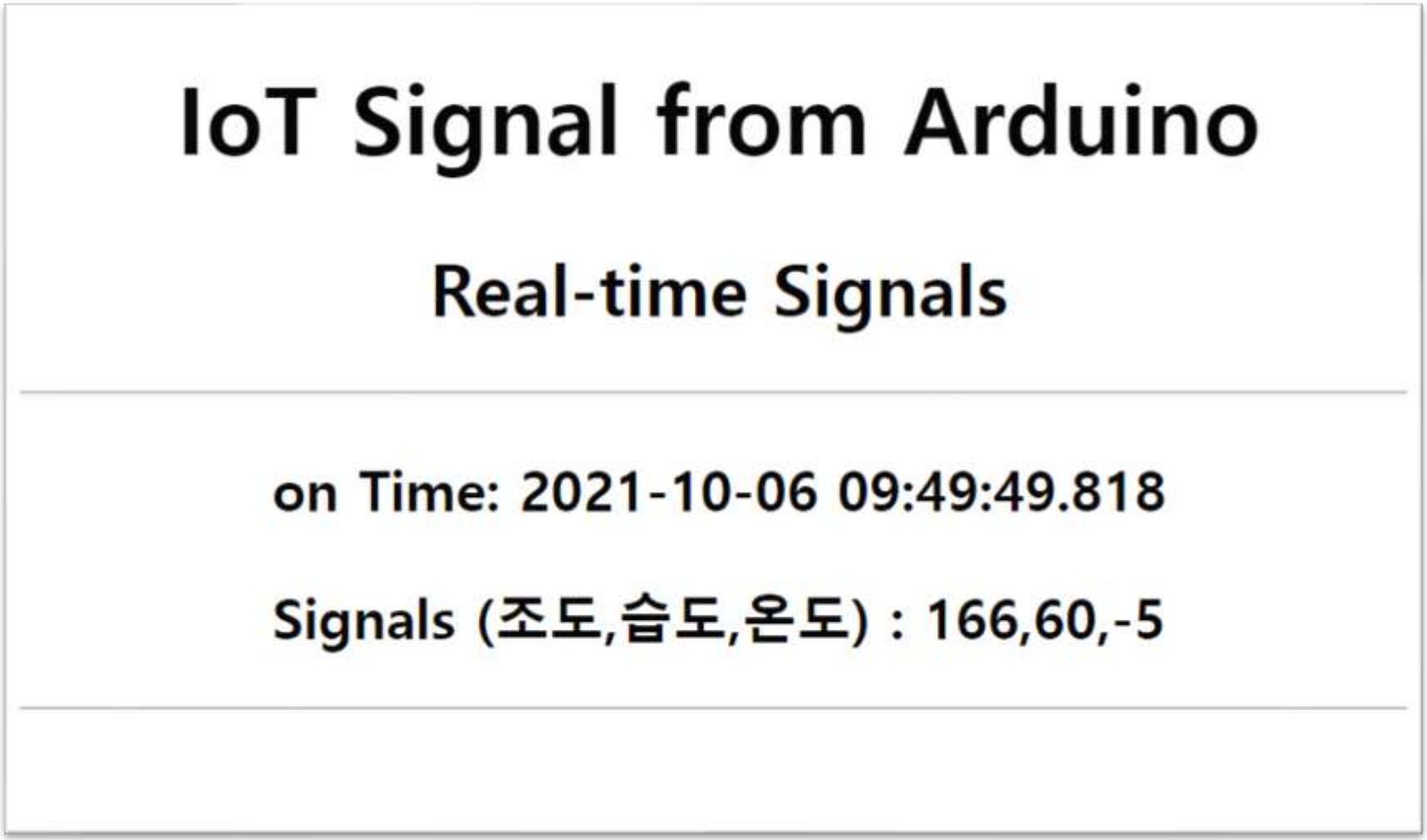




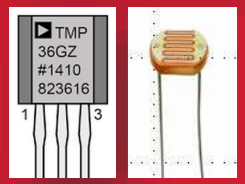


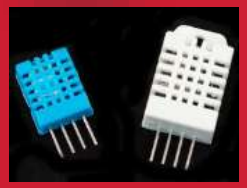


on WEB monitoring Arduino data

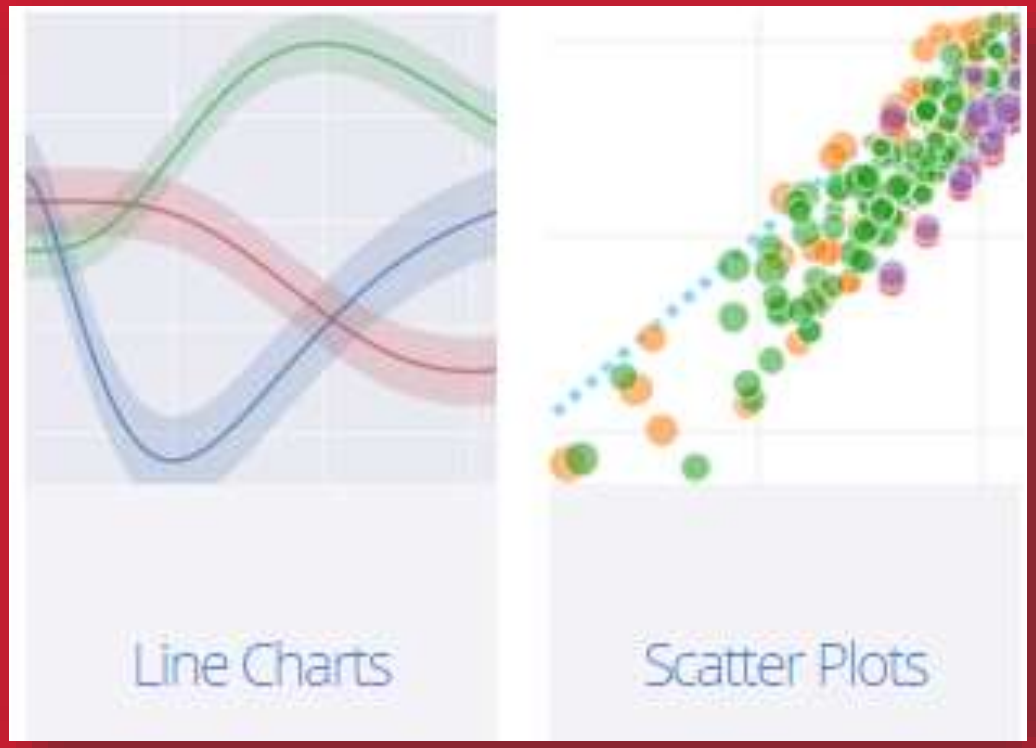


http://chaos.inje.ac.kr:3030/iot_multi.html





Data charts using plotly.js

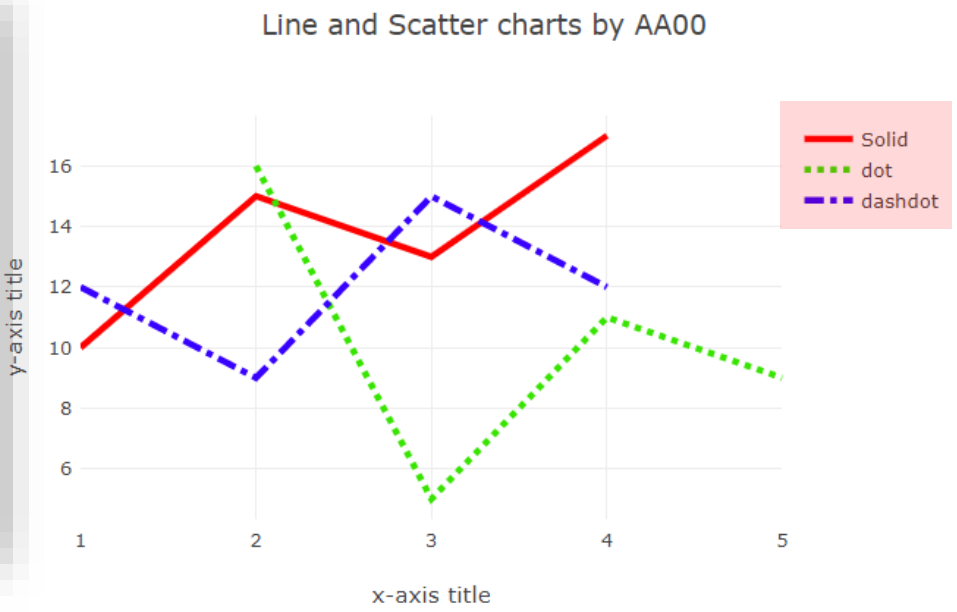


A5.2.6.6 plotly.js: Line & Scatter plot

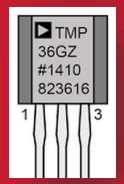
[3.5] Line & scatter plot with dash and dot

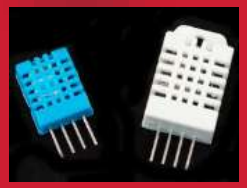
```
var trace1 = {
  x: [1, 2, 3, 4],
  y: [10, 15, 13, 17],
  mode: 'lines',
  name: 'Solid',
  line: {
    color: 'rgb(255, 0, 0)',
    dash: 'solid',
    width: 4
  }
};

var trace2 = {
  x: [2, 3, 4, 5],
  y: [16, 5, 11, 9],
  mode: 'lines',
  name: 'dot',
  line: {
    color: 'rgb(55, 228, 0)',
    dash: 'dot',
    width: 4
  }
};
```

```
var trace3 = {
  x: [1, 2, 3, 4],
  y: [12, 9, 15, 12],
  mode: 'lines',
  name: 'dashdot',
  line: {
    color: 'rgb(55, 0, 255',
    dash: 'dashdot',
    width: 4
  }
};
```

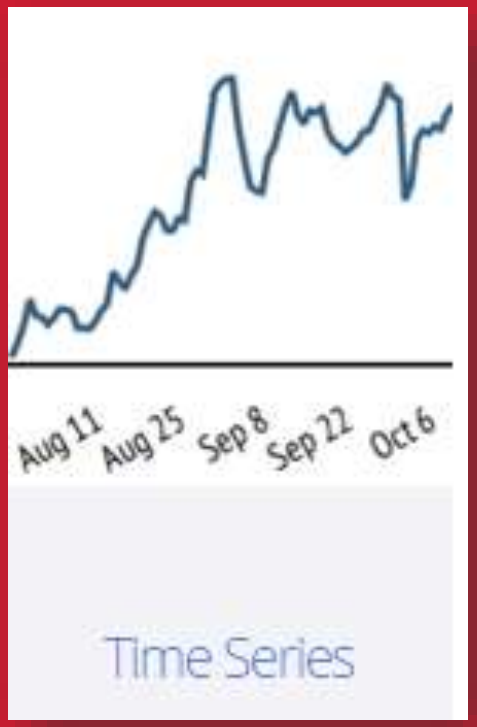


AAnn_Line_Dash_Dot.png





Data visualization using plotly.js



Project: Time series with Rangeslider

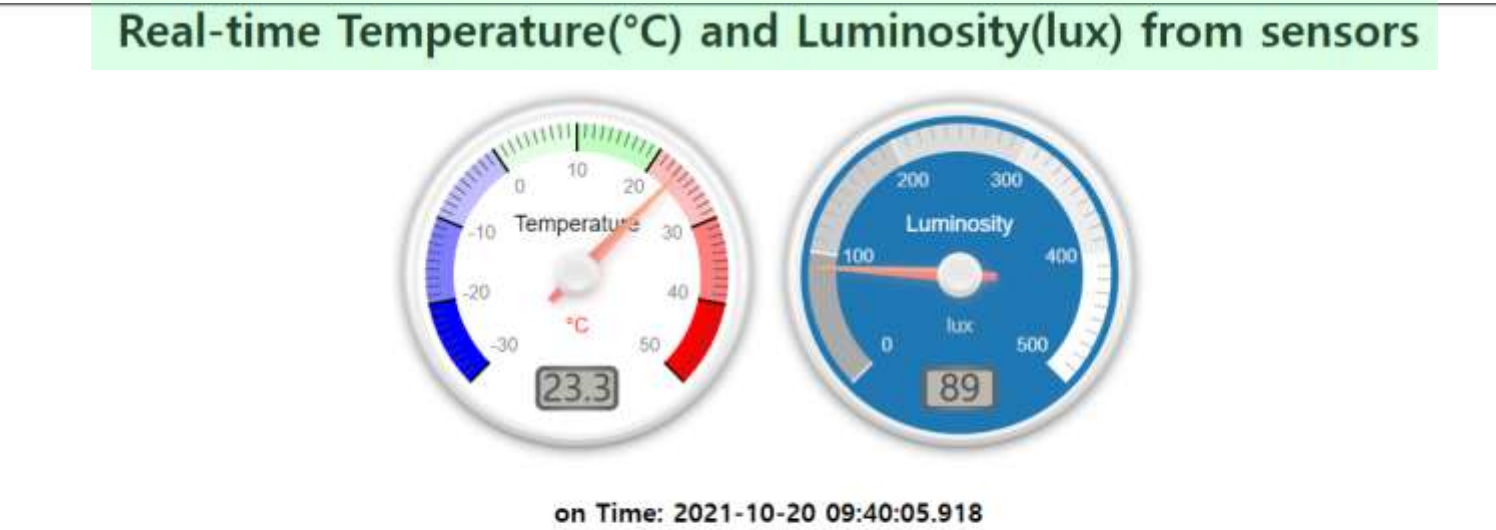
[Project-DIY] AAnn_lux_Rangelslider.html

AAnn_lux_Rangelslider.png

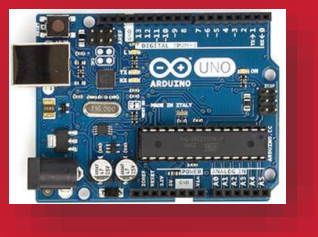
Time series with Rangeslider

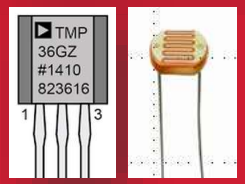
```
var layout = {
  title:'lux time series by AA00',
  width: 750, height: 500,
  margin: {
    l: 50,
    r: 50,
    b: 100,
    t: 100,
    pad: 4
  },
  xaxis: {
    title: 'date',
    autorange: true,
  range: ['2015-11-05 12:09:40.383', '2015-11-05 12:10:30.413'],
  rangeselector: {buttons: [
      {
        count: 10,
        label: '10s',
        step: 'second',
        stepmode: 'backward'
      },
      {
        count: 30,
        label: '30s',
        step: 'second',
        stepmode: 'backward'
      },
      {step: 'all'}
    ]},
  rangeslider: {range: ['2015-11-05 12:09:40.383', '2015-11-05 12:10:30.413']},
  type: 'date'
  },
  yaxis: {
    title: 'data: lux'
  }
};
```

