IoT Inertial Measurement Unit Monitoring

จัดทำโดย

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เสนอ

ผู้ช่วยศาสตราจารย์ ดร.สุพจน์ แก้วกรณ์

รายงานเล่มนี้เป็นส่วนหนึ่งของวิชาการโปรแกรมคอมพิวเตอร์สำหรับงานควบคุม

สาขาวิชาเทคโนโลยีวิศวกรรมแมคคาทรอนิกส์

ภาควิชาเทคโนโลยีวิศวกรรมเครื่องกล

วิทยาลัยเทคโนโลยีอุตสาหกรรม

มหาวิทยาลัยเทคโนโลยีพระจอมเกล้าพระนครเหนือ

พ.ศ.2565

คำนำ

รายงานเล่มนี้เป็นส่วนหนึ่งของวิชา 030143361 Computer Programming For Control โดยจัดทำขึ้นโดยเพื่อศึกษาการเขียนโปรแกรมคอมพิวเตอร์สำหรับการควบคุมโดยใช้โปรแกรม Delphi ซึ่งรายงานเล่มนี้มีเนื้อหาเกี่ยวกับการเขียนโปรแกรมติดต่อรับส่งข้อมูลกับคอนโทลเลอร์แสดงผล และบันทึกผลการทำงาน

ผู้จัดทำได้ทำรายงานเล่มนี้ขึ้นเพื่อแสดงการใช้โปรแกรม Delphi ในการเขียนโปรแกรมติดต่อสื่อสาร และแสดงผล โดยใช้ Arduino และคอมพิวเตอร์ร่วมกัน ผู้จัดทำหวังว่ารายงานเล่มนี้จะมีประโยชน์แก่ผู้ที่เข้ามาศึกษา หากรายงานเล่มนี้มีข้อผิดพลาดประการใดทางผู้จัดทำขออภัยมา ณ ที่นี้ด้วย

ผู้จัดทำ
ธนวินท์ ศิริวรรณ

1. ที่มาและความสำคัญ

เพื่อพัฒนาระบบแสดงสถานการทำงานของเซนเซอร์ GY-91 ที่เชื่อมต่อ Arduino และสื่อสารรับส่งข้อมูลกับคอมพิวเตอร์ด้วย TCP/IP โดยสามารถนำข้อมูลที่ได้จาก Arduino ที่ต่อกับเซนเซอร์ GY-91 (IMU) นำมาพล็อตกราฟ Acceleration, Gyro, Magnetometer, Temperature และบันทึกค่าไปยังฐานข้อมูล MQTT สามารถบันทึกเป็น Text ไฟล์ และสามารถแสดงสถานะการทำงานผ่าน Node-RED

2. วัตถุประสงค์

2.1 เพื่อศึกษาการเขียน VCL/FMX Application ด้วย Delphi

2.2 เพื่อศึกษาการส่งข้อมูลสื่อสารกับ Arduino ผ่าน TCP/IP ด้วย Delphi

2.3 เพื่อออกแบบระบบ IoT Inertia Measurement Unit Monitoring

3. ขอบเขตการทำงาน

3.1 สามารถรับส่งข้อมูลไปยัง Arduino ผ่าน TCP/IP

3.2 สามารถทำการแสดงค่าสัญญาณของ GY-91

3.3 สามารถส่งข้อมูลไปเก็บที่ฐานข้อมูล

3.4 สามารถบันทึกค่าที่อ่านจากเซนเซอร์ลง Text ไฟล์

3.5 สามารถควบคุมการเคลื่อนที่วัตถุ 3 มิติ

3.6. สามารถส่งข้อมูลไปยัง MQTT

3.7 สามารถทำการแสดงสถานการณ์ทำงานของระบบด้วย Node-RED

4. ผลที่คาดว่าจะได้รับ

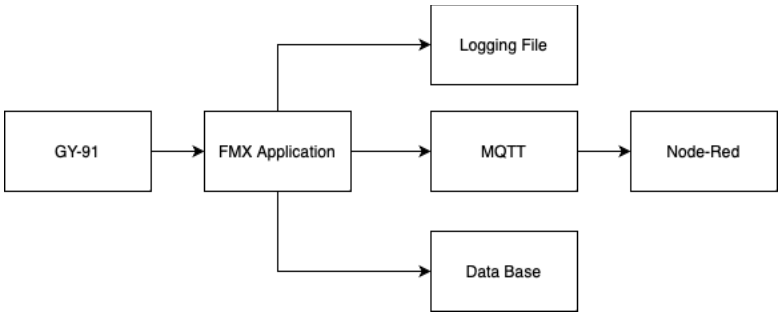
4.1 ระบบสามารถรับส่งข้อมูลกับ Arduino ผ่าน TCP/IP ได้

4.2 ระบบสามารถส่งบันทึกข้อมูลไปยังฐานข้อมูลได้

4.3 ระบบสามารถส่งบันทึกข้อมูลในรูปแบบ Text ไฟล์ได้

4.4 ระบบสามารถรับส่งข้อมูลกับ MQTT ได้

5. Block Diagram แสดงขั้นตอนการทำงาน



6. การเชื่อมต่อ

6.1 Arduino เชื่อมต่อกับโมดูล GY-19 ด้วย I2C

6.2 Arduino เชื่อมต่อ Arduino Ethernet Shield ด้วย SPI

6.3 คอมพิวเตอร์สื่อสารกับ Arduino ผ่าน TCP/IP โดย Arduino จะเป็น Server และคอมพิวเตอร์เป็น Client