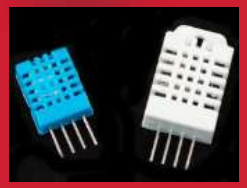
Arduino data + plotly + gauge.js

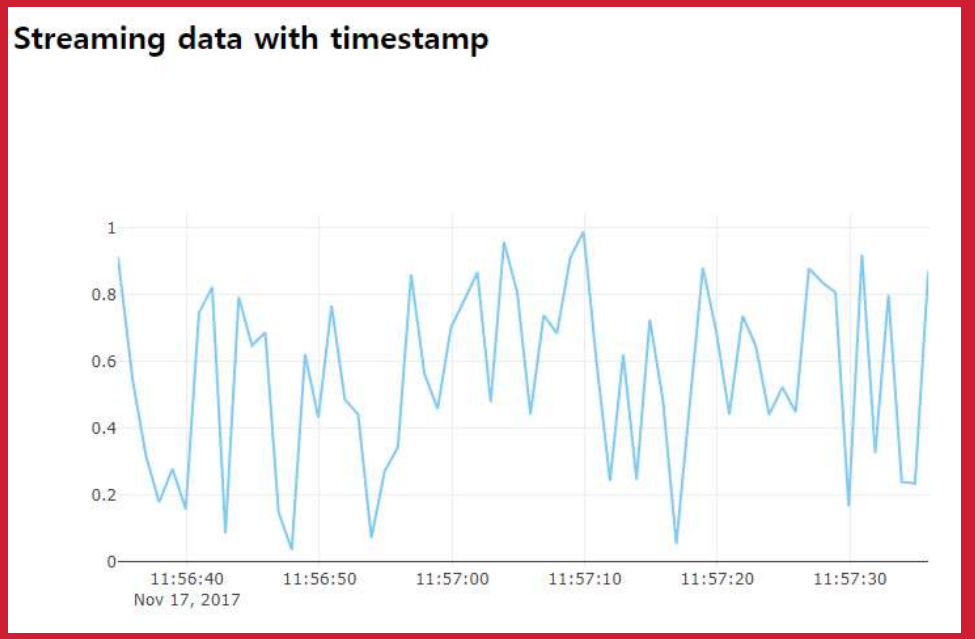


Data Streaming using plotly.js



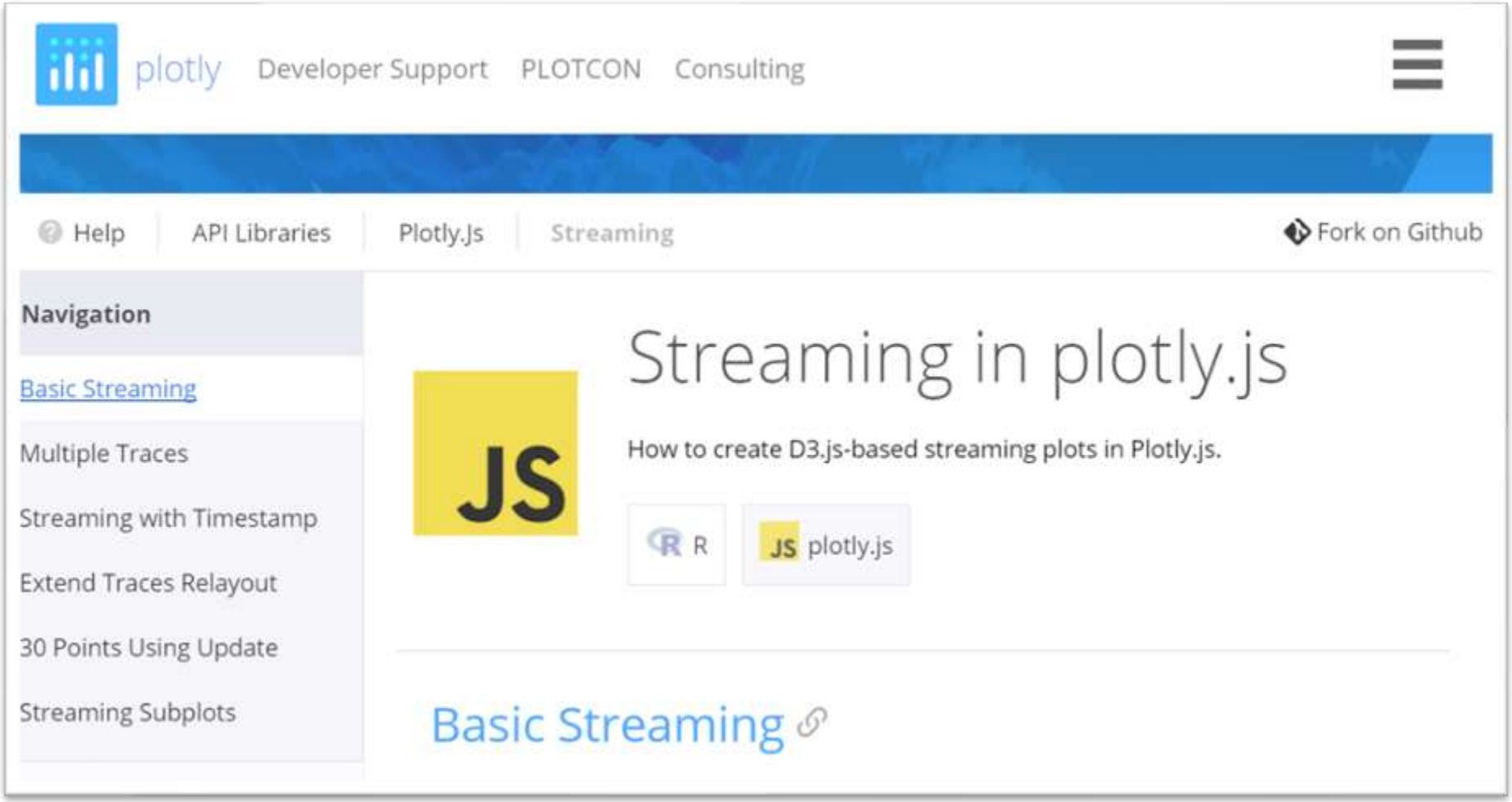






A5.4 plotly.js: Streaming data

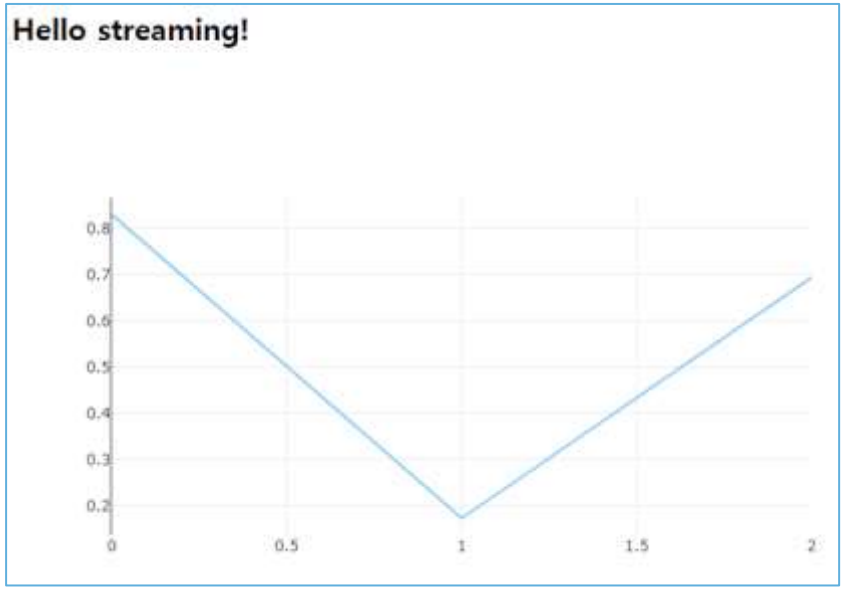
Plot.ly > Streaming



A5.4.1 plotly.js: Streaming data

[1.0] Starting chart

```
<h2>Hello streaming!</h2>
<div id="graph"></div>
<script>
  function rand() {
    return Math.random();
  }
  trace = {
    y: [1, 2, 3].map(rand),
    mode: "lines",
    line: { color: "#80CAF6" },
  };
  data = [trace];
  Plotly.newPlot("graph", data);

  /*var cnt = 0;
    var interval = setInterval(function() {
        cnt++;
        Plotly.extendTraces('graph', {
            y: [[rand()]]
        }, [0]);
        if(cnt == 30) clearInterval(interval);
    }, 2000);*/
```

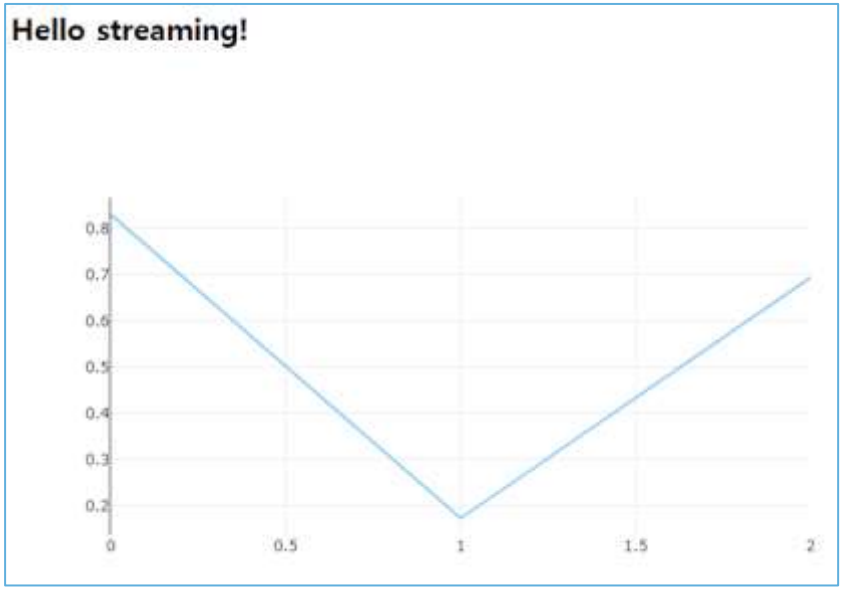


https://developer.mozilla.org/ko/docs/Web/JavaScript/Reference/Global_Objects/Array/map

A5.4.2.1 plotly.js: Streaming data

[1.1] Starting chart (new) DV_streaming01.html

```
<h2>Hello streaming!</h2>
<div id="graph"></div>
<script>
  function rand() {
    return Math.random();
  }

  Plotly.newPlot("graph", [
    {
      y: [1, 2, 3].map(rand),
      mode: "lines",
      line: { color: "#80CAF6" },
    },
  ]);

  /*var cnt = 0;
var interval = setInterval(function() {
  cnt++;
  Plotly.extendTraces('graph', {
    y: [[rand()]]
  }, [0]);
  if(cnt == 30) clearInterval(interval);
}, 2000);*/
</script>
```

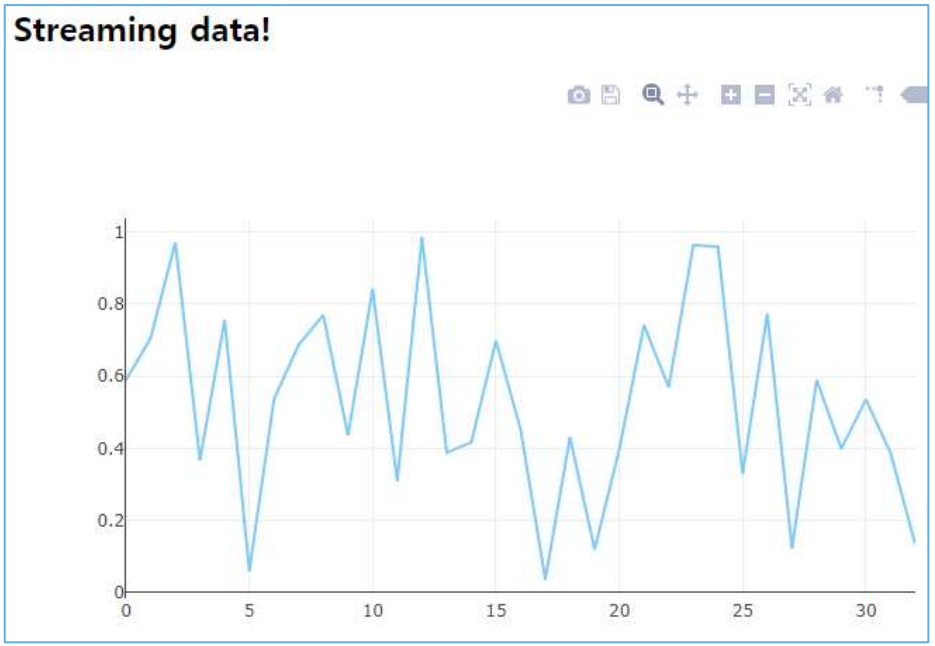


A5.4.2.2 plotly.js: Streaming data

[1.2] Basic streaming

DV_streaming01S.html

```
<h2>Streaming data!</h2>
<div id="graph"></div>
<script>
  function rand() {
    return Math.random();
  }
  Plotly.newPlot("graph", [
    {
      y: [1, 2, 3].map(rand),
      mode: "lines",
      line: { color: "#80CAF6" },
    },
  ]);
  var cnt = 0;
  var interval = setInterval(function () {
    cnt++;
    Plotly.extendTraces(
      "graph",
      {
        y: [[rand()]],
      },
      [0]
    );
    if (cnt == 30) clearInterval(interval);
  }, 2000);
</script>
```

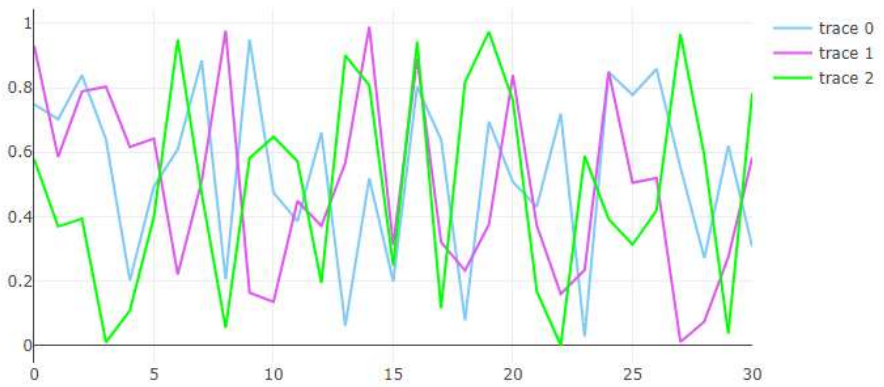


A5.4.3.1 plotly.js: Streaming data

[2.1] Streaming multiple traces

```
function rand() {
    return Math.random();
}

// initial plot
trace1 = {
    y: [1,2,3].map(rand),
    mode: 'lines',
    line: {color: '#80CAF6'}
};
trace2 = {
    y: [1,2,3].map(rand),
    mode: 'lines',
    line: {color: '#DF56F1'}
};
trace3 = {
    y: [1,2,3].map(rand),
    mode: 'lines',
    line: {color: '#00FF00'}
};

data = [trace1, trace2, trace3];

Plotly.plot('graph', data);
```

```
// continous plot
var cnt = 0;
var interval = setInterval(function() {

    Plotly.extendTraces('graph', {
        y: [[rand()], [rand()], [rand()]]
    }, [0, 1, 2])

    cnt++;
    if(cnt === 100) clearInterval(interval);
}, 300);
```



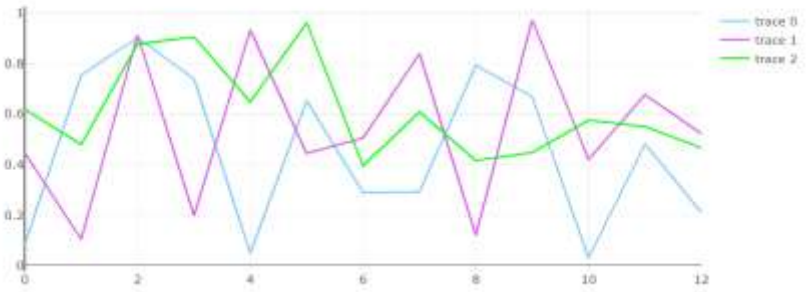
A5.4.3.2 plotly.js: Streaming data

[2.2] Streaming multiple traces (new code) DV_streaming02.html

```
function rand() {
  return Math.random();
}
Plotly.newPlot("graph", [
  {
    y: [1, 2, 3].map(rand),
    mode: "lines",
    line: { color: "#80CAF6" },
  },
  {
    y: [1, 2, 3].map(rand),
    mode: "lines",
    line: { color: "#DF56F1" },
  },
  {
    y: [1, 2, 3].map(rand),
    mode: "lines",
    line: { color: "#00FF00" },
  },
]);
```

```
// continous plot
var cnt = 0;
var interval = setInterval(function() {

    Plotly.extendTraces('graph', {
        y: [[rand()], [rand()], [rand()]]
    }, [0, 1, 2])

    cnt++;

    if(cnt === 100) clearInterval(interval);
}, 300);
```

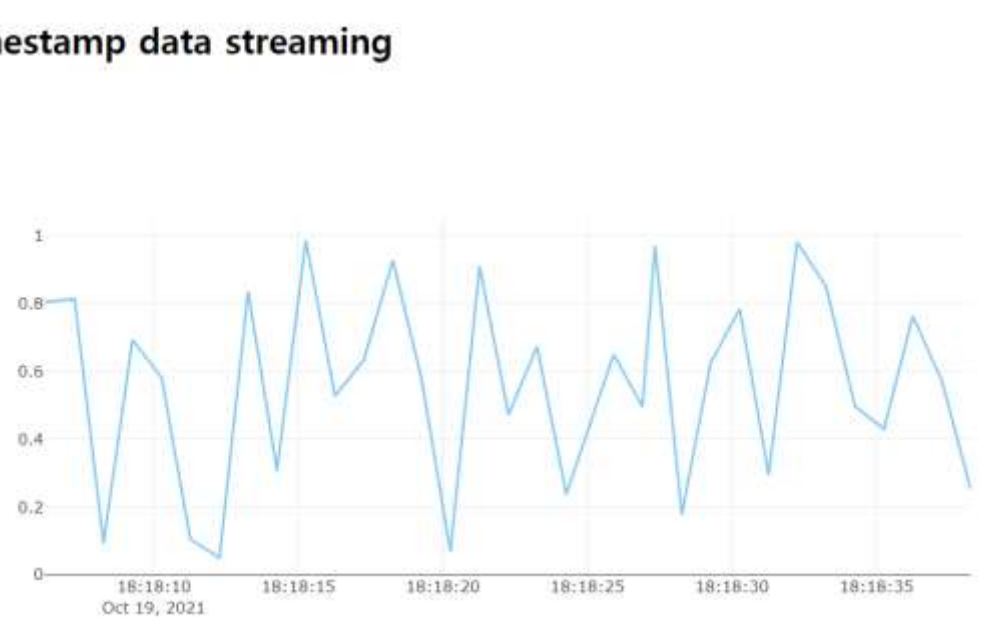
Hello multiple streaming!



A5.4.4 plotly.js: Streaming data

[3] Streaming data with timestamp DV_streaming03_timestamp.html

```
function rand() {
  return Math.random();
}
var time = new Date();
var data = [
  {
    x: [time],
    y: [rand()],
    mode: "lines",
    line: { color: "#80CAF6" },
  },
];
Plotly.newPlot("graph", data);

var cnt = 0;
var interval = setInterval(function () {
  var time = new Date();
  var update = {
    x: [[time]],
    y: [[rand()]],
  };
  Plotly.extendTraces("graph", update, [0]);

  if (cnt === 100) clearInterval(interval);
}, 1000);
```



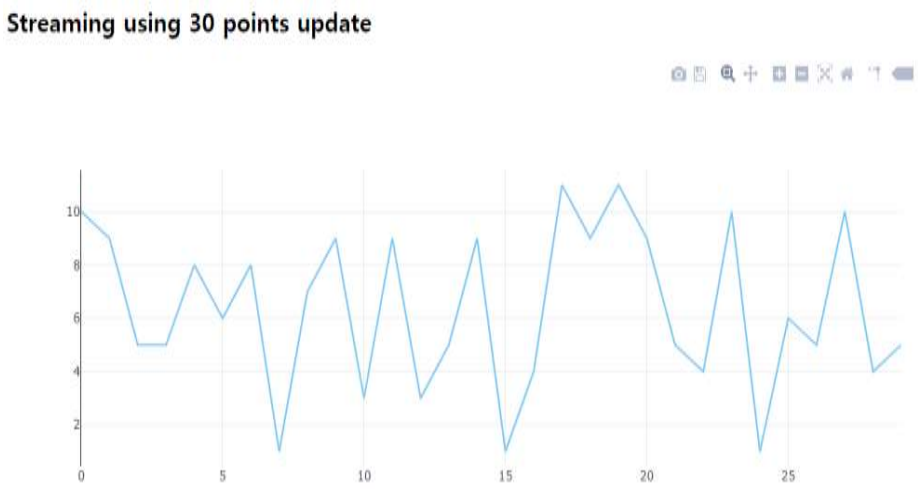
A5.4.5 plotly.js: Streaming data

[4] Streaming data using 30 points update

```
var arrayLength = 30;
var newArray = [];
// initial 30 data
for (var i = 0; i < arrayLength; i++) {
  var y = Math.round(Math.random() * 10) + 1;
  newArray[i] = y;
}
var data = [
  {
    y: newArray,
    mode: "lines",
    line: { color: "#80CAF6" },
  },
];
Plotly.newPlot("graph", data);
```