7. การดำเนินงาน

7.1 ออกแบบระบบ

7.2 การเขียนโปรแกรมให้ Arduino อ่านค่าจาก GY-91

7.3 การเขียนโปรแกรมให้ Arduino เชื่อมต่อกับอินเทอร์เน็ต

7.4 การเขียนโปรแกรม Delphi สื่อสารกับ Arduino ผ่าน TCP/IP

7.5 การเขียนโปรแกรม Delphi ส่งข้อมูลไปยังฐานข้อมูล

7.6 การเขียนโปรแรกม Delphi ส่งและรับข้อมูลจาก MQTT

7.7 การเขียนโปรแกรมบันทึกค่าจาก GY-91 ลง text ไฟล์

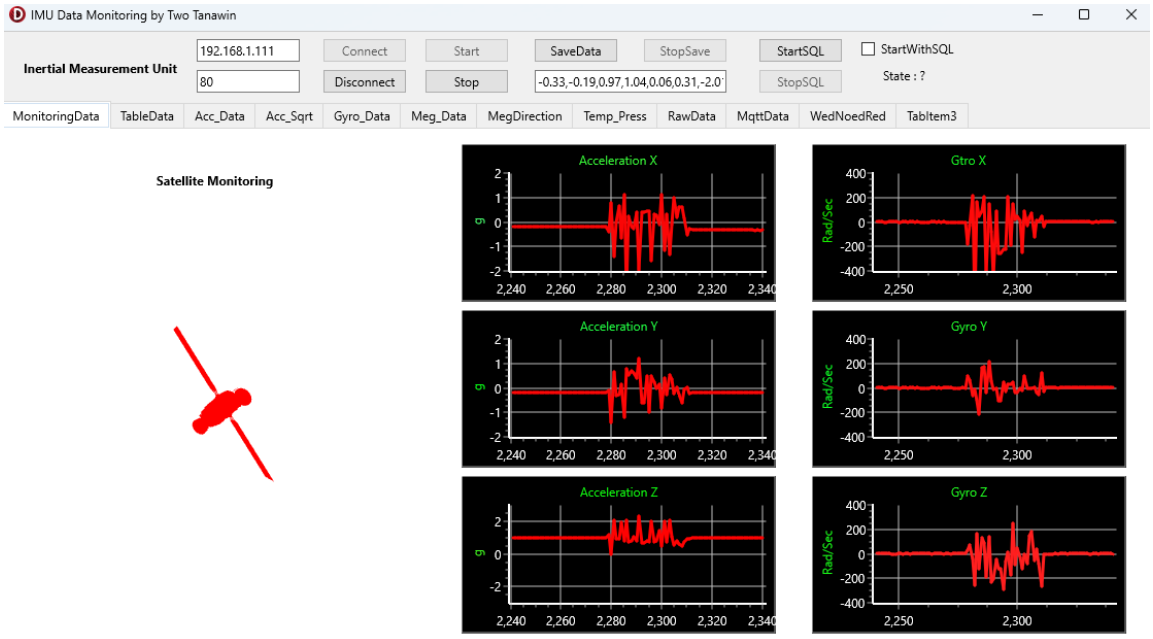
7.8 การเขียนโปรแกรมควบคุมวัตถุ 3 มิติ

7.9 การเขียนโปรแกรม Delphi พล็อตกราฟ

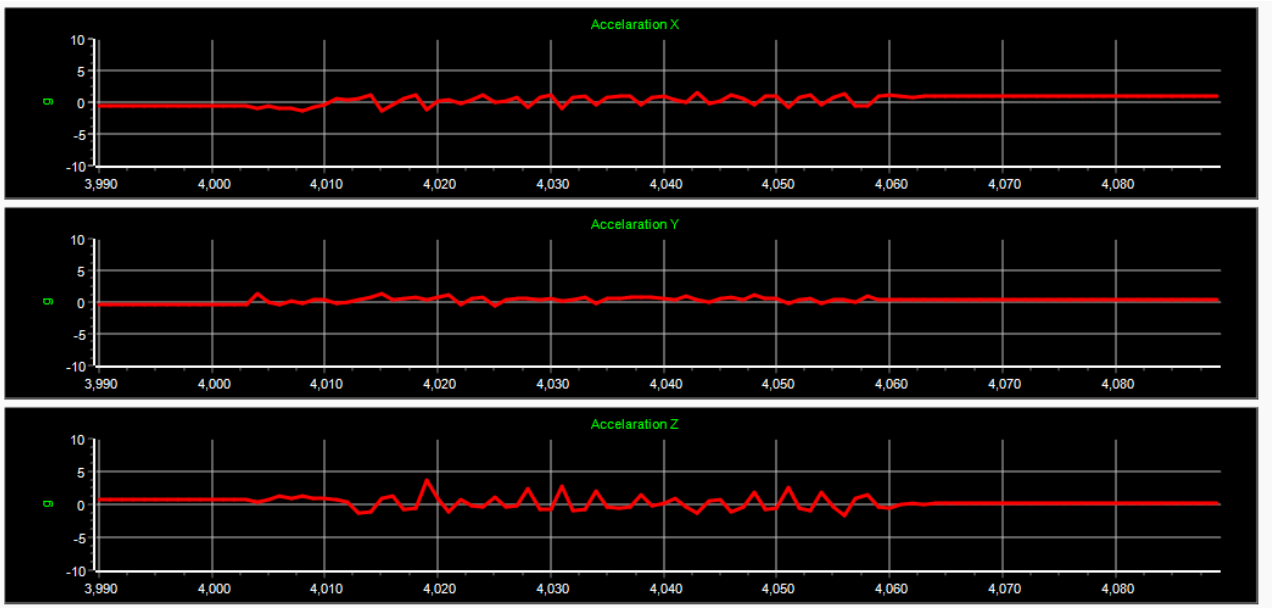
7.10 การเขียนโปรแกรม Node-RED รับค่าจาก MQTT

8. การออกแบบ Interface

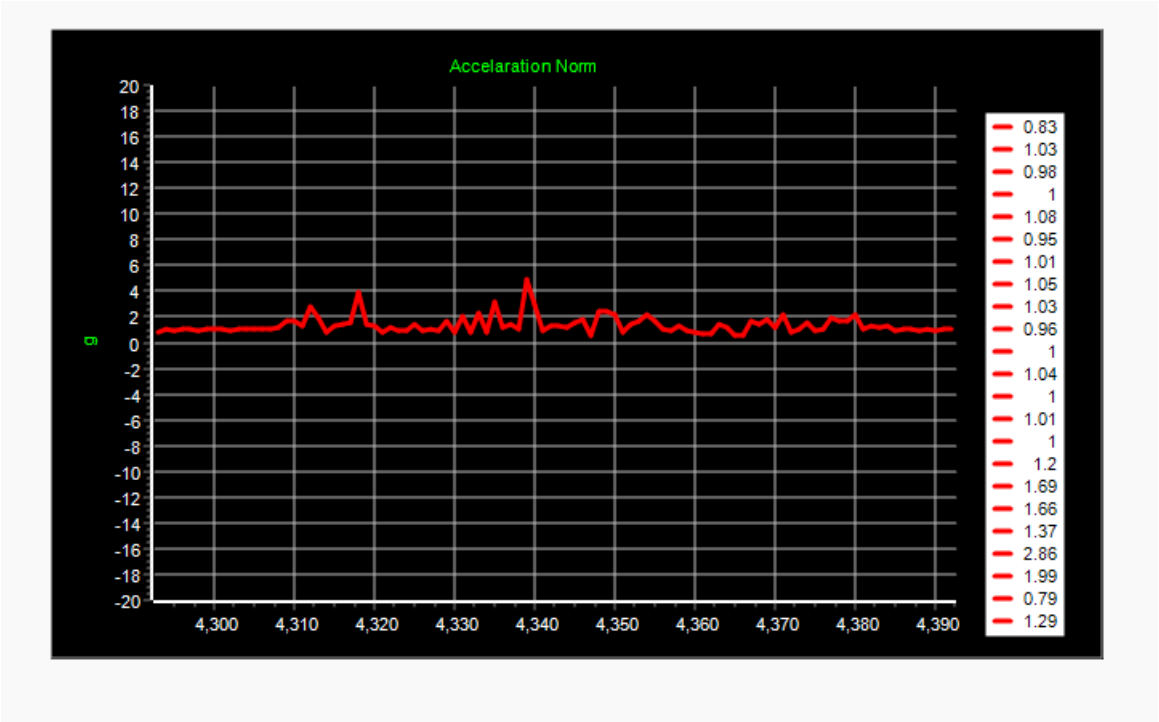
8.1 หน้าหลัก



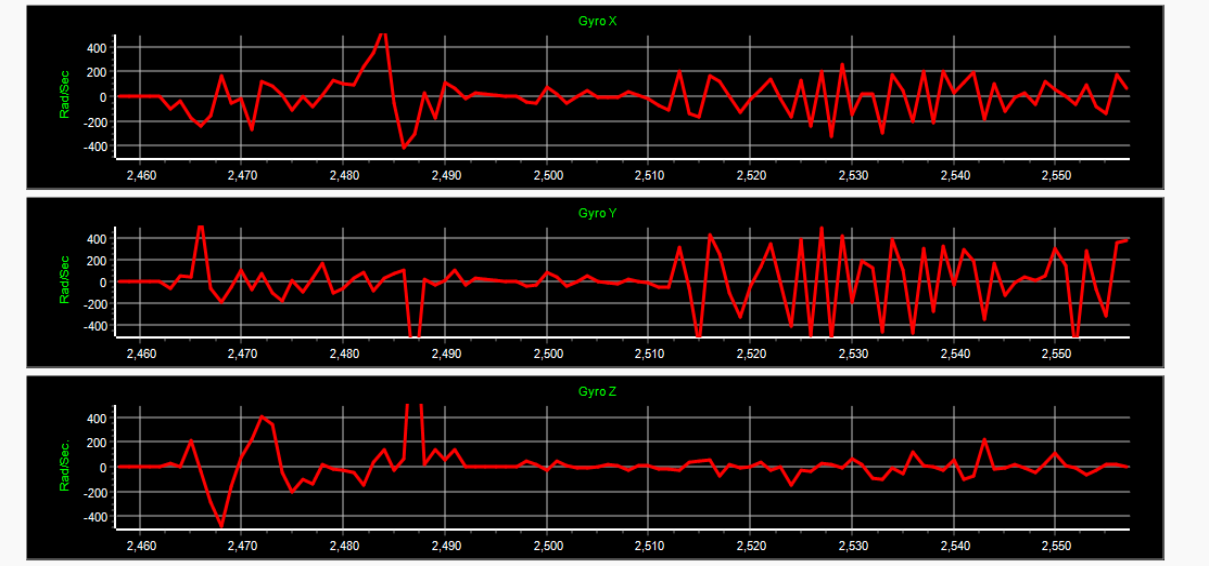
8.2 การพล็อตกราฟ Acceleration X, Y, Z



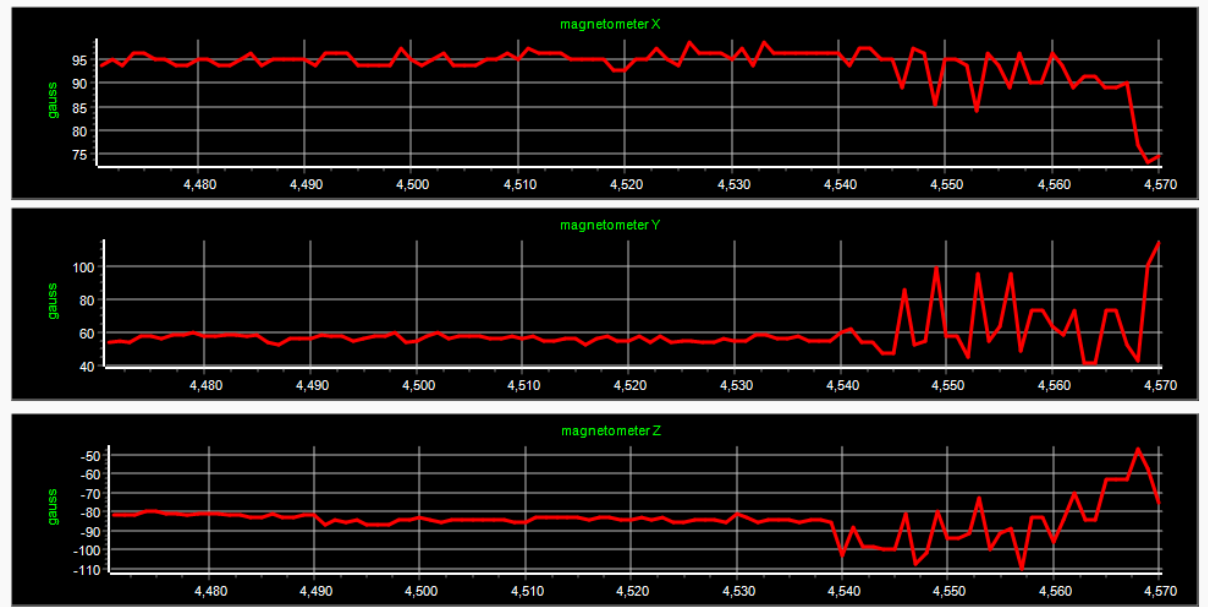