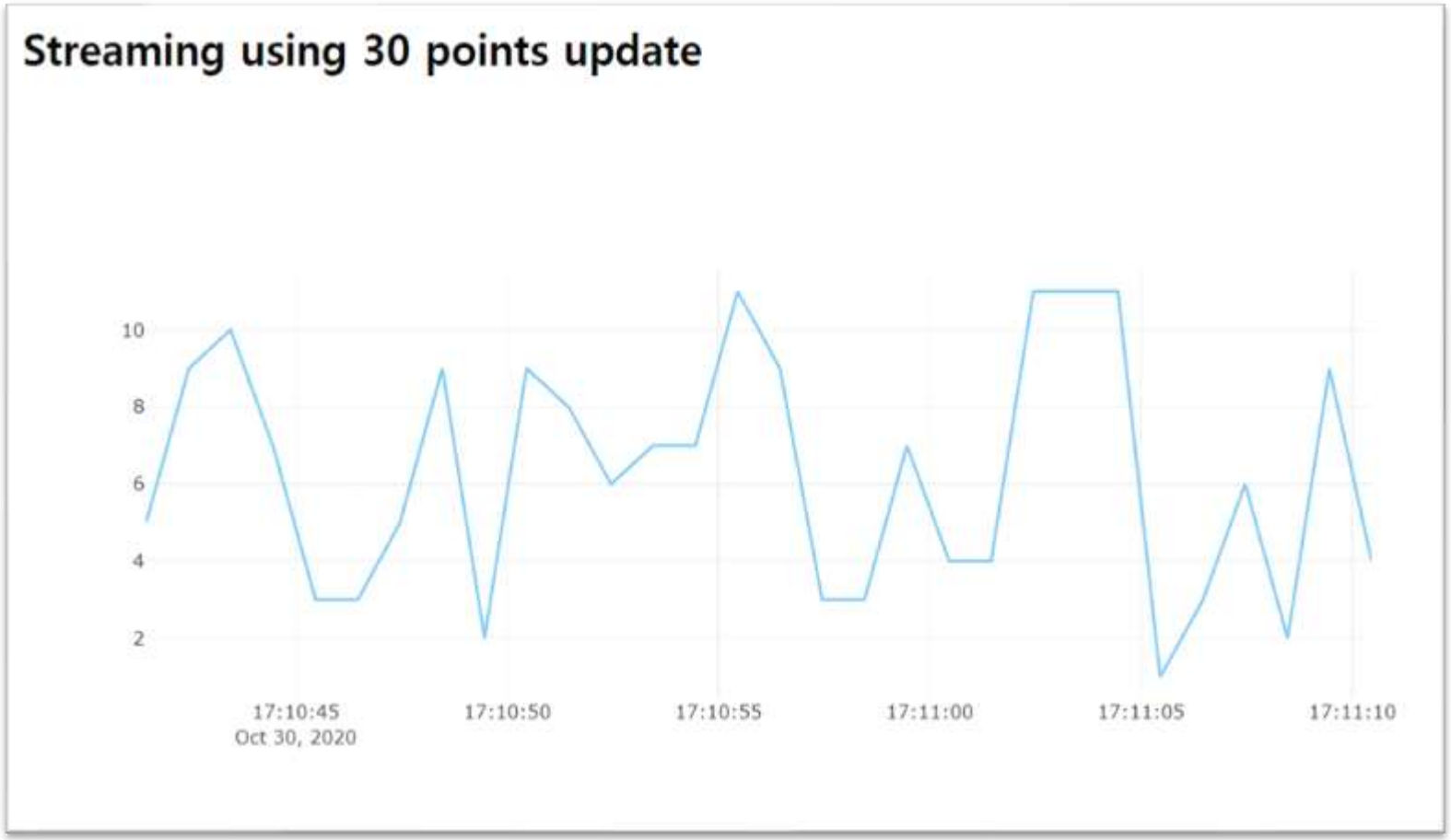
```
var cnt = 0;
var interval = setInterval(function () {
  var y = Math.round(Math.random() * 10) + 1;
  newArray = newArray.concat(y); // add new data
  newArray.splice(0, 1); //remove the oldest data
  var update = {
    y: [newArray],
  };
  Plotly.update("graph", update);
  cnt++;
  if (cnt === 50) clearInterval(interval);
}, 1000);
```

DV_streaming04_range_START.html



A5.4.5.1 plotly.js: Streaming data

[4.1] Streaming data using 30 points update (with timestamp)



A5.4.5.2 plotly.js: Streaming data

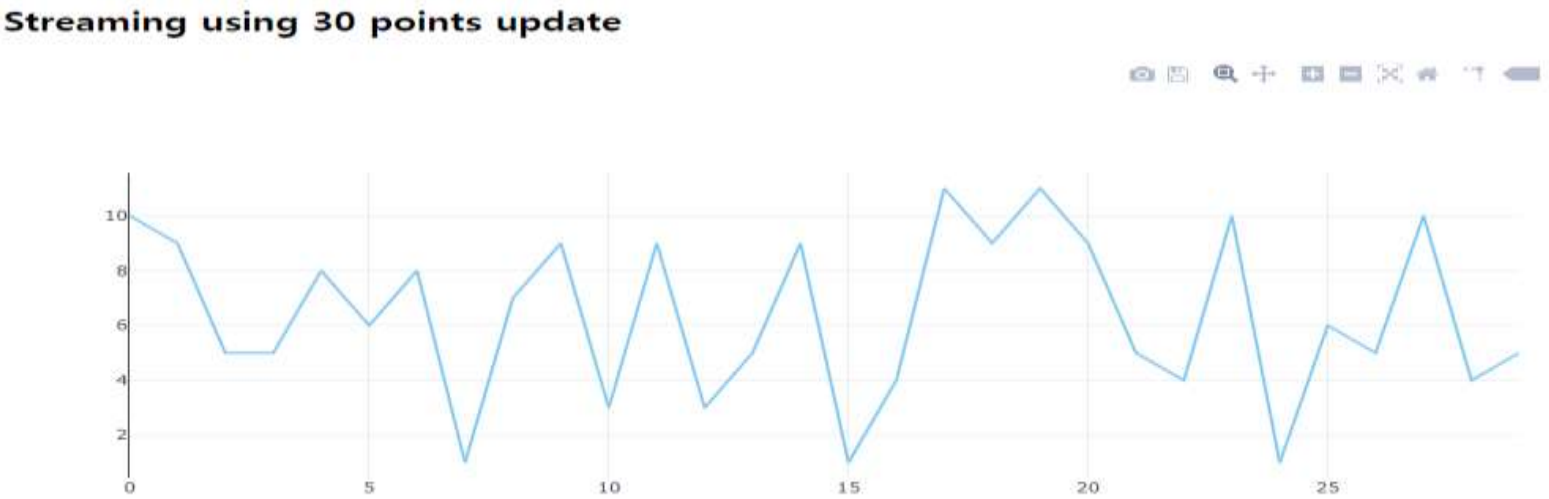
[4.2] Streaming data using 30 points update DV_streaming04_range.html

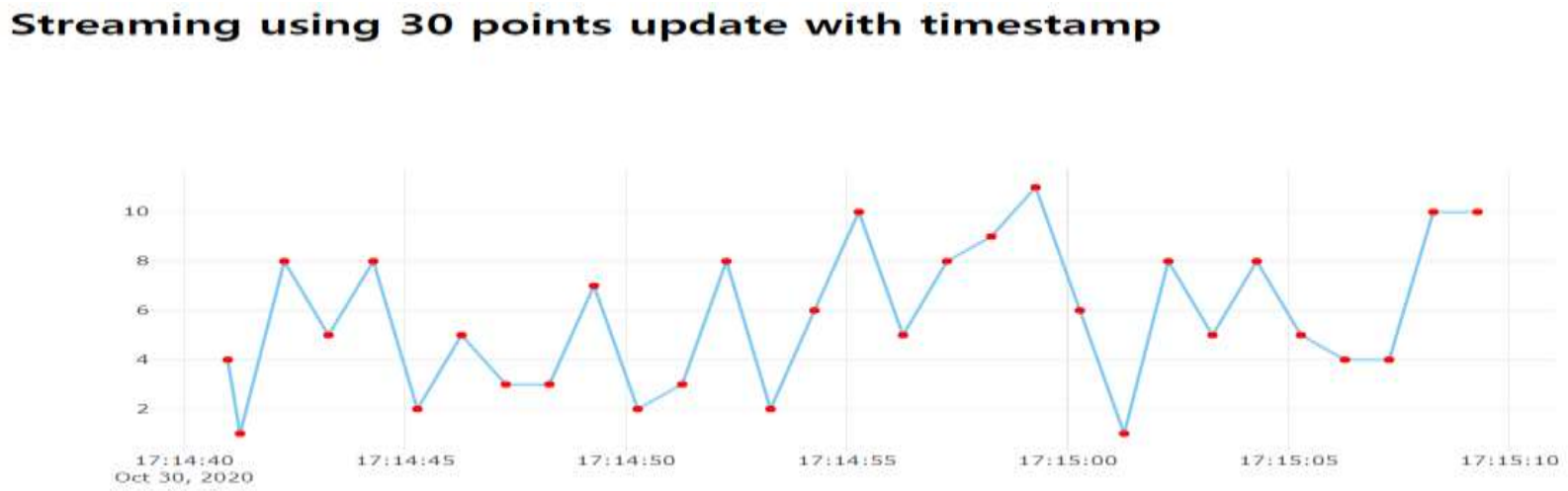
```
var arrayLength = 30;
var newArray = [];
var timeArray = [];
// initial 30 data
for (var i = 0; i < arrayLength; i++) {
  var y = Math.round(Math.random() * 10) + 1;
  var time = new Date();
  newArray[i] = y;
  timeArray[i] = time;
}
var data = [
  {
    x: timeArray,
    y: newArray,
    mode: "lines",
    line: { color: "#80CAF6" },
  },
];
Plotly.newPlot("graph", data);
```

```
var cnt = 0;
var interval = setInterval(function () {
  var y = Math.round(Math.random() * 10) + 1;
  var time = new Date();
  timeArray = timeArray.concat(time);
  timeArray.splice(0, 1);
  newArray = newArray.concat(y);
  newArray.splice(0, 1);
  var update = {
    x: [timeArray],
    y: [newArray],
  };
  Plotly.update("graph", update);
  cnt++;
  if (cnt === 50) clearInterval(interval);
}, 1000);
```

A5.4.5.3 plotly.js: Streaming data

[DIY] Streaming time series using 30 points update





AAnn_DS_30timestamps.png 로 캡처 저장.

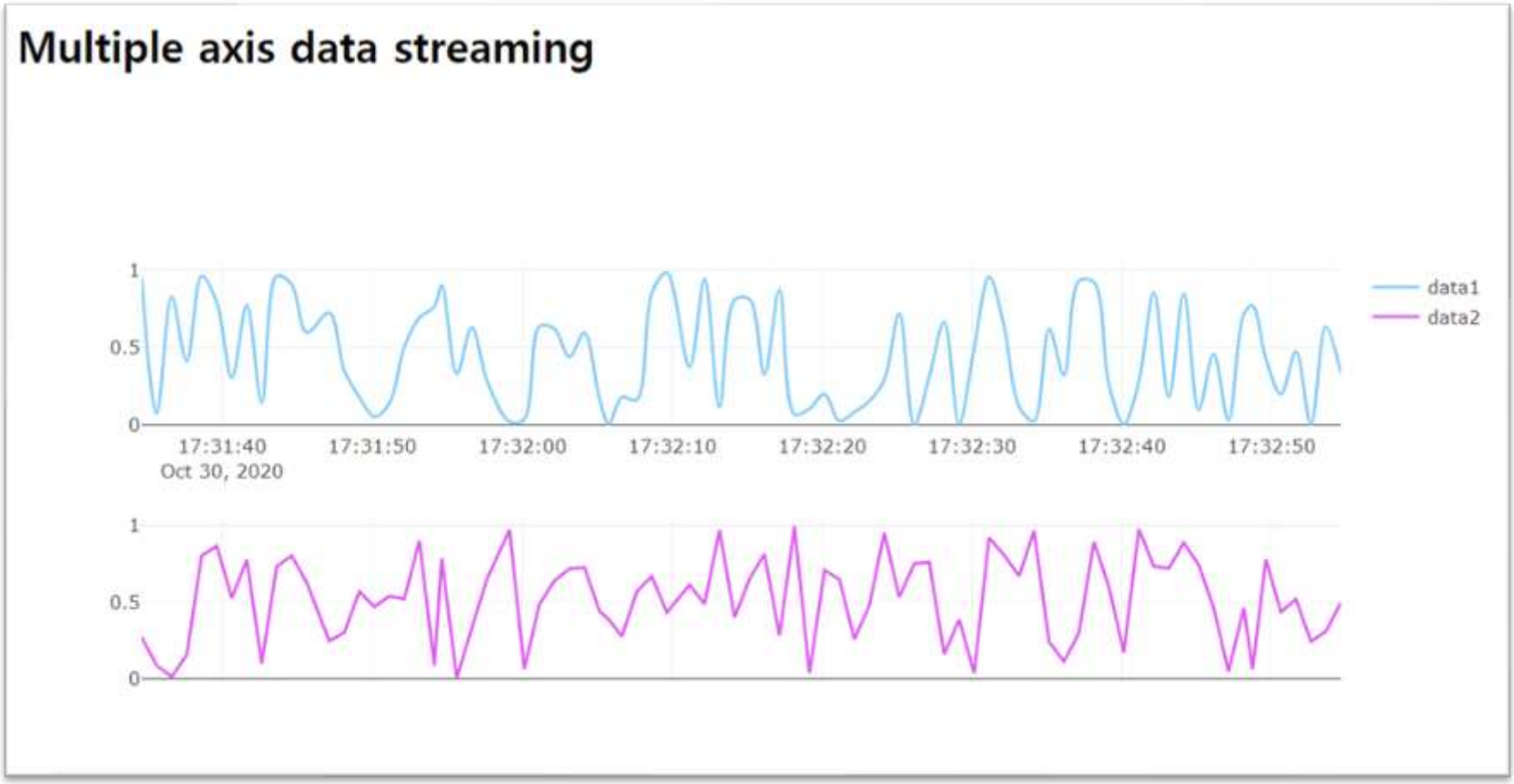
A5.4.5.4 plotly.js: Streaming data

[DIY-hint] Streaming time series using 30 points update

```
var data = [
  {
    x: timeArray,
    y: newArray,
    mode: "lines+markers",
    marker: { color: "#FF0000" },
    line: { color: "#80CAF6" },
  },
];
Plotly.newPlot("graph", data);
```

A5.4.6 plotly.js: Streaming multiple data

[5] Streaming data using multiple axis



A5.4.6.1 plotly.js: Streaming data

[5.1] Streaming data using multiple axis DV_streaming05_multiple_axis.html

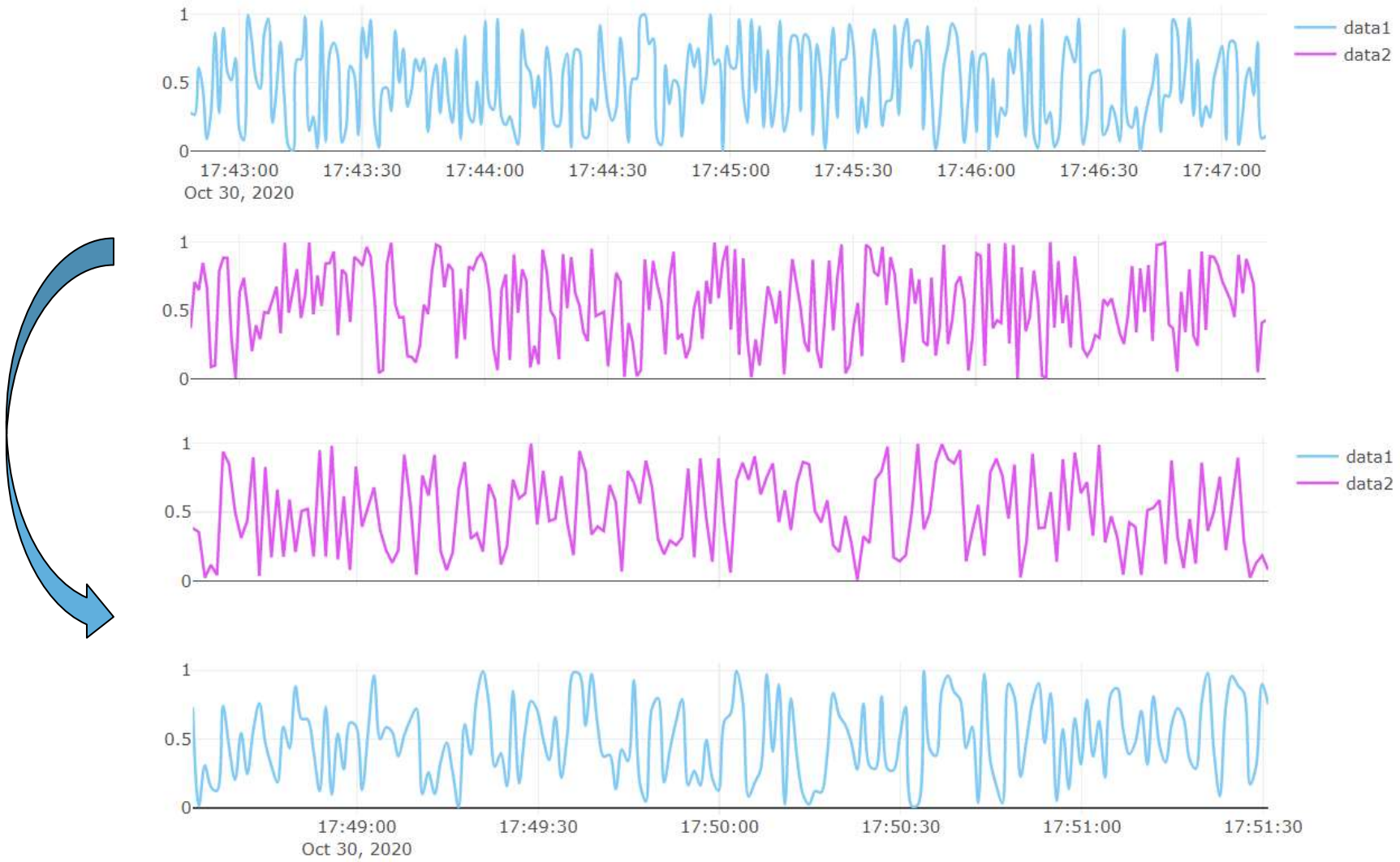
```
<h2>Multiple axis data streaming</h2>
<div id="graph"></div>

<script>
  function rand() {
    return Math.random();
  }

  var time = new Date();
  var trace1 = {
    x: [],
    y: [],
    mode: "lines",
    line: {
      color: "#80CAF6",
      shape: "spline",
    },
    name: "data1",
  };
  var trace2 = {
    x: [],
    y: [],
    xaxis: "x2",
    yaxis: "y2",
    mode: "lines",
    line: { color: "#DF56F1" },
    name: "data2",
  };
```

```
var layout = {
  xaxis: {
    type: "date",
    domain: [0, 1],
  },
  yaxis: { domain: [0.6, 1] },

  xaxis2: {
    type: "date",
    anchor: "y2",
    domain: [0, 1],
    showticklabels: false, // 중요!
  },
  yaxis2: {
    anchor: "x2",
    domain: [0, 0.4],
  },
};
var data = [trace1, trace2];
Plotly.newPlot("graph", data, layout);
```

```
// streaming
var cnt = 0;
var interval = setInterval(function () {
  var time = new Date();
  var update = {
    x: [[time], [time]],
    y: [[rand()], [rand()]],
  };
  Plotly.extendTraces("graph", update, [0, 1]);
  // cnt++;
  if (cnt === 100) clearInterval(interval);
}, 1000);
```

A5.4.6.2 plotly.js: Streaming data

[DIY] Streaming data using multiple axis → change axis

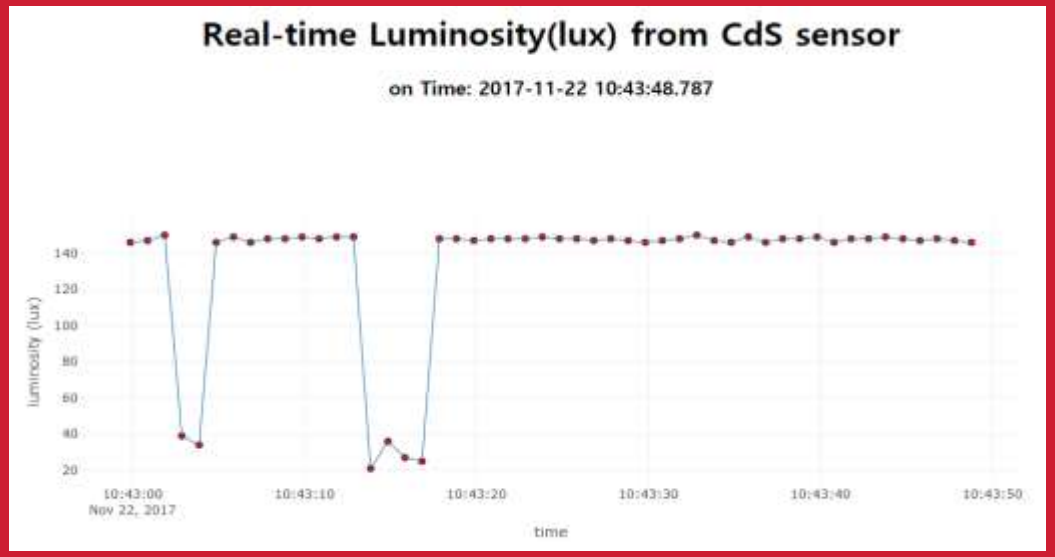


AAnn_DS_multiple_axis.png 로 캡처 저장.