8.3 การพล็อตกราฟ Acceleration Norm



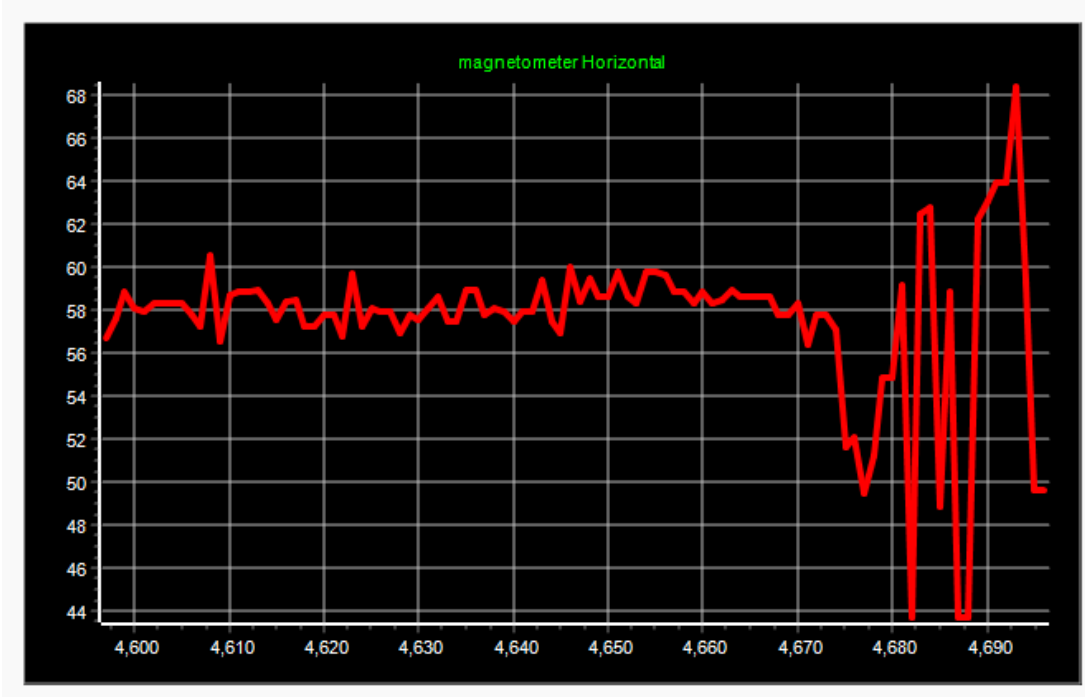
8.4 การพล็อตกราฟ Gyro X,Y,Z



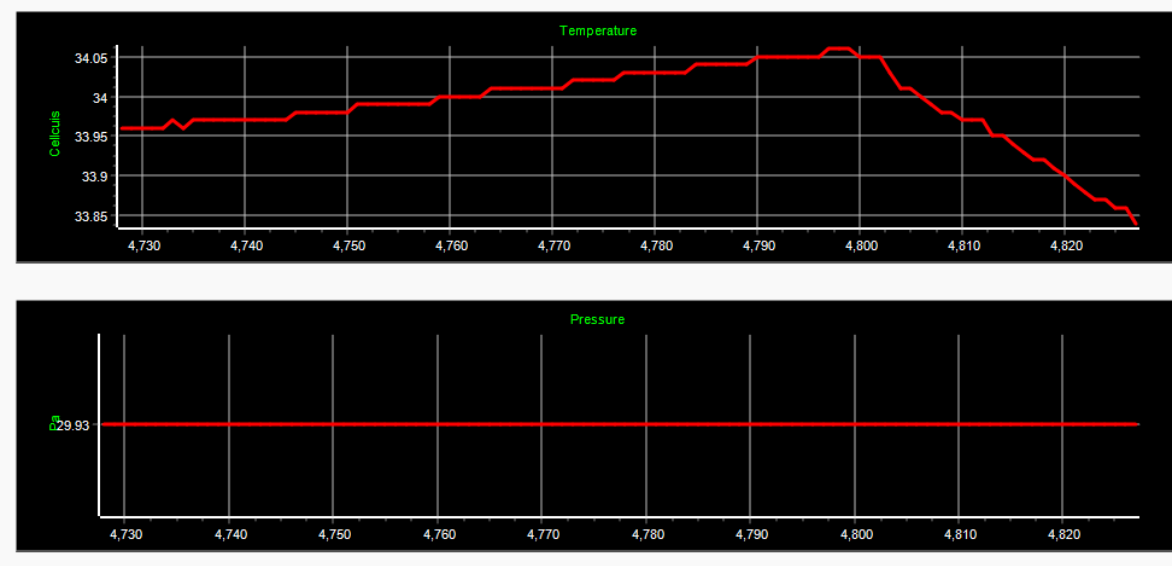
8.5 การพล็อตกราฟ Magnetometer X,Y,Z Axis