Arduino sensor data

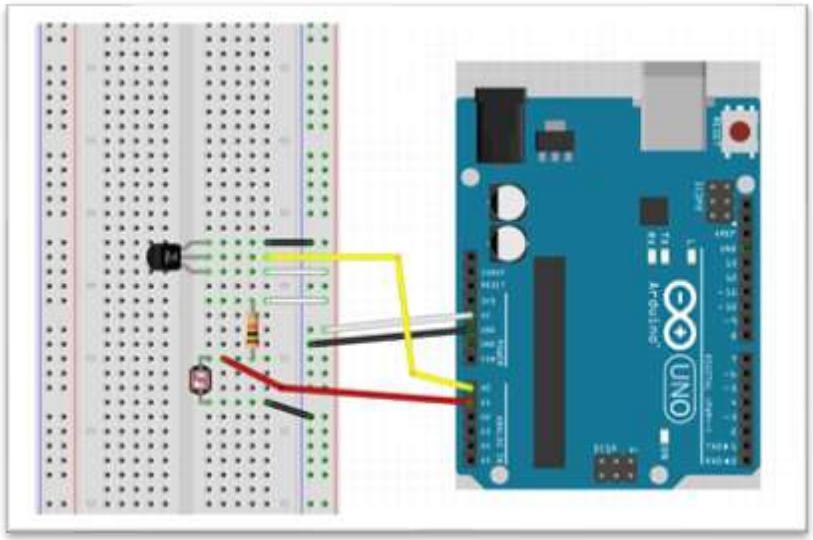
RT visualization using plotly.js

```
AA00,2017-11-22 10:43:11.859,149
AA00,2017-11-22 10:43:12.851,149
AA00,2017-11-22 10:43:13.845,21
AA00,2017-11-22 10:43:14.854,36
AA00,2017-11-22 10:43:15.844,27
AA00,2017-11-22 10:43:16.837,25
AA00,2017-11-22 10:43:17.846,148
AA00,2017-11-22 10:43:18.839,148
AA00,2017-11-22 10:43:19.847,147
```



Network socket emitting data

tmp36 + CdS circuit



```
AA00,2020-10-17 11:41:30.533,25.27,245
AA00,2020-10-17 11:41:31.535,25.27,243
AA00,2020-10-17 11:41:32.535,25.27,158
AA00,2020-10-17 11:41:33.534,24.29,40
AA00,2020-10-17 11:41:34.538,24.29,33
AA00,2020-10-17 11:41:35.537,24.78,86
AA00,2020-10-17 11:41:36.541,25.27,249
AA00,2020-10-17 11:41:37.540,25.76,245
AA00,2020-10-17 11:41:38.543,25.76,243
AA00,2020-10-17 11:41:39.543,25.27,245
```

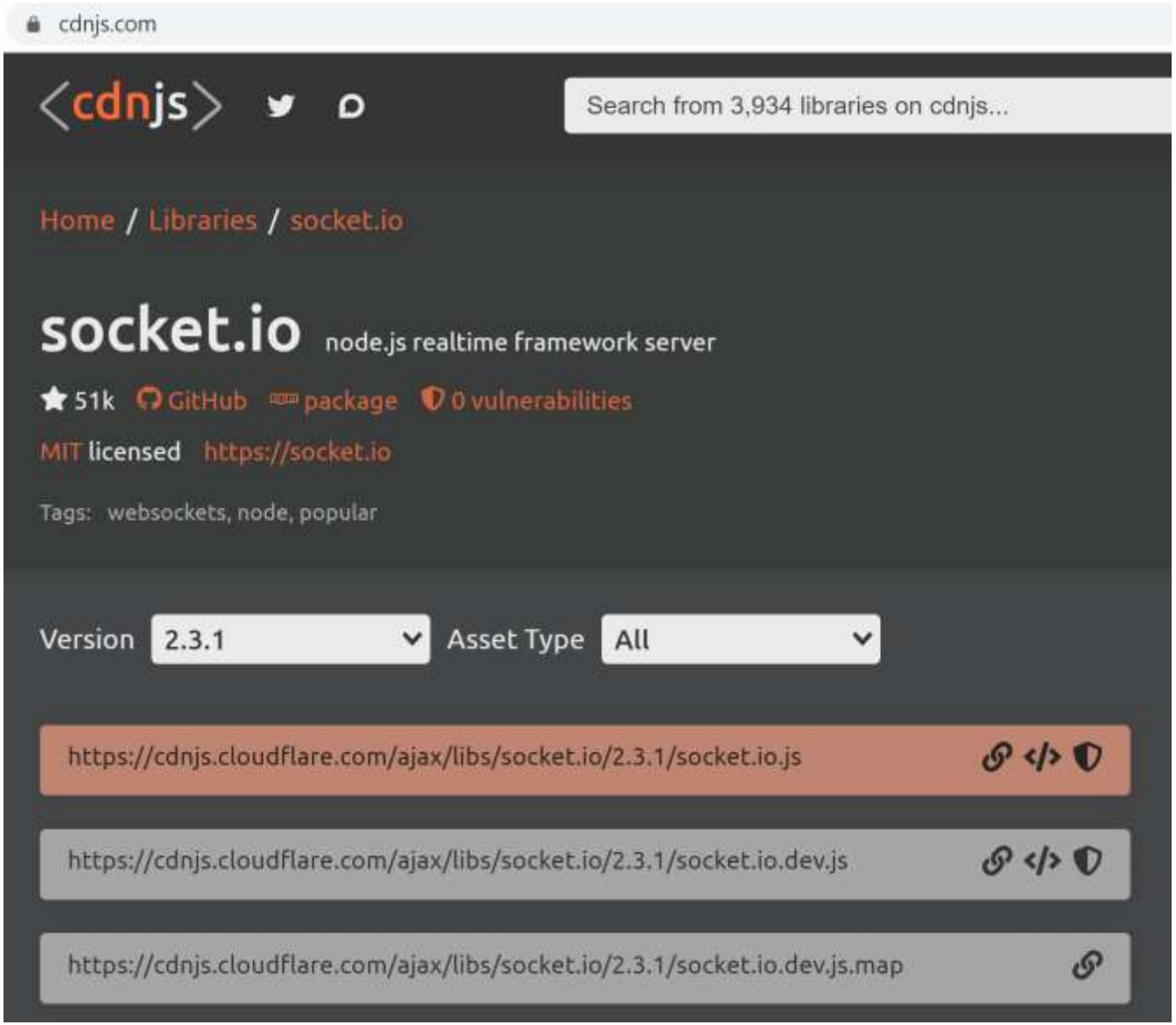
```
var readData = "";
var temp = "";
var lux = "";
var mdata = [];
var firstcommaidx = 0;

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

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

시간,온도,조도

Arduino data on network socket

Google search

socket.io.js cdn



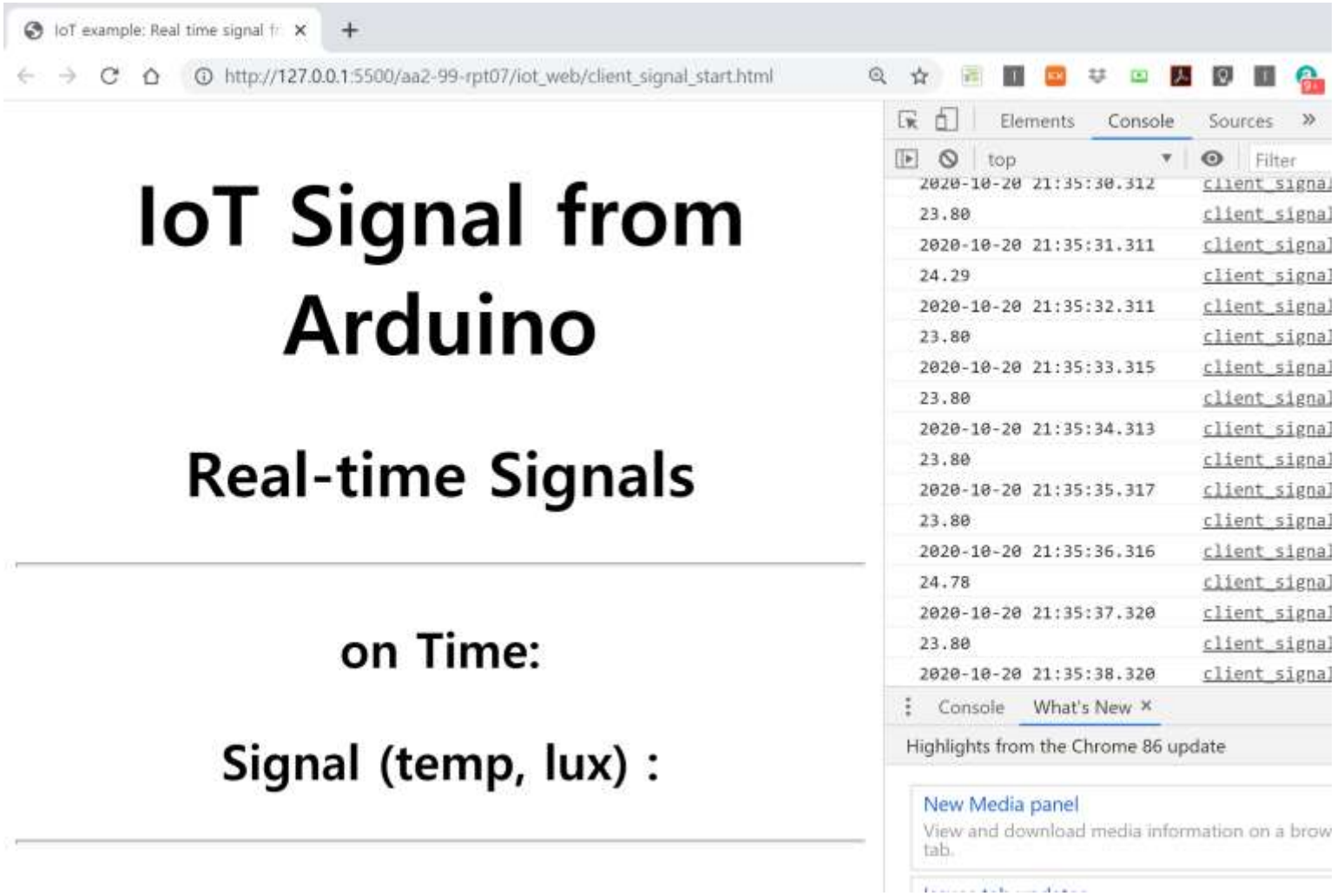
Arduino data on network socket

client_signal_start.html

```
1  <!DOCTYPE html>
2  <head>
3    <meta charset="utf-8">
4    <title>IoT example: Real time signal from Arduino</title>
5
6    <script type="text/javascript" src="https://cdnjs.cloudflare.com/ajax/libs/socket.io/2.3.1/socket.io.js"></script>
7    <!-- <script type="text/javascript" src="https://cdnjs.cloudflare.com/ajax/libs/socket.io/1.3.6/socket.io.js"></scr
8    <style>body{padding:0;margin:30;background:#fff}</style>
9  </head>
10
11 <body>  <!-- style="width:100%;height:100%"> -->
12
13 <h1 align="center"> IoT Signal from Arduino </h1>
14
15 <h2 align="center"> Real-time Signals </h2>
16
17 <hr>
18
19 <h3 align="center"> on Time: <span id="time"> </span> </h3>
20
21 <h3 align="center"> Signal (temp, lux) : <span id="data"> </span> </h3>
22
```

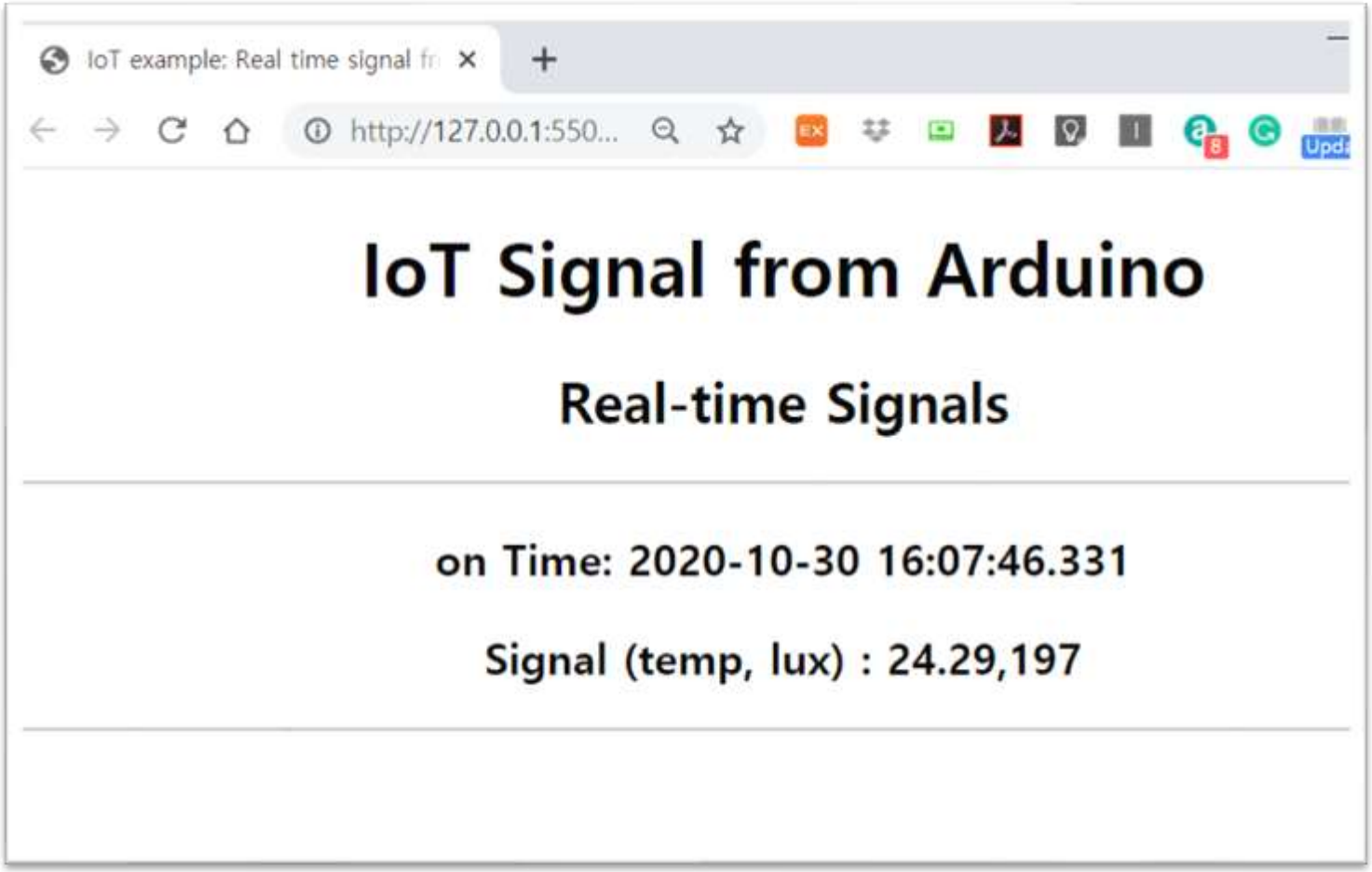
Google search : socket.io.js cdn

Arduino data on network socket



Real-time console showing a signal from Arduino in Chrome browser – F12

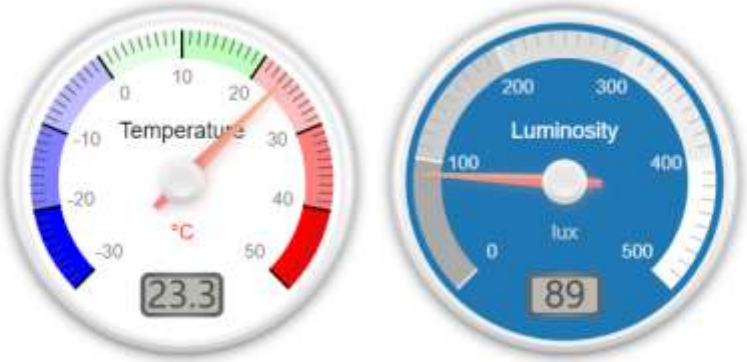
Arduino data on network socket



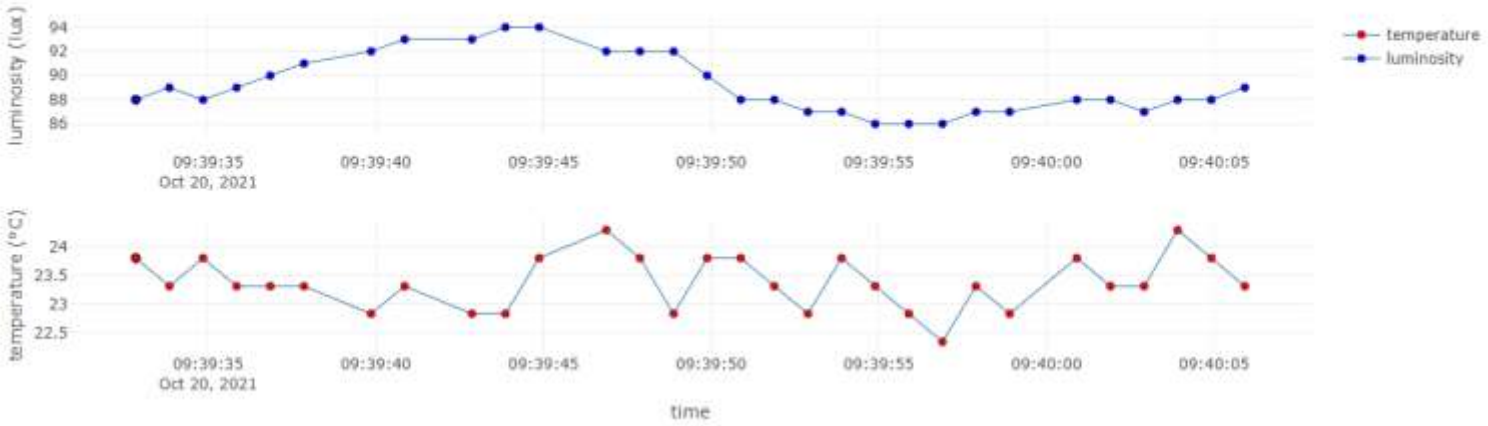
Real-time monitoring of a signal from Arduino tmp36 + CdS circuit

TMP36 + CdS streaming project

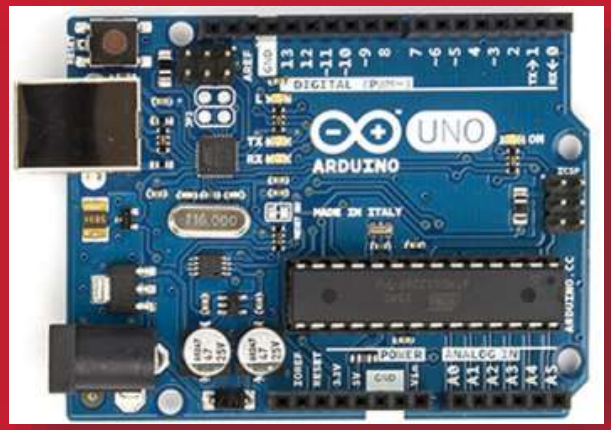
Real-time Temperature(°C) and Luminosity(lux) from sensors



on Time: 2021-10-20 09:40:05.918

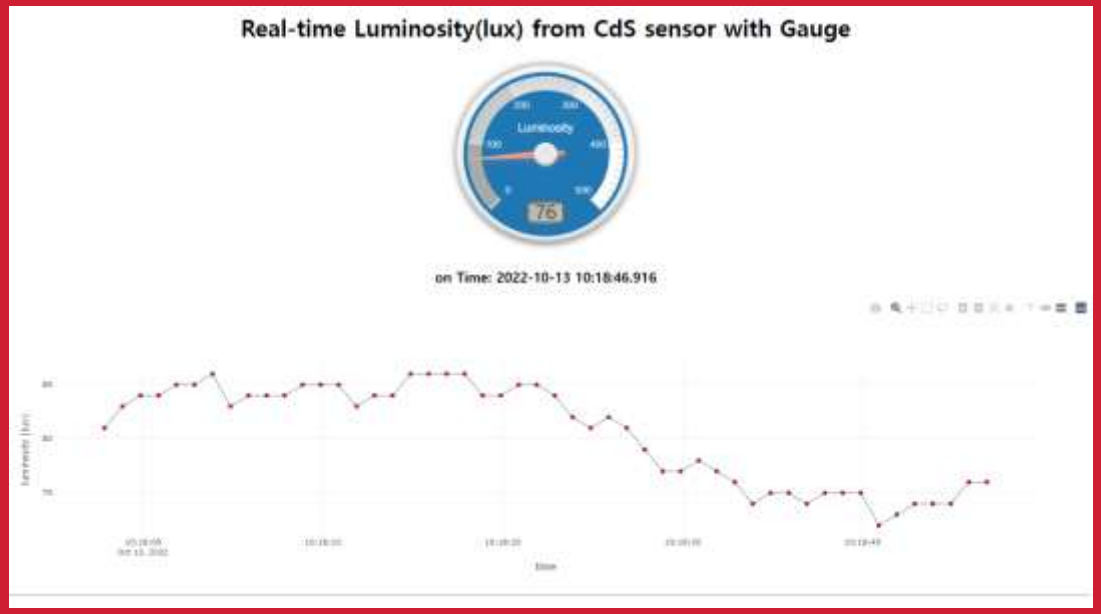


Single sensor: CdS



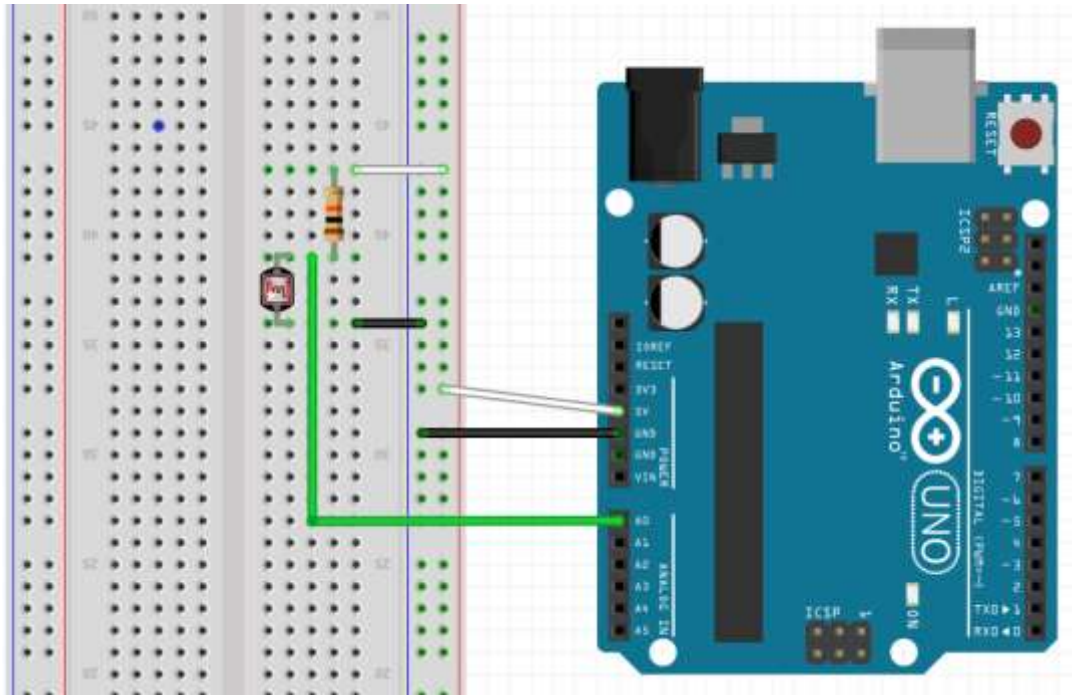
CdS (LDR)

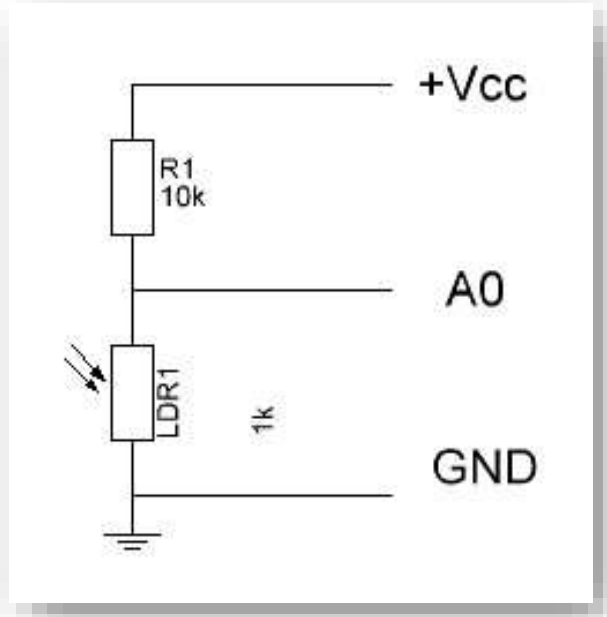
Node project



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

A4.2.1 Luminosity sensor [Photocell LDR]

1. **Make cds node project**
   - **md cds**
   - **cd cds**
2. **Go to cds subfolder**
   - **npm init**
   - **npm install –save serialport@9.2.4**
   - **npm install –save socket.io@2.4.1**

- **npm Error 발생하면,**
  - **npm update**

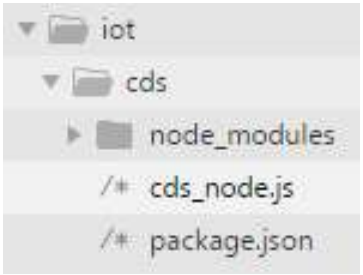
Package.json

aann > aann-rpt08 > Node > cds > package.json > ...

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

npm install

A4.2.2 Luminosity sensor [Photocell LDR]

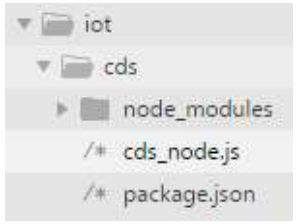


cds_node.js

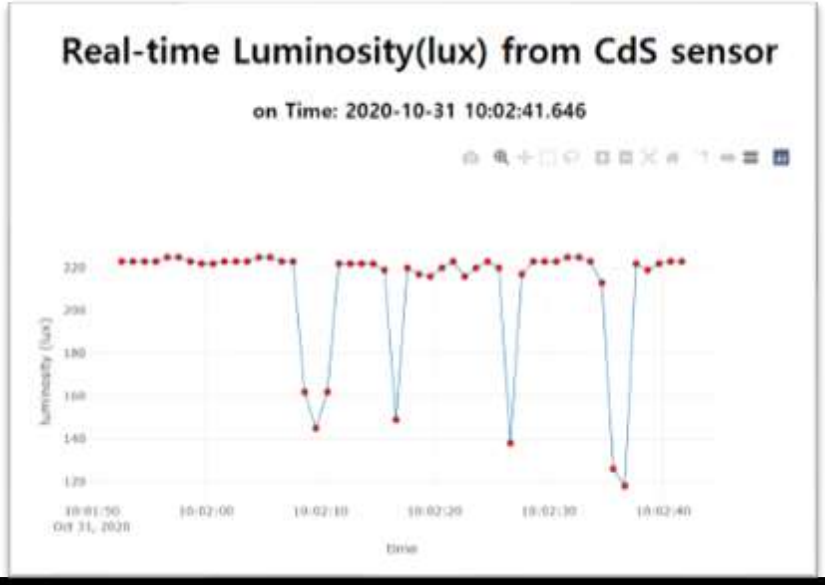
```
var dStr = "";
var tdata = []; // Array

parser.on("data", (data) => {
  // call back when data is received
  // raw data only
  //console.log(data);
  dStr = getDateString();
  tdata[0] = dStr; // date
  tdata[1] = data; // data
  console.log("AA00," + tdata);
  io.sockets.emit("message", tdata); //
});
```

시간,조도

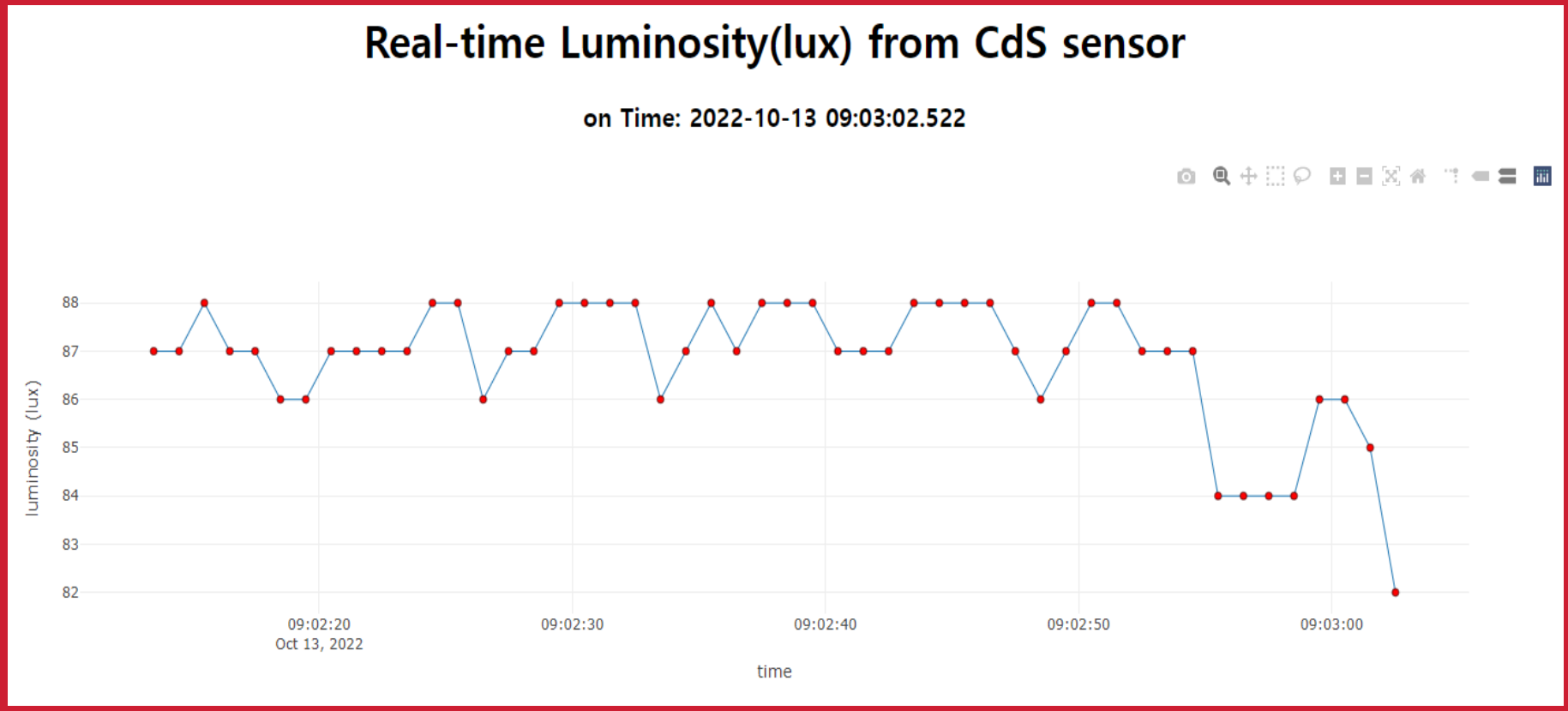
A4.2.3 cds_ node project (실행 결과)




```
D:\Portable\vscode-portable\data\aa2-00\aa2-99-rpt08\wk11_src_start\Node\cds>node cds_node
serial port open
AA00,2020-10-31 09:40:24.912,220
AA00,2020-10-31 09:40:25.910,220
AA00,2020-10-31 09:40:26.914,220
AA00,2020-10-31 09:40:27.913,220
AA00,2020-10-31 09:40:28.912,222
AA00,2020-10-31 09:40:29.912,220
AA00,2020-10-31 09:40:30.915,220
AA00,2020-10-31 09:40:31.914,91
AA00,2020-10-31 09:40:32.914,217
AA00,2020-10-31 09:40:33.917,220
```



```
io.sockets.emit('message', tdata);  // send data to all clients
```



A5.5.1 RT sensor-data streaming in Arduino

[1] Client html : client_cds.html (using socket.io.js & plotly.js)

```
<!DOCTYPE html>
<head>
  <meta charset="utf-8">
  <title>plotly.js client: Real time signals from sensors</title>
  <script src="https://cdn.plot.ly/plotly-latest.min.js"></script>
  <script type="text/javascript" src="https://cdnjs.cloudflare.com/ajax/libs/socket.io/2.3.1/socket.io.js"></script>
  <style>body{padding:0;margin:30;background:#fff}</style>
</head>
```

[2] Client html : client_cds.html (global variables)

```
<body>  <!-- style="width:100%;height:100%"> -->
<!-- Plotly chart will be drawn inside this DIV -->
<h1 align="center"> Real-time Luminosity(lux) from CdS sensor </h1>

<h3 align="center"> on Time: <span id="time"> </span> </h3>

<div id="myDiv"></div> <!-- graph here! -->

<hr>

  <script>
  /* JAVASCRIPT CODE GOES HERE */
    var streamPlot = document.getElementById('myDiv');
    var ctime = document.getElementById('time');

    var tArray = [], // time of data arrival
        xTrack = [], // value of CdS sensor 1 : lux
        numPts = 50, // number of data points
        dtda = [],  // 1 x 2 array : [date, lux] from CdS
        preX = -1,  // check change in data
        initFlag = true;
```

A5.5.3 RT sensor-data streaming in Arduino

[3] Client html : client_cds.html (socket connection & handling message)

```
var socket = io.connect('http://localhost:3000'); // port = 3000
socket.on('connect', function () {
    socket.on('message', function (msg) {
        // initial plot
        if(msg[0]!='' && initFlag){
            dtda[0]=msg[0];
            dtda[1]=parseInt(msg[1]);  // lux
            init();  // start streaming
            initFlag=false;
        }
        console.log(msg[0]);
        console.log(parseInt(msg[1])); // Convert value to integer
        dtda[0]=msg[0];
        dtda[1] = parseInt(msg[1]);

        // when new data is coming, keep on streaming data
        ctime.innerHTML = dtda[0];
        nextPt();
    });
});
```

[4] Client html : client_cds.html (init() & nextPt())

```
function init() {  // initial screen ()
    // starting point : first data (lux)
    for ( i = 0; i < numPts; i++) {
        tArray.push(dtda[0]);  // date
        xTrack.push(dtda[1]);  // CdS sensor (lux)
    }

    Plotly.plot(streamPlot, data, layout);
}

function nextPt() {

    tArray.shift();
    tArray.push(dtda[0]);

    xTrack.shift();
    xTrack.push(dtda[1]);  // CdS sensor: lux

    Plotly.redraw(streamPlot);
}
```

[5] Client html : client_cds.html (data & layout)