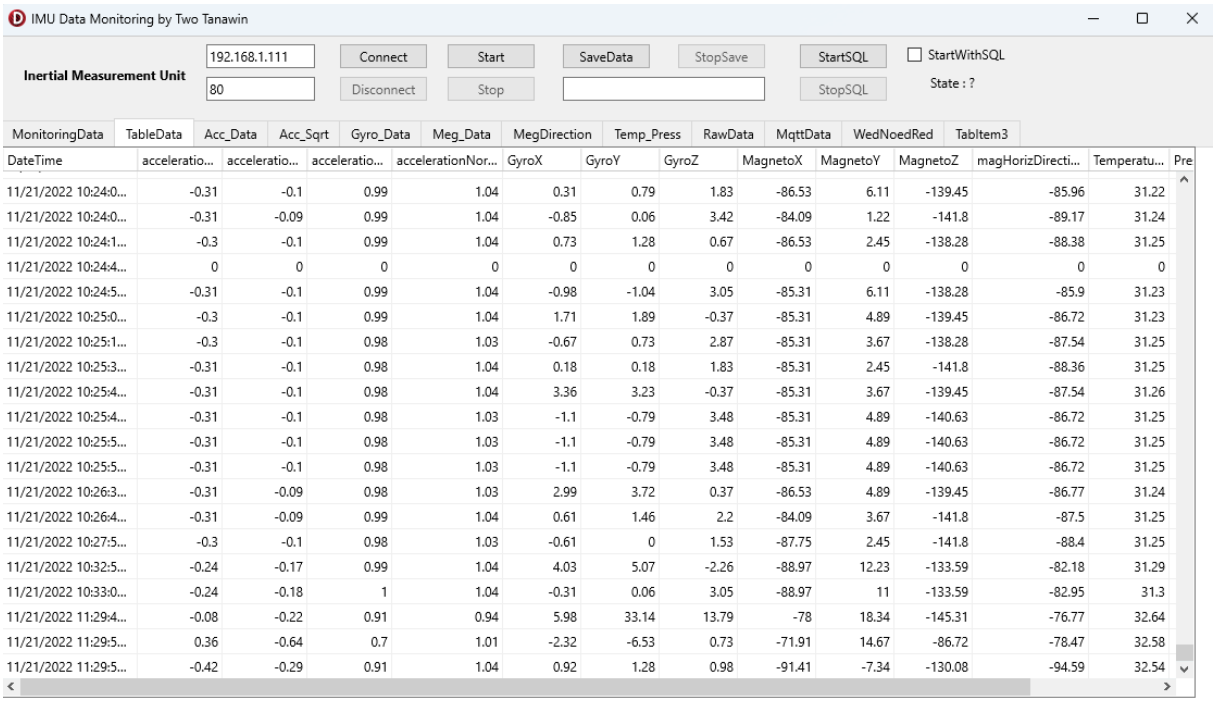
8.6 การพล็อตกราฟ Magnetometer Horizontal