```
// data
var data = [{
    x : tArray,
    y : xTrack,
    name : 'luminosity',
    mode: "markers+lines",
    line: {
        color: "#1f77b4",
        width: 1
     },
    marker: {
        color: "rgb(255, 0, 0)",
        size: 6,
        line: {
          color: "black",
          width: 0.5
        }
     }
}];
```

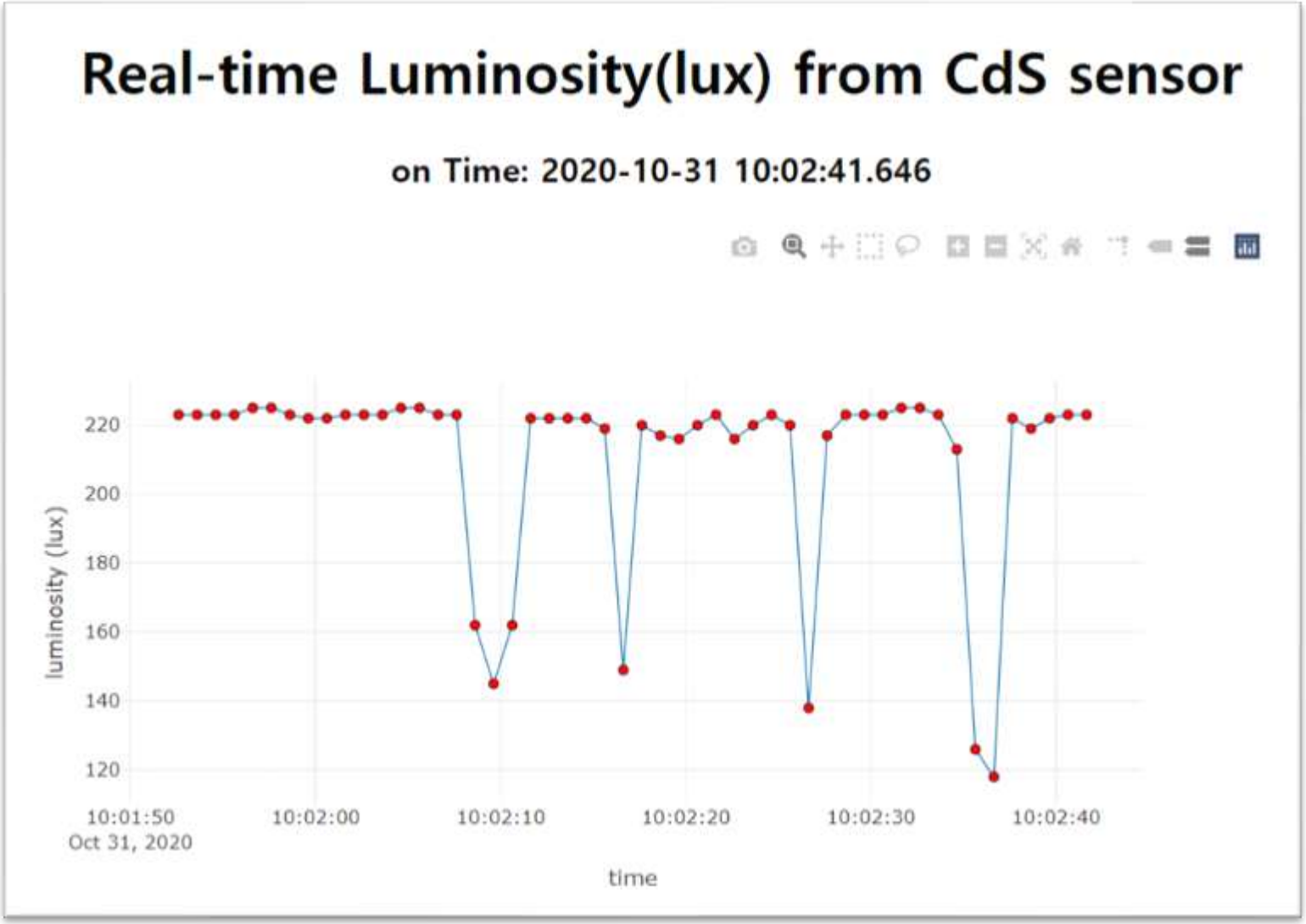
```
// layout
var layout = {
    xaxis : {
        title : 'time',
        domain : [0, 1]
    },
    yaxis : {
        title : 'luminosity (lux)',
        domain : [0, 1],
        range : [0, 500]
    }
};
```

domain: [0,1] → x 또는 y 축을 100% 사용

range: [0,500] → y 축의 범위를 0~500 설정

A5.5.6 RT sensor-data streaming in Arduino

[6] Client html : client_cds.html (real time monitoring of the luminosity)



A5.5.7.1 RT sensor-data streaming in Arduino

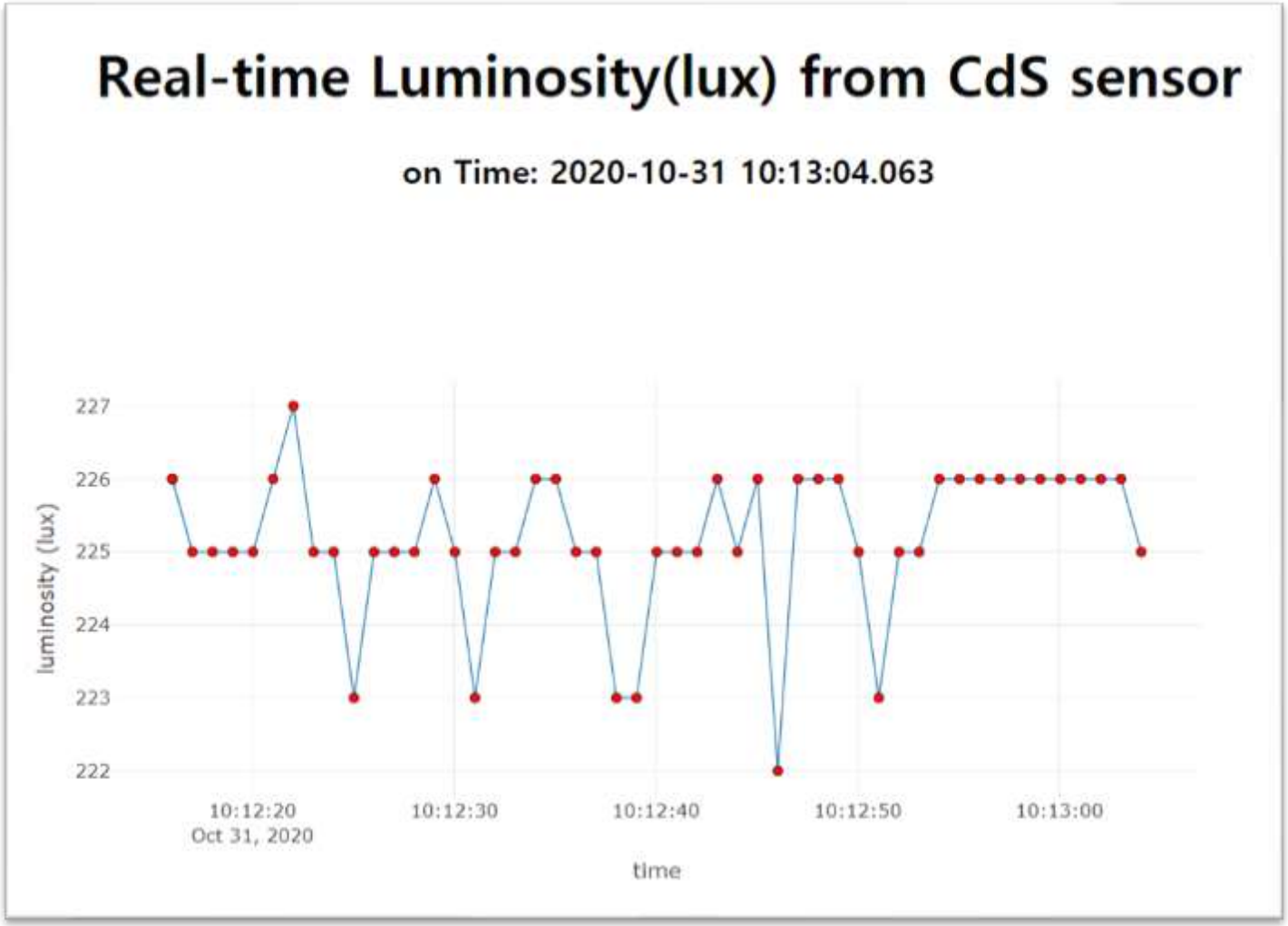
[7.1] Client html : client_cds2.html (using plotly streaming without nextPt())

```
/* function nextPt() {

    tArray.shift();
    tArray.push(dtda[0]);

    xTrack.shift();
    xTrack.push(dtda[1]);  //

    Plotly.redraw(streamPlot);
}       */
```

nextPt() 주석 처리

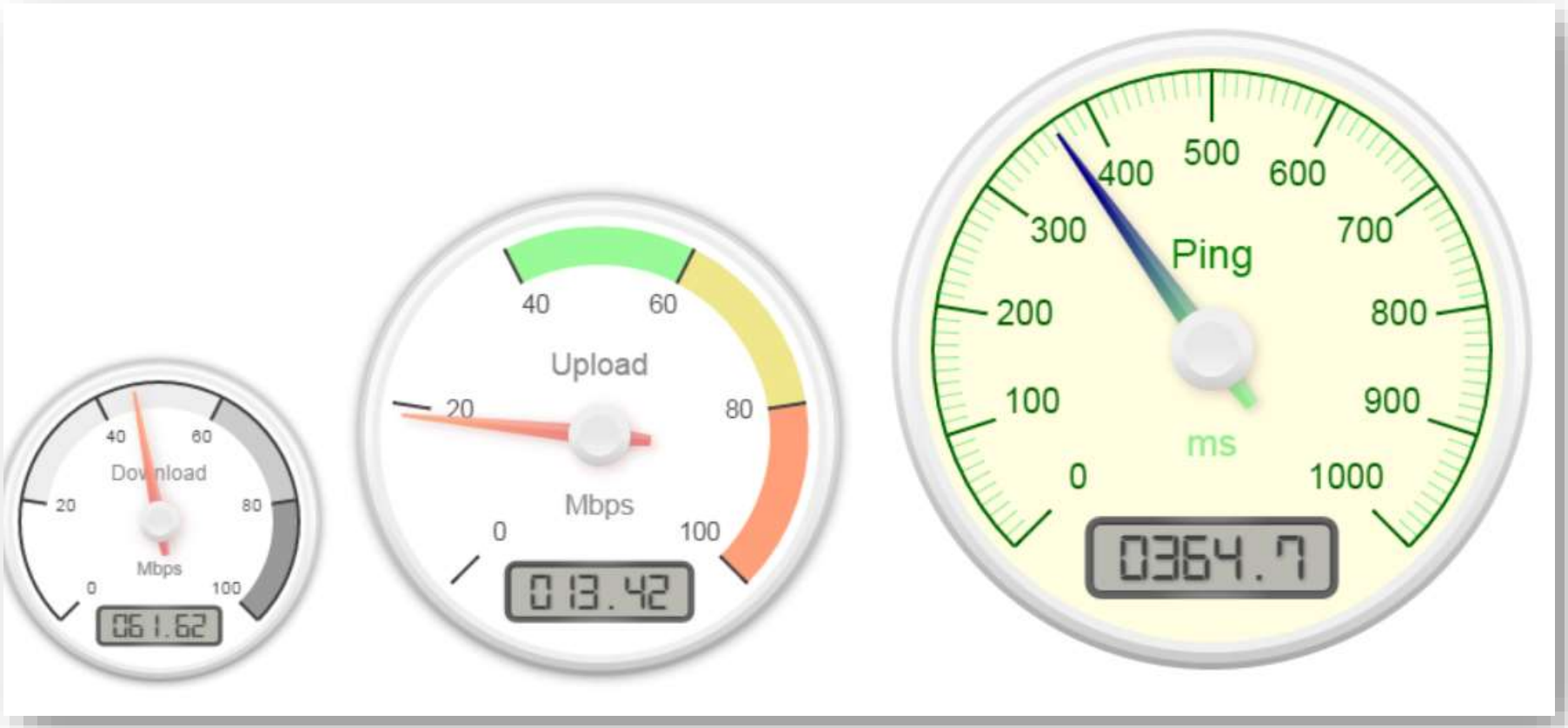
```
socket.on('connect', function () {
    socket.on('message', function (msg) {
        // initial plot
        if(msg[0]!='' && initFlag){
            dtda[0]=msg[0];
            dtda[1]=parseInt(msg[1]);  // lux
            init();  // start streaming
            initFlag=false;
        }
        console.log(msg[0]);
        console.log(parseInt(msg[1])); // Convert
        dtda[0]=msg[0];
        dtda[1] = parseInt(msg[1]);

        // when new data is coming, keep on streami
        ctime.innerHTML = dtda[0];
        //nextPt();
        tArray = tArray.concat(dtda[0]);  // time
        tArray.splice(0,1);
        xTrack = xTrack.concat(dtda[1]);  // lux
        xTrack.splice(0,1);

        var update = {
            x: [tArray],
            y: [xTrack]
        }

        Plotly.update(streamPlot, update);
    });
});
```

[7.2] Client html : client_cds2.html (using plotly streaming without nextPt())



Canvas Gauge

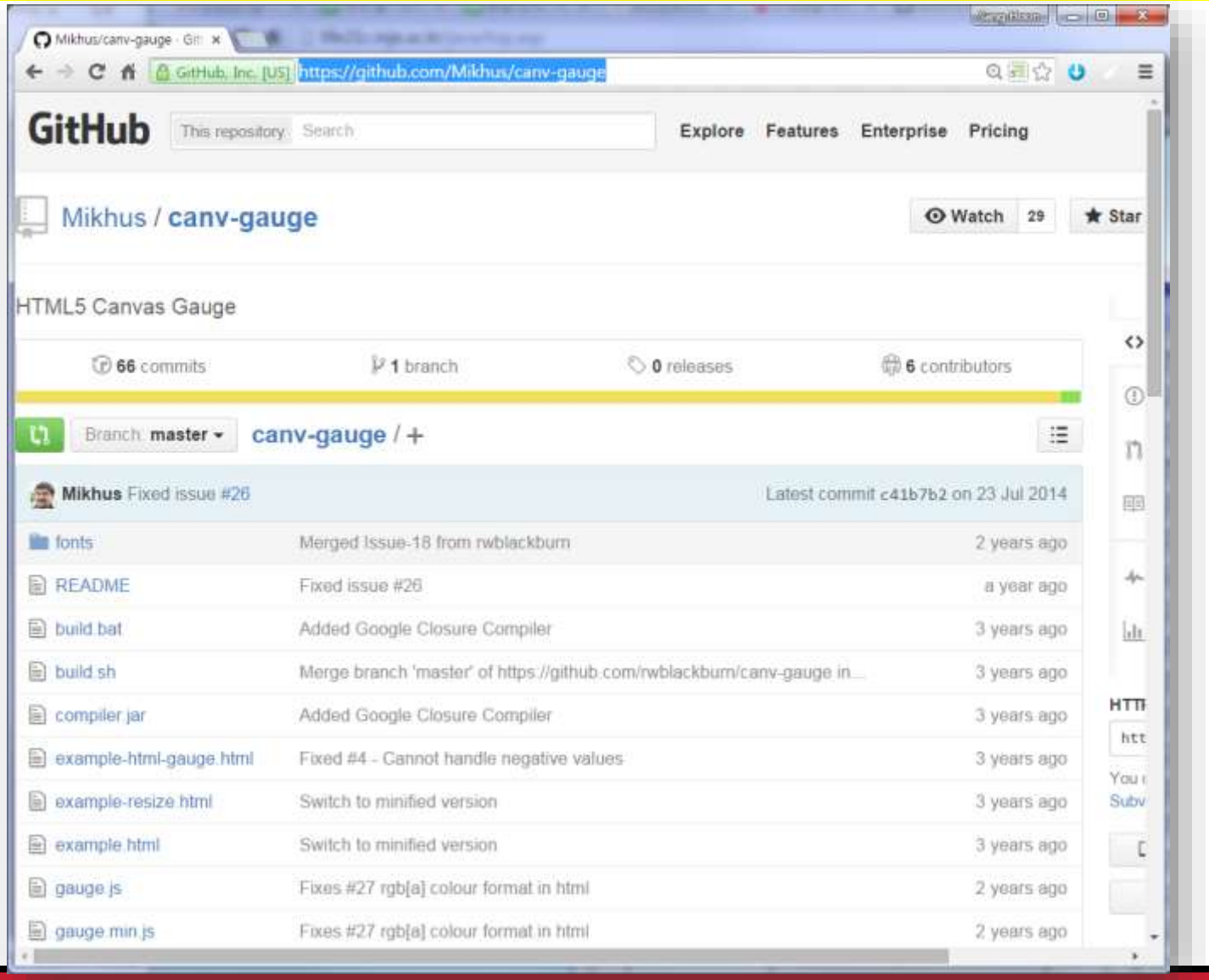
[1] Canvas gauge javascript library : example



http://ru.smart-ip.net/gauge.html

Canvas Gauge

[2] Canvas gauge javascript library : gauge.js



[DIY] Client html : client_cds_gauge.html (add Gauge)

```
<head>
  <meta charset="utf-8">
  <title>plotly.js client: Real time signals from sensors</title>
  <script src="https://cdn.plot.ly/plotly-latest.min.js"></script>
  <script type="text/javascript" src="https://cdnjs.cloudflare.com/ajax/libs/socket.io/2.3.1/socket.io.js"></script>

  <script src="gauge.min.js"></script>

  <style>body{padding:0;margin:30;background:#fff}</style>
</head>

<body>  <!-- style="width:100%;height:100%"> -->
<!-- Plotly chart will be drawn inside this DIV -->
<h1 align="center"> Real-time Luminosity(lux) from CdS sensor with Gauge</h1>
<!-- Lux gauge -->
<div align="center">
    <canvas id='gauge'></canvas>
</div>
```

A5.5.8.2 RT sensor-data streaming in Arduino

[DIY] Client html : client_cds_gauge.html (add Gauge)

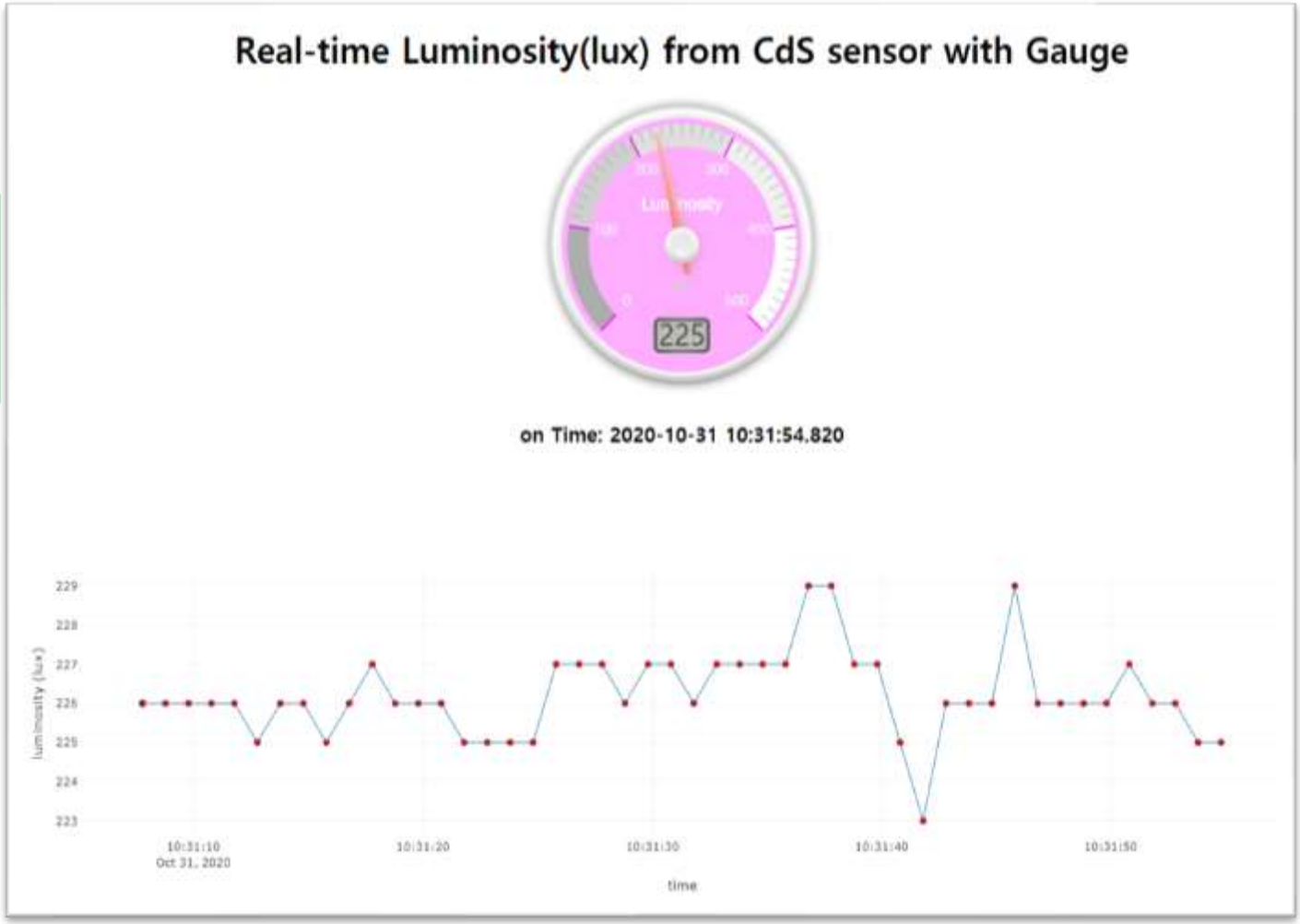
```
socket.on('connect', function () {
    socket.on('message', function (msg) {
        // initial plot
        if(msg[0]!='' && initFlag){
            dtda[0]=msg[0];
            dtda[1]=parseInt(msg[1]);  // lux
            init();  // start streaming
            initFlag=false;
        }
        console.log(msg[0]);
        console.log(parseInt(msg[1])); // Conv
        dtda[0]=msg[0];
        dtda[1] = parseInt(msg[1]);

        // when new data is coming, keep on st
        ctime.innerHTML = dtda[0];
        gauge_lux.setValue(dtda[1]); // lux ga
        //nextPt();
        tArray = tArray.concat(dtda[0]);  // t
        tArray.splice(0,1);
        xTrack = xTrack.concat(dtda[1]);  // l
        xTrack.splice(0,1);

        var update = {
            x: [tArray],
            y: [xTrack]
        }

        Plotly.update(streamPlot, update);

    });
});
```

```
var gauge_lux = new Gauge({
    renderTo    : 'gauge',
    width       : 300,
    height      : 300,
    glow        : true,
    units       : 'lux',
    valueFormat : { int : 2, dec : 0 },
    title       : "Luminosity",
    minValue    : 0,
    maxValue    : 500,  // new
    majorTicks  : ['0','100','200','300','400','500'],
    minorTicks  : 10,
    strokeTicks : false,
    highlights  : [
        { from : 0,   to : 100, color : '#aaa' },
        { from : 100, to : 200, color : '#ccc' },
        { from : 200, to : 300, color : '#ddd' },
        { from : 300, to : 400, color : '#eee' },
        { from : 400, to : 500, color : '#fff' }
    ],
    colors      : {
        plate      : '#1f77b4',
        majorTicks : '#f5f5f5',
        minorTicks : '#aaa',
        title      : '#fff',
        units      : '#ccc',
        numbers    : '#eee',
        needle     : { start : 'rgba(240, 128, 128, 1)',
        end : 'rgba(255, 160, 122, .9)' }
    }
});
gauge_lux.draw();
```

A5.5.8.3 RT sensor-data streaming in Arduino

[DIY] Client html : client_cds_gauge.html (change design of Gauge)

변경된 디자인으로 된 그래프를 캡처하여 AAnn_cds_gauge.png 로 저장



[DIY] Client html : client_cds_change.html (detecting change)

이상 감지 (anomaly detection)

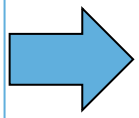
입력되는 lux 값이 변하는 경우에만 그래프를 그림.

실시간 모니터링에서 이상 감지 기능이 필요함.

밝기 값 변화의 문턱값을 설정해서 이상 감지 기능 구현

[DIY. hint] Client html : client_cds_change.html (detecting change)

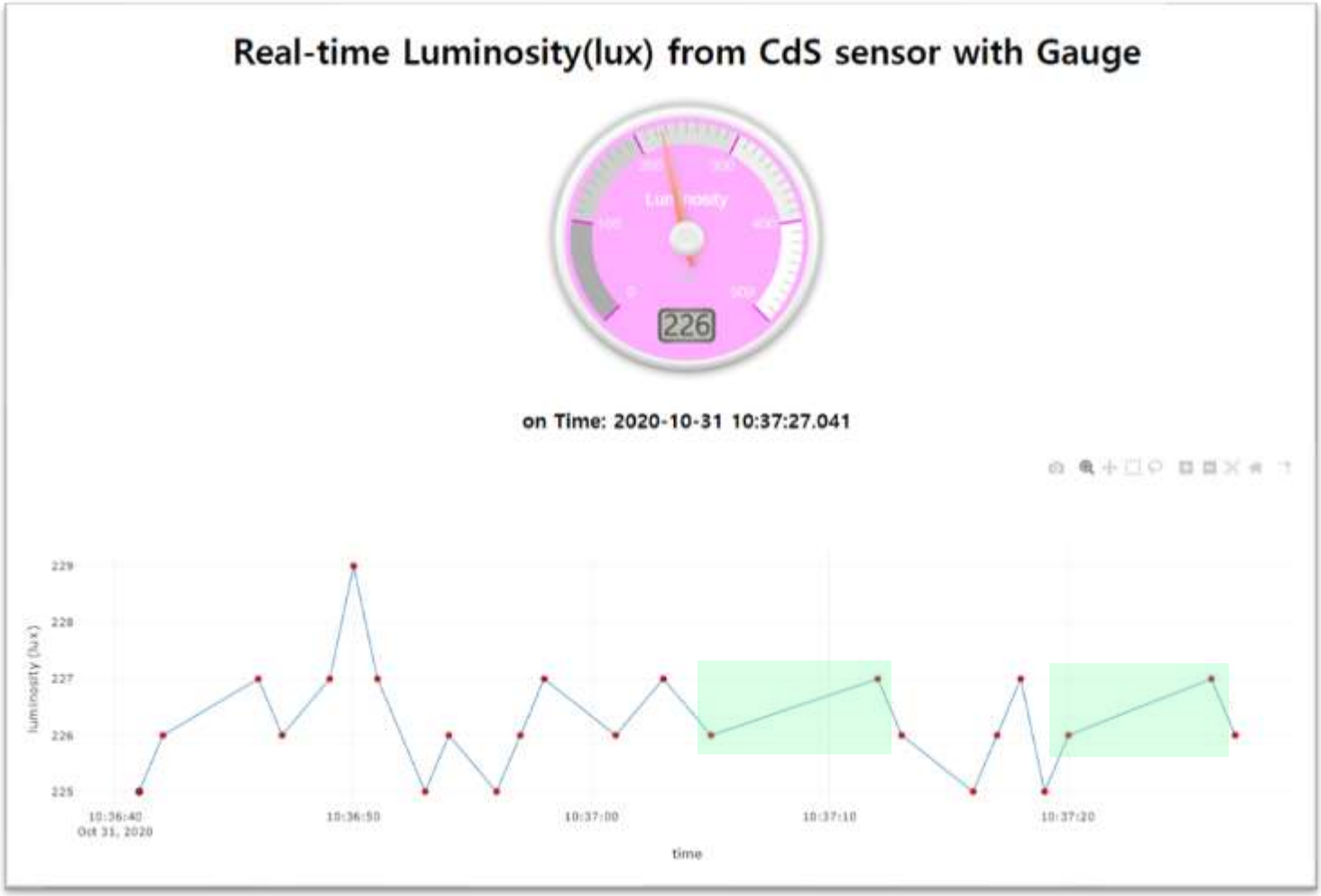
```
// when new data is coming,
// keep on streaming data
ctime.innerHTML = dtda[0];
gauge_lux.setValue(dtda[1]); // lux gauge
//nextPt();
tArray = tArray.concat(dtda[0]);  // time
tArray.splice(0,1);
xTrack = xTrack.concat(dtda[1]);  // lux
xTrack.splice(0,1);

var update = {
    x: [tArray],
    y: [xTrack]
}

Plotly.update(streamPlot, update);
```



```
// Only when the value of lux is different
// from the previous one, the screen is redrawed.
if (dtda[1] != preX) {  // any change?
    preX = dtda[1];

    ctime.innerHTML = dtda[0];
    gauge_lux.setValue(dtda[1]); // lux gauge
    //nextPt();
    tArray = tArray.concat(dtda[0]);  // time
    tArray.splice(0,1);
    xTrack = xTrack.concat(dtda[1]);  // lux
    xTrack.splice(0,1);

    var update = {
        x: [tArray],
        y: [xTrack]
    }

    Plotly.update(streamPlot, update);
}
```

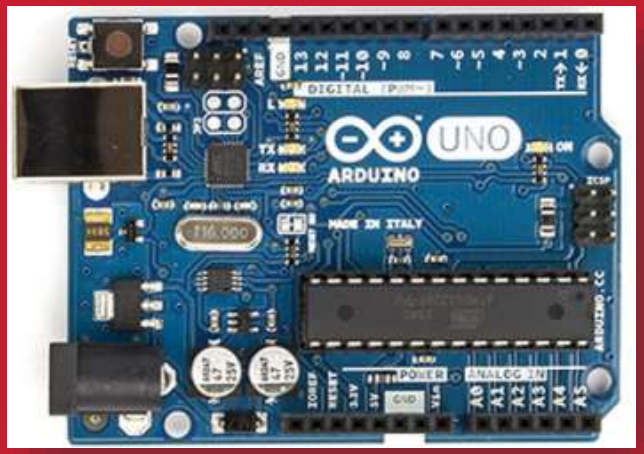
A5.5.9.3 RT sensor-data streaming in Arduino

[DIY] Client html : client_cds_change.html (detecting change)



측정되는 주변 광의 밝기가 일정 시간 유지되다가 변하는 그래프를 캡처하여 AAnn_cds_change.png 로 저장

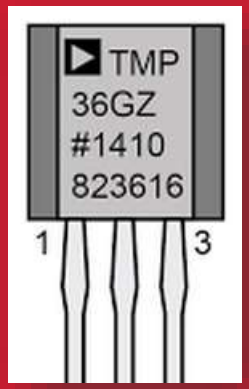
Multiple sensors



CdS + TMP36

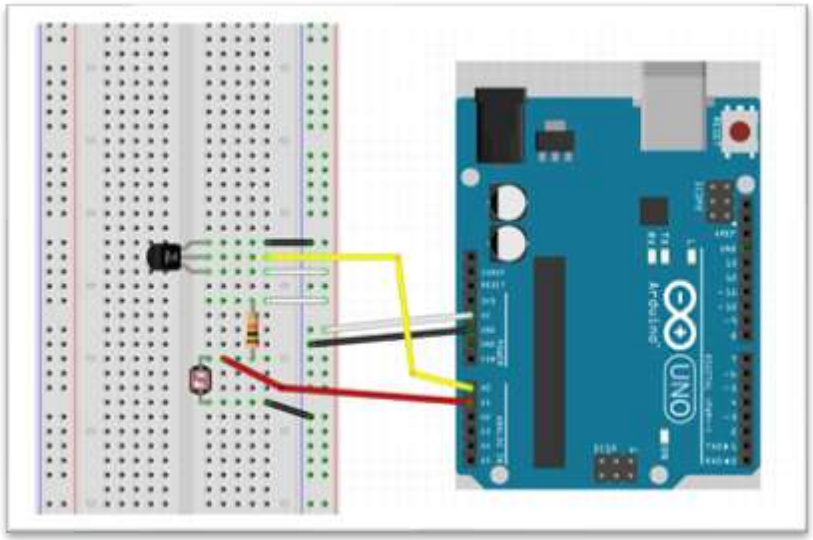
+ plotly.js

Node project



CdS + TMP36 + Node.js + Plotly

tmp36 + CdS circuit



```
AA00,2020-10-17 11:41:30.533,25.27,245
AA00,2020-10-17 11:41:31.535,25.27,243
AA00,2020-10-17 11:41:32.535,25.27,158
AA00,2020-10-17 11:41:33.534,24.29,40
AA00,2020-10-17 11:41:34.538,24.29,33
AA00,2020-10-17 11:41:35.537,24.78,86
AA00,2020-10-17 11:41:36.541,25.27,249
AA00,2020-10-17 11:41:37.540,25.76,245
AA00,2020-10-17 11:41:38.543,25.76,243
AA00,2020-10-17 11:41:39.543,25.27,245
```

```
var readData = "";
var temp = "";
var lux = "";
var mdata = [];
var firstcommaidx = 0;

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

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

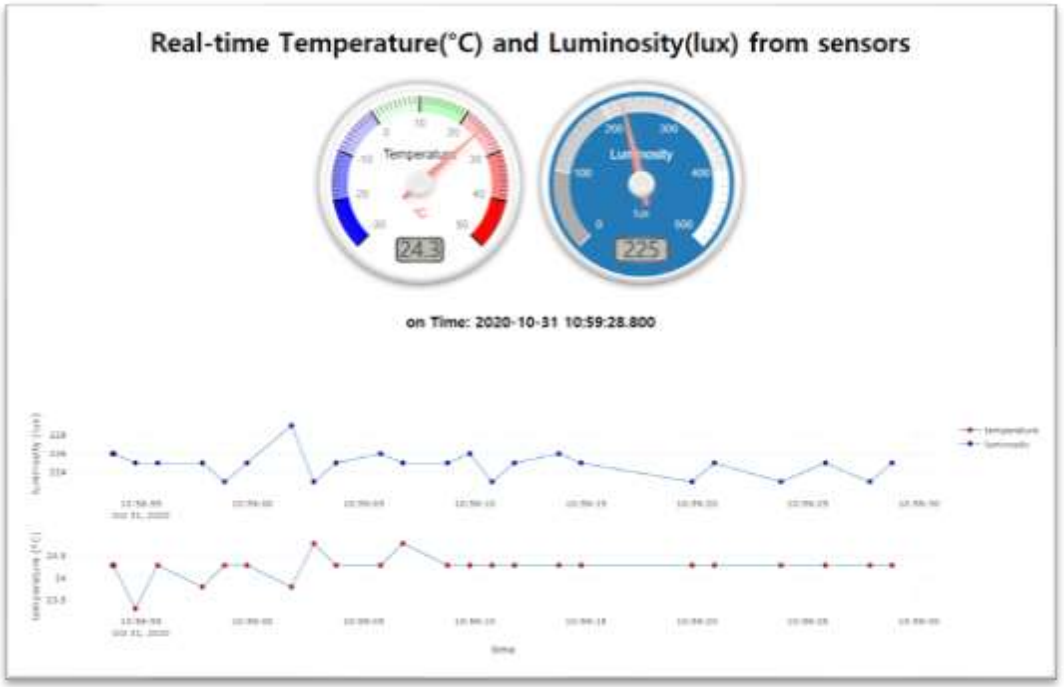
시간,온도,조도

A5.6.1 cds_ tmp36_node project (실행 결과)

```
D:\Portable\vscode-portable\data\aa2-00\aa2-99-rpt08\wk11_src_start\Node\cds_tmp36>node cds_tmp36_node
serial port open
AA00,2020-10-31 10:51:17.221,23.80,226
AA00,2020-10-31 10:51:18.220,24.29,226
AA00,2020-10-31 10:51:19.223,24.29,225
AA00,2020-10-31 10:51:20.223,24.29,225
AA00,2020-10-31 10:51:21.226,24.78,225
AA00,2020-10-31 10:51:22.226,25.27,225
AA00,2020-10-31 10:51:23.230,24.29,208
AA00,2020-10-31 10:51:24.229,25.27,213
AA00,2020-10-31 10:51:25.228,24.78,219
AA00,2020-10-31 10:51:26.232,24.29,193
AA00,2020-10-31 10:51:27.231,24.29,151
AA00,2020-10-31 10:51:28.234,24.29,225
AA00,2020-10-31 10:51:29.234,24.29,225
AA00,2020-10-31 10:51:30.237,24.29,225
AA00,2020-10-31 10:51:31.237,24.29,226
AA00,2020-10-31 10:51:32.236,24.29,226
AA00,2020-10-31 10:51:33.240,24.29,227
AA00,2020-10-31 10:51:34.239,24.29,223
AA00,2020-10-31 10:51:35.243,24.29,223
AA00,2020-10-31 10:51:36.242,24.29,225
AA00,2020-10-31 10:51:37.245,24.29,226
AA00,2020-10-31 10:51:38.245,24.29,226
```

IOT data format

시간, 온도,조도



A5.6.1 TMP36 + CdS streaming project

[DIY] Client html : client_cds_tmp36.html (data from multi sensors)

```
<!DOCTYPE html>
<head>
  <meta charset="utf-8">
  <title>plotly.js client: Real time signals from sensors</title>
  <script src="https://cdn.plot.ly/plotly-latest.min.js"></script>
  <script type="text/javascript" src="https://cdnjs.cloudflare.com/ajax/libs/socket.io/2.3.1/socket.io.js"></script>

  <script src="gauge.min.js"></script>

  <style>body{padding:0;margin:30;background:#fff}</style>
</head>

<body>  <!-- style="width:100%;height:100%"> -->
<!-- Plotly chart will be drawn inside this DIV -->
<h1 align="center">Real-time Temperature(°C) and Luminosity(lux) from sensors</h1>
<div align="center">
    <!-- 1st gauge -->
    <canvas id="gauge1"> </canvas>
    <!-- 2nd gauge -->
    <canvas id="gauge2"> </canvas>
</div>

<h3 align="center"> on Time: <span id="time"> </span> </h3>
```