8.7 การพล็อตกราฟ Temperature and pressure

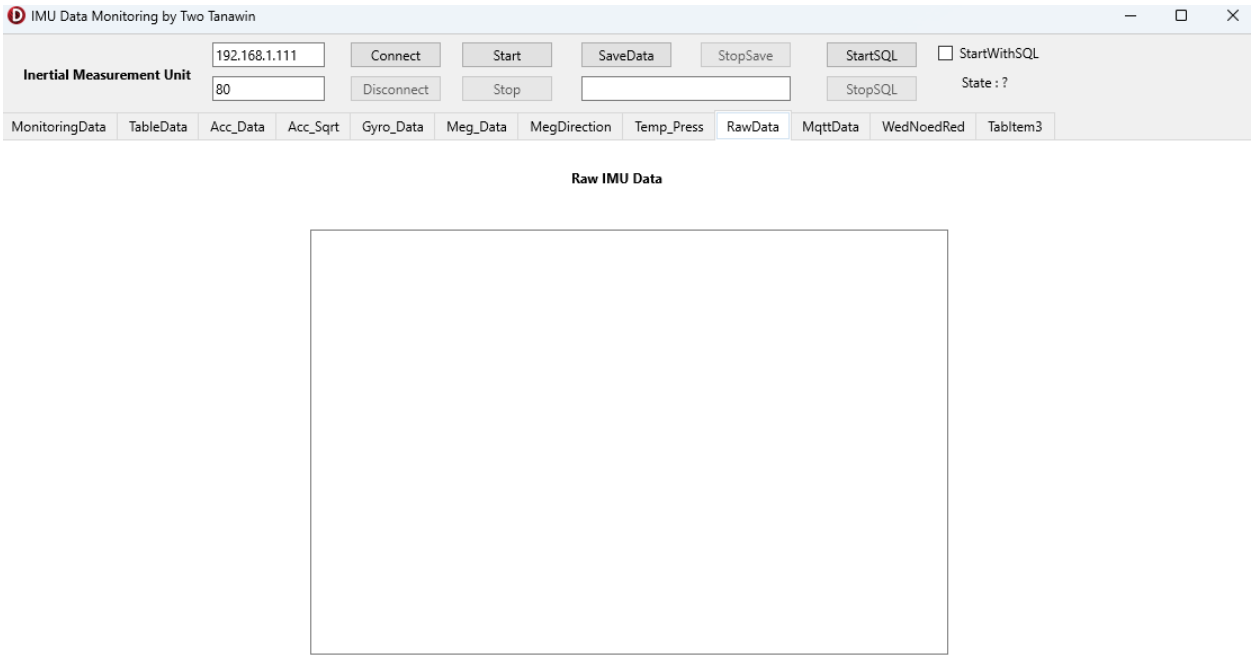


8.8 MySQL

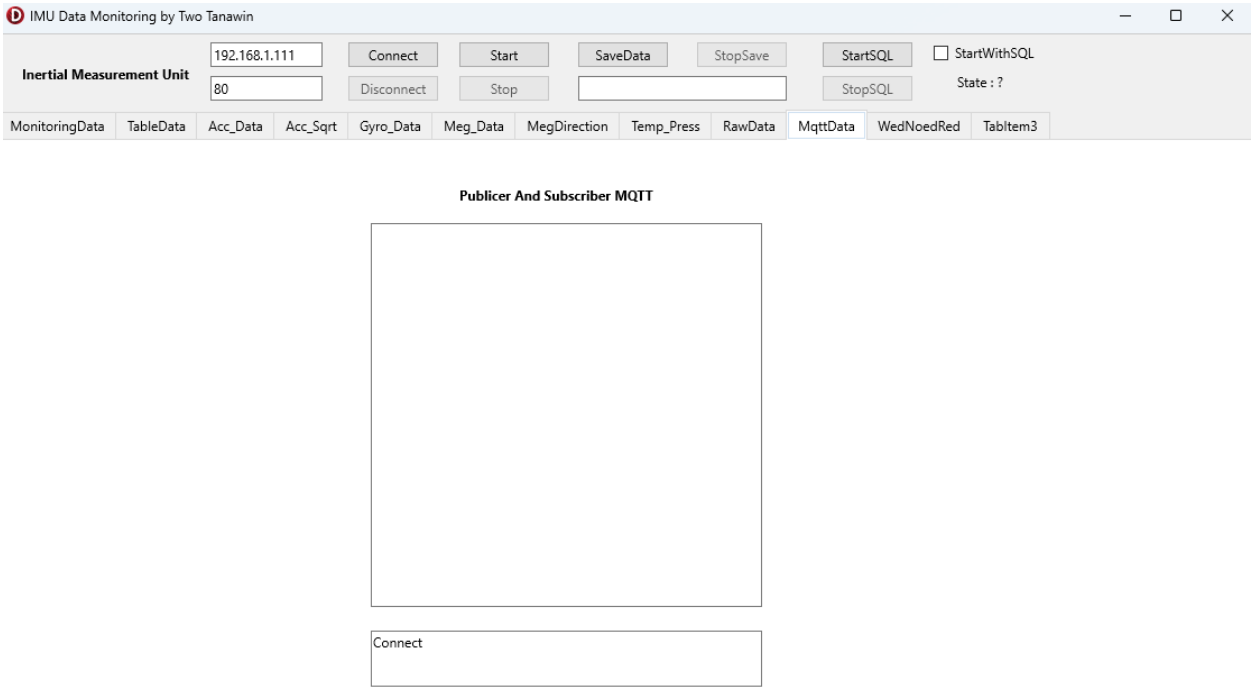


DateTime	acceleratio...	acceleratio...	acceleratio...	accelerationNor...	GyroX	GyroY	GyroZ	MagnetoX	MagnetoY	MagnetoZ	magHorizDirecti...	Temperatu...	Pre
11/21/2022 10:24:0...	-0.31	-0.1	0.99	1.04	0.31	0.79	1.83	-86.53	6.11	-139.45	-85.96	31.22	
11/21/2022 10:24:0...	-0.31	-0.09	0.99	1.04	-0.85	0.06	3.42	-84.09	1.22	-141.8	-89.17	31.24	
11/21/2022 10:24:1...	-0.3	-0.1	0.99	1.04	0.73	1.28	0.67	-86.53	2.45	-138.28	-88.38	31.25	
11/21/2022 10:24:4...	0	0	0	0	0	0	0	0	0	0	0	0	
11/21/2022 10:24:5...	-0.31	-0.1	0.99	1.04	-0.98	-1.04	3.05	-85.31	6.11	-138.28	-85.9	31.23	
11/21/2022 10:25:0...	-0.3	-0.1	0.99	1.04	1.71	1.89	-0.37	-85.31	4.89	-139.45	-86.72	31.23	
11/21/2022 10:25:1...	-0.3	-0.1	0.98	1.03	-0.67	0.73	2.87	-85.31	3.67	-138.28	-87.54	31.25	
11/21/2022 10:25:3...	-0.31	-0.1	0.98	1.04	0.18	0.18	1.83	-85.31	2.45	-141.8	-88.36	31.25	
11/21/2022 10:25:4...	-0.31	-0.1	0.98	1.04	3.36	3.23	-0.37	-85.31	3.67	-139.45	-87.54	31.26	
11/21/2022 10:25:4...	-0.31	-0.1	0.98	1.03	-1.1	-0.79	3.48	-85.31	4.89	-140.63	-86.72	31.25	
11/21/2022 10:25:5...	-0.31	-0.1	0.98	1.03	-1.1	-0.79	3.48	-85.31	4.89	-140.63	-86.72	31.25	
11/21/2022 10:25:5...	-0.31	-0.1	0.98	1.03	-1.1	-0.79	3.48	-85.31	4.89	-140.63	-86.72	31.25	
11/21/2022 10:26:3...	-0.31	-0.09	0.98	1.03	2.99	3.72	0.37	-86.53	4.89	-139.45	-86.77	31.24	
11/21/2022 10:26:4...	-0.31	-0.09	0.99	1.04	0.61	1.46	2.2	-84.09	3.67	-141.8	-87.5	31.25	
11/21/2022 10:27:5...	-0.3	-0.1	0.98	1.03	-0.61	0	1.53	-87.75	2.45	-141.8	-88.4	31.25	
11/21/2022 10:32:5...	-0.24	-0.17	0.99	1.04	4.03	5.07	-2.26	-88.97	12.23	-133.59	-82.18	31.29	
11/21/2022 10:33:0...	-0.24	-0.18	1	1.04	-0.31	0.06	3.05	-88.97	11	-133.59	-82.95	31.3	
11/21/2022 11:29:4...	-0.08	-0.22	0.91	0.94	5.98	33.14	13.79	-78	18.34	-145.31	-76.77	32.64	
11/21/2022 11:29:5...	0.36	-0.64	0.7	1.01	-2.32	-6.53	0.73	-71.91	14.67	-86.72	-78.47	32.58	
11/21/2022 11:29:5...	-0.42	-0.29	0.91	1.04	0.92	1.28	0.98	-91.41	-7.34	-130.08	-94.59	32.54	