A5.6.2 TMP36 + CdS streaming project

[DIY] Client html : client_cds_tmp36.html (data from multi sensors)

```
<script>
/* JAVASCRIPT CODE GOES HERE */
  var streamPlot = document.getElementById('myDiv');
  var ctime = document.getElementById('time');

  var tArray = [], // time of data arrival
      xTrack = [], // value of sensor 1 : temperature
      yTrack = [], // value of sensor 2 : Luminosity
      numPts = 50, // number of data points in x-axis
      dtda = [],  // 1 x 3 array : [date, data1, data2] from sensors
      preX = -1,
      preY = -1,
      initFlag = true;
```

A5.6.3 TMP36 + CdS streaming project

[DIY] Client html : client_cds_tmp36.html (data from multi sensors)

```
var socket = io.connect('http://localhost:3000'); // port = 3000
socket.on('connect', function () {
    socket.on('message', function (msg) {
        // initial plot
        if(msg[0]!='' && initFlag){
            dtda[0]=msg[0];
            dtda[1]=parseFloat(msg[1]);  // temperature
            dtda[2]=parseInt(msg[2]);    // Luminosity
            init();  // start streaming
            initFlag=false;
        }
        dtda[0]=msg[0];
        dtda[1] = parseFloat(msg[1]);
        dtda[2] = parseInt(msg[2]);
```

A5.6.4 TMP36 + CdS streaming project

[DIY] Client html : client_cds_tmp36.html (data from multi sensors)

```
        // Only when any of temperature or Luminosity is different from
        // the previous one, the screen is redrawed.
        if (dtda[1] != preX || dtda[2] != preY) {  // any change?
            preX = dtda[1];
            preY = dtda[2];

            ctime.innerHTML = dtda[0];
            gauge_temp.setValue(dtda[1])  // temp gauge
            gauge_lux.setValue(dtda[2]);  // lux gauge
            //nextPt();
            tArray = tArray.concat(dtda[0]);  // time
            tArray.splice(0,1);
            xTrack = xTrack.concat(dtda[1])   // temp
            xTrack.splice(0, 1)  // remove the oldest data
            yTrack = yTrack.concat(dtda[2])   // lux
            yTrack.splice(0, 1)

            var update = {
                x: [tArray, tArray],
                y: [xTrack, yTrack]
            }
            Plotly.update(streamPlot, update);
        }
    });
});
```

A5.6.5 TMP36 + CdS streaming project

[DIY] Client html : client_cds_tmp36.html (data from multi sensors)

```
function init() {  // initial screen ()
    // starting point : first data (temp, lux)
    for ( i = 0; i < numPts; i++) {
        tArray.push(dtda[0]);  // date
        xTrack.push(dtda[1]);  // sensor 1 (temp)
        yTrack.push(dtda[2]);  // sensor 2 (lux)
    }

    Plotly.newPlot(streamPlot, data, layout);
}
```

A5.6.6 TMP36 + CdS streaming project

[DIY] Client html : client_cds_tmp36.html (data from multi sensors)

```
// data
var data = [{
    x : tArray,
    y : xTrack,
    name : 'temperature',
    mode: "markers+lines",  // "l
    line: {
        color: "#1f77b4",
        width: 1
    },
    marker: {
        color: "rgb(255, 0, 0)",
        size: 6,
        line: {
          color: "black",
          width: 0.5
        }
    }
}, {
    x : tArray,
    y : yTrack,
    name : 'luminosity',
    xaxis: 'x2',
    yaxis : 'y2',
    mode: "markers+lines",  // "l
    line: {
        color: "#1f77b4",
        width: 1
    },
    marker: {
        color: "rgb(0, 0, 255)",
        size: 6,
        line: {
          color: "black",
          width: 0.5
        }
    }
}];
```

```
var layout = {
    xaxis : {
        title : 'time',
        domain : [0, 1]
    },
    yaxis : {
        title : 'temperature (°C)',
        domain : [0, 0.4],
        range : [-30, 50]
    },
    xaxis2 : {
        title : '',
        domain : [0, 1],
        position : 0.6
    },
    yaxis2 : {
        title : 'luminosity (lux)',
        domain : [0.65, 1],
        range : [0, 500]
    }
};
```

A5.6.7 TMP36 + CdS streaming project

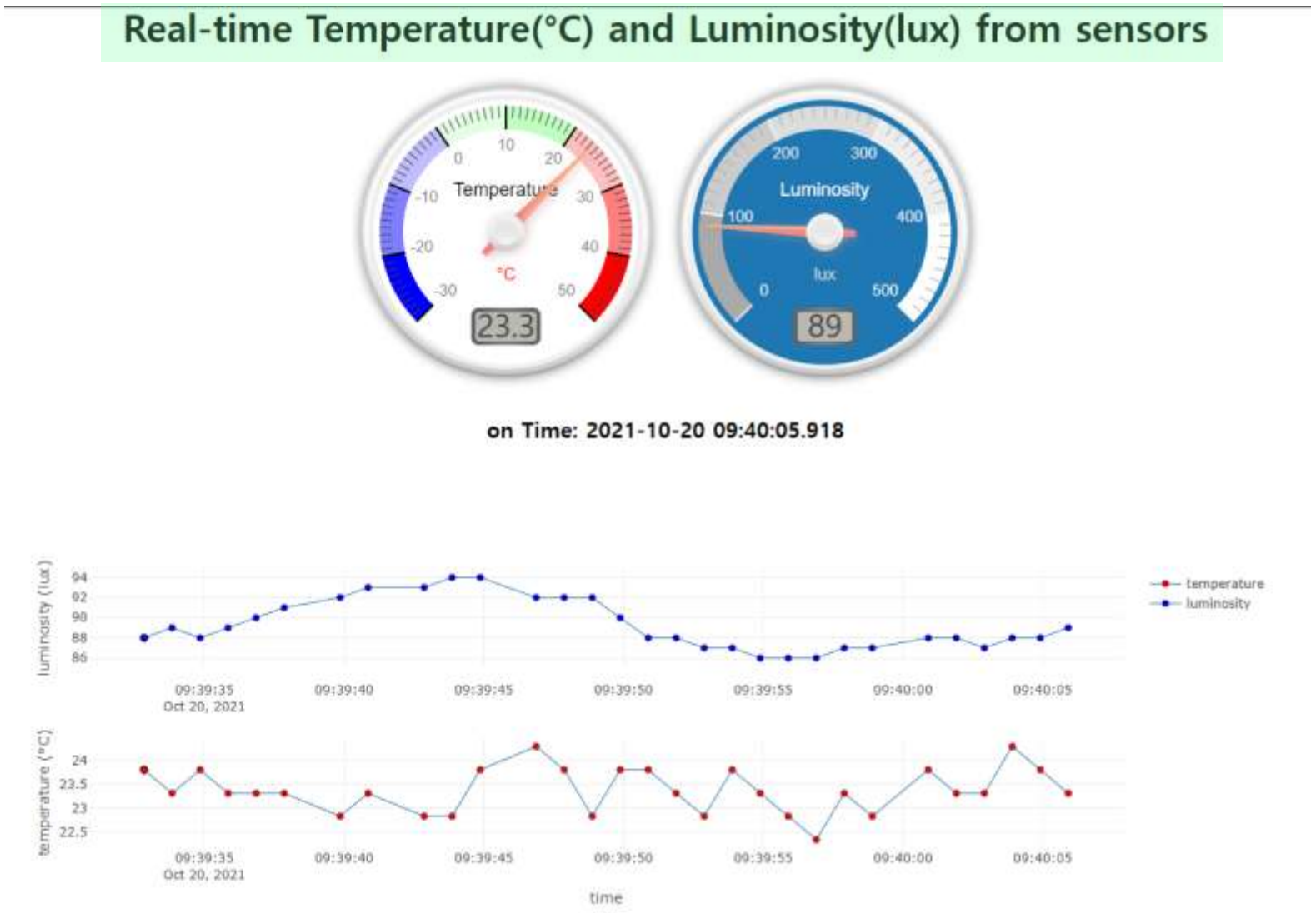
[DIY] Client html : client_cds_tmp36.html (data from multi sensors)

```
// gauge configuration
var gauge_temp = new Gauge({
    renderTo    : 'gauge1',
    width       : 300,
    height      : 300,
    glow        : true,
    units       : '°C',
    valueFormat : { int : 1, dec : 1 },
    title       : "Temperature",
    minValue    : -30,
    maxValue    : 50,
    majorTicks  : ['-30','-20','-10','0','10','20','30','40','50'],
    minorTicks  : 10,
    strokeTicks : false,
    highlights  : [
    { from : -30,   to : -20, color : 'rgba(0, 0, 255, 1)' },
    { from : -20,   to : -10, color : 'rgba(0, 0, 255, .5)' },
    { from : -10, to : 0, color : 'rgba(0, 0, 255, .25)' },
    { from : 0,   to : 10, color : 'rgba(0, 255, 0, .1)' },
    { from : 10, to : 20, color : 'rgba(0, 255, 0, .25)' },
    { from : 20, to : 30, color : 'rgba(255, 0,  0, .25)' },
    { from : 30, to : 40, color : 'rgba(255, 0,  0, .5)' },
    { from : 40, to : 50, color : 'rgba(255, 0,  0, 1)' }
    ],
    colors      : {
        plate      : '#fff',
        majorTicks : '#000',
        minorTicks : '#444',
        title      : '#000',
        units      : '#f00',
        numbers    : '#777',
        needle     : { start : 'rgba(240, 128, 128, 1)',
        end : 'rgba(255, 160, 122, .9)' }
    }
});
gauge_temp.draw();
```

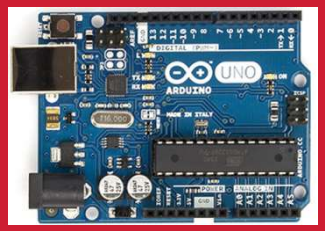
```
var gauge_lux = new Gauge({
    renderTo    : 'gauge2',
    width       : 300,
    height      : 300,
    glow        : true,
    units       : 'lux',
    valueFormat : { int : 3, dec : 0 },
    title       : "Luminosity",
    minValue    : 0,
    maxValue    : 500,  // new
    majorTicks  : ['0','100','200','300','400','500'],
    minorTicks  : 10,
    strokeTicks : false,
    highlights  : [
    { from : 0,   to : 100, color : '#aaa' },
    { from : 100, to : 200, color : '#ccc' },
    { from : 200, to : 300, color : '#ddd' },
    { from : 300, to : 400, color : '#eee' },
    { from : 400, to : 500, color : '#fff' }
    ],
    colors      : {
        plate      : '#1f77b4',
        majorTicks : '#f5f5f5',
        minorTicks : '#aaa',
        title      : '#fff',
        units      : '#ccc',
        numbers    : '#eee',
        needle     : { start : 'rgba(240, 128, 128, 1)',
        end : 'rgba(255, 160, 122, .9)' }
    }
});
gauge_lux.draw();
```

A5.6.8 TMP36 + CdS streaming project

[DIY] Client html : client_cds_tmp36.html (result)



Gauge 디자인 변경한 후에, AAnn_DS_cds_tmp36.png 로 저장



[Practice]

- [wk09]
  - RT Data Visualization with node.js
  - Usage of gauge.js
  - Complete your plotly-node project
  - Upload folder: aann-rpt09
  - Use repo “aann” in github

wk09 : Practice : aann-rpt09

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

제출폴더명 : **aann-rpt09**

- 압축할 파일들

① AAnn_DS_30timestamps.png

② AAnn_DS_multiple_axis.png

③ AAnn_cds_gauge.png

④ AAnn_cds_change.png

⑤ AAnn_DS_cds_tmp36.png

⑥ All *.ino

⑦ All *.js

⑧ All *.html

Email : chaos21c@gmail.com

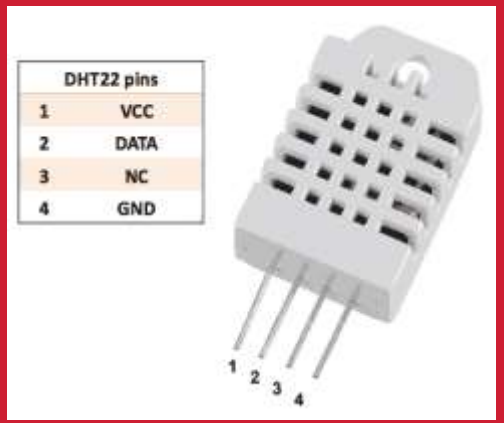
CdS + DHT22

+ plotly.js

Node project

Multi-sensors

DHT22 + CdS



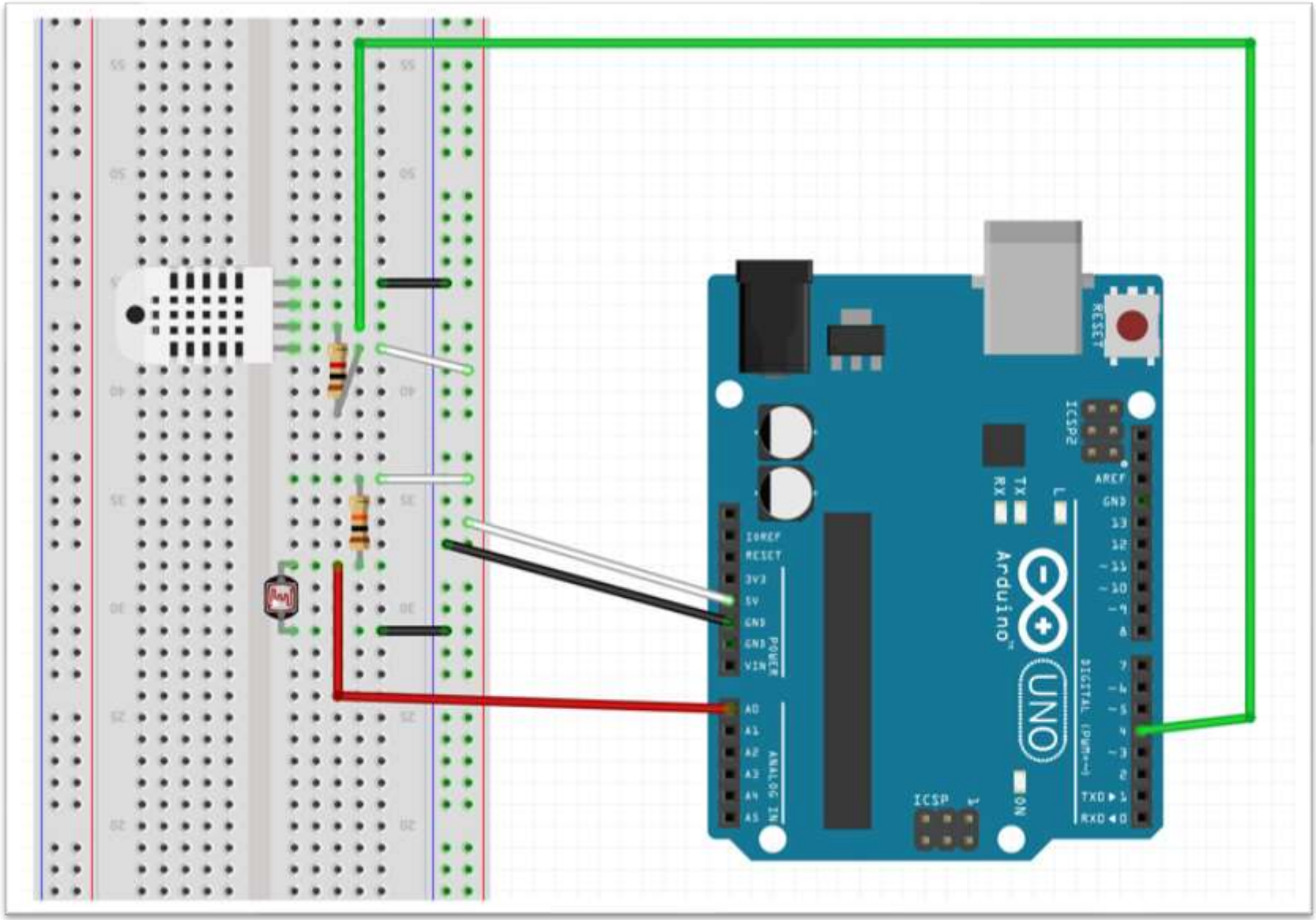
DHT22 pins	
1	VCC
2	DATA
3	NC
4	GND

그림 8-7 DHT22 pin 구조

- 3 ~ 5V power and I/O
- 2.5mA max current
- [0-100%] humidity readings with 2-5% accuracy
- [-40 to 80°C] temperature readings ±0.5°C accuracy
- 0.5 Hz sampling rate

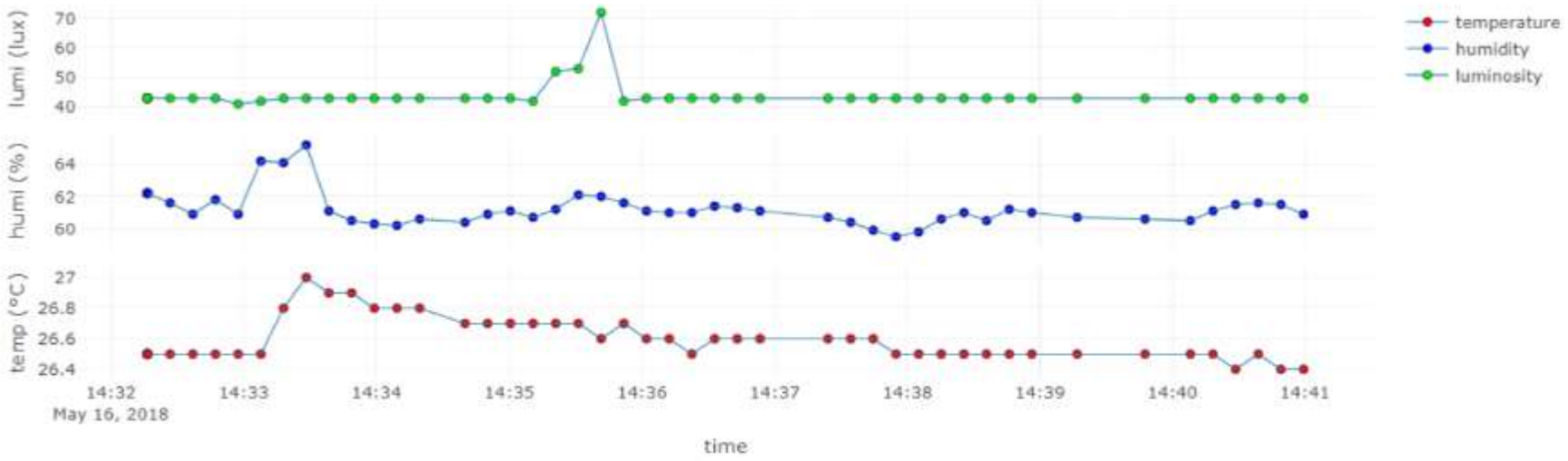
https://learn.adafruit.com/dht/overview

A5.7.1 DHT22 + CdS circuit



Real-time Weather Station from sensors

on Time: 2018-05-16 14:40:59.402



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