8.9 Raw Data



8.10 MQTT



9. โปรแกรม Delphi

```
unit Main;

interface

uses
  System.SysUtils, System.Types, System.UITypes, System.Classes, System.Variants,
  FMX.Types, FMX.Controls, FMX.Forms, FMX.Graphics, FMX.Dialogs, FMX.Edit,
  FMX.Controls.Presentation, FMX.StdCtrls, IdBaseComponent, IdComponent,
  IdTCPConnection, IdTCPClient, FMX.Memo.Types, FMX.ScrollBox, FMX.Memo,
  FMX.TabControl, FMXTee.Engine, FMXTee.Procs, FMXTee.Chart,
  System.Math.Vectors, FMX.Types3D, FMX.Objects3D, FMX.Controls3D,
  FMX.Viewport3D, FMXTee.Series, FireDAC.Phys.FBDef, FireDAC.Stan.Intf,
  FireDAC.Stan.Option, FireDAC.Stan.Error, FireDAC.UI.Intf, FireDAC.Phys.Intf,
  FireDAC.Stan.Def, FireDAC.Stan.Pool, FireDAC.Stan.Async, FireDAC.Phys,
  FireDAC.FMXUI.Wait, FireDAC.Stan.Param, FireDAC.DatS, FireDAC.DApt.Intf,
  FireDAC.DApt, Data.DB, FireDAC.Comp.DataSet, FireDAC.Comp.Client,
  FireDAC.Phys.IBBase, FireDAC.Phys.FB, FireDAC.Phys.MySQL,
  FireDAC.Phys.MySQLDef, System.Rtti, FMX.Grid.Style, FMX.Grid,
  Data.Bind.EngExt, Fmx.Bind.DBEngExt, Fmx.Bind.Grid, System.Bindings.Outputs,
  Fmx.Bind.Editors, Data.Bind.Components, Data.Bind.Grid, Data.Bind.DBScope,
  FMXTee.Control, FMXTee.Grid, FMX.TMSBaseControl, FMX.TMSGridCell,
  FMX.TMSGridOptions, FMX.TMSGridData, FMX.TMSCustomGrid, FMX.TMSGrid,
  FMX.Layouts, FMX.ListBox, TMS.MQTT.Global, TMS.MQTT.Client, Math, IniFiles,
  FMX.WebBrowser, FMX.TMSWebBrowser, FMX.TMSTaskDialog;

const
 GRAPH_MAX_NUM = 200;

 LP_K = 0.3;
 HP_K = 0.01;
 SAMPLING_TIME = 0.01; // 10mS.
 MOVIVE_AVG_LEN = 10;   // 10mS. * 100 = 1000mS.

 ACC_NORM_VAL = 101;

type
TClientRead = class(TThread)
private
protected
 procedure Execute; override;
end;
```

```
type
TModel = class(TThread)
private
protected
 procedure Execute; override;
end;

type
TMyThreadSQL = class(TThread)
private
LastData:String;
procedure DataToSQL(aX,aY,aZ,aN,gR,gP,gY,mgX,mgY,mgZ,mgH,temp,press,Alti:Single);
procedure ShowDataSQL();
protected
 procedure Execute; override;
end;

type
Tmy3d = class(TThread)
  private
  procedure callSig();
  protected
  procedure Execute; override;
end;


type
TMyPlot = class(TThread)
private
protected
procedure Execute; override;
end;


type
TrecData = class(TThread)
  private
  protected
  procedure Execute; override;
end;

type
 TMoveAvg = record
```

```
  Data:Array [1..10] of Single;
 end;

type
 TLowPass = record
  LastLp:Single;
   LastHp:Single;
 end;

 type
 THighPass = record
   LastHp:Single;
   LastDataIn:Single;
 end;

Type
  tAcc = record
    X:Single;
    Y:Single;
    Z:Single;
  end;

type
 TaccData = record
 aX:String;
 aY:String;
 aZ:String;
 rq:String;
end;

type
 TgyroData = record
 gyroX:String;
 gyroY:String;
 gyroZ:String;
end;

type
 TmagData = record
 magX:String;
 magY:String;
 magZ:String;
 magH:String;
end;
```

```
type
 TtempData = record
 TempX:String;
 PressX:String;
end;

type
  Tsignal = record
    accX:Single;
    accY:Single;
    accZ:Single;
    accNorm:Single;
    gyroR:Single;
    gyroP:Single;
    gyroY:Single;
  end;

type
  TsignalLP = record
    accX:Single;
    accY:Single;
    accZ:Single;
    accNorm:Single;
    gyroR:Single;
    gyroP:Single;
    gyroY:Single;
  end;

type
TMydata = record
    accX:Single;
    accY:Single;
    accZ:Single;
    accNorm:Single;
    gyroR:Single;
    gyroP:Single;
    gyroY:Single;
    magX:Single;
    magY:Single;
    magZ:Single;
end;

type
```

```
 TGyro = record
  X:Integer;
  Y:Integer;
  Z:Integer;
  Norm:Single;
 end;

type
 TEmailDetail = record
  User, Pass, FromAddr, ToAddr, Subject, Body, Info, FilePath:String;
end;

type
 TMovingAvgBuffer = record
  Data:array[1..MOVIVE_AVG_LEN] of Integer;
end;

type
 TGyroForce = record
  FX: Single;
  FY: Single;
  FZ: Single;
  Fr:Single;
end;

type
 TCalData = record
  OldData: Single;
  NewData: Single;
end;

type
 TImuAngle = record
  AngX: TCalData;
  AngY: TCalData;
  AngZ: TCalData;
end;

type
  TForm1 = class(TForm)
    IdTCPClient1: TIdTCPClient;
    Z: TPanel;
    Edit1: TEdit;
    Edit2: TEdit;
```

```
Connect: TButton;
Disconnect: TButton;
Edit3: TEdit;
Stop: TButton;
Start: TButton;
TabControl1: TTabControl;
MonitoringData: TTabItem;
TableData: TTabItem;
Acc_Data: TTabItem;
Acc_Sqrt: TTabItem;
Gyro_Data: TTabItem;
Meg_Data: TTabItem;
MegDirection: TTabItem;
Temp_Press: TTabItem;
RawData: TTabItem;
Memo1: TMemo;
Chart1: TChart;
Chart2: TChart;
Chart3: TChart;
Chart4: TChart;
Chart5: TChart;
Chart6: TChart;
AccX: TLineSeries;
GyroX: TLineSeries;
AccY: TLineSeries;
GyroY: TLineSeries;
AccZ: TLineSeries;
GyroZ: TLineSeries;
Viewport3D1: TViewport3D;
Camera1: TCamera;
Light1: TLight;
Model3D1: TModel3D;
FDPhysFBDriverLink1: TFDPhysFBDriverLink;
FDConnection1: TFDConnection;
FDTable1: TFDTable;
DataSource1: TDataSource;
FDTable1DateTime: TDateTimeField;
FDTable1accelerationX: TSingleField;
FDTable1accelerationY: TSingleField;
FDTable1accelerationZ: TSingleField;
FDTable1accelerationNorm: TSingleField;
FDTable1GyroX: TSingleField;
FDTable1GyroY: TSingleField;
FDTable1GyroZ: TSingleField;
```

FDTable1MagnetoX: TSingleField;
FDTable1MagnetoY: TSingleField;
FDTable1MagnetoZ: TSingleField;
FDTable1magHorizDirection: TSingleField;
FDTable1Temperature: TSingleField;
FDTable1Pressure: TSingleField;
FDTable1Altitude: TSingleField;
BindSourceDB1: TBindSourceDB;
BindingsList1: TBindingsList;
StringGrid1: TStringGrid;
LinkGridToDataSourceBindSourceDB12: TLinkGridToDataSource;
Chart7: TChart;
Chart8: TChart;
Chart9: TChart;
AccXD: TLineSeries;
AccYD: TLineSeries;
AccZD: TLineSeries;
Chart10: TChart;
Chart11: TChart;
Chart12: TChart;
Chart13: TChart;
Chart14: TChart;
AccSQRTD: TLineSeries;
GyroXD: TLineSeries;
GyroYD: TLineSeries;
GyroZD: TLineSeries;
Chart15: TChart;
Chart16: TChart;
Chart17: TChart;
Chart18: TChart;
Chart19: TChart;
magX: TLineSeries;
MagY: TLineSeries;
MagZ: TLineSeries;
MagH: TLineSeries;
TempS: TLineSeries;
PressS: TLineSeries;
Timer1: TTimer;
MqttData: TTabItem;
TMSMQTTClient1: TTMSMQTTClient;
SaveData: TButton;
WedNoedRed: TTabItem;
Label1: TLabel;
ListBox1: TListBox;

```
  Memo2: TMemo;
  TabItem3: TTabItem;
  EditWeb: TEdit;
  TMSFMXWebBrowser1: TTMSFMXWebBrowser;
  ReFresh: TButton;
  StopSave: TButton;
  StopSQL: TButton;
  TMSFMXTaskDialog1: TTMSFMXTaskDialog;
  CheckBox1: TCheckBox;
  Button1: TButton;
  StartSQL: TButton;
  SQLStat: TLabel;
  Label2: TLabel;
  Label3: TLabel;
  Label4: TLabel;
  procedure ConnectClick(Sender: TObject);
  procedure DisconnectClick(Sender: TObject);
  procedure FormCreate(Sender: TObject);
  procedure TestClick(Sender: TObject);
  procedure StopClick(Sender: TObject);
  procedure StartClick(Sender: TObject);
  procedure FormClose(Sender: TObject; var Action: TCloseAction);
  procedure Timer1Timer(Sender: TObject);
  procedure TMSMQTTClient1ConnectedStatusChanged(ASender: TObject;
    const AConnected: Boolean; AStatus: TTMSMQTTConnectionStatus);
  procedure TMSMQTTClient1PublishReceived(ASender: TObject; APacketID: Word;
    ATopic: string; APayload: TArray<System.Byte>);
  procedure SaveDataClick(Sender: TObject);
  procedure FormKeyDown(Sender: TObject; var Key: Word; var KeyChar: Char;
    Shift: TShiftState);
  procedure ReFreshClick(Sender: TObject);
  procedure IdTCPClient1Connected(Sender: TObject);
  procedure IdTCPClient1Disconnected(Sender: TObject);
  procedure StopSaveClick(Sender: TObject);
  procedure StartSQLClick(Sender: TObject);
  procedure StopSQLClick(Sender: TObject);
  procedure FormDestroy(Sender: TObject);
  procedure CheckBox1Change(Sender: TObject);
  procedure IdTCPClient1Status(ASender: TObject; const AStatus: TIdStatus;
    const AStatusText: string);
private
  { Private declarations }
  accData:TaccData;
  gyroData:TgyroData;
```

```
magData:TmagData;
MoveAvg:TMoveAvg;
LowPass:TLowPass;
HighPass:THighPass;
tempData:TtempData;
Accel:TAcc;
Signal:Tsignal;
signalLP:TsignalLP;
MyData:TMyData;
MyDataFile:TextFile;
MyDataPath:String;
myEmailDetail:TEmailDetail;
MyCleint:TClientRead;
MyModel:TModel;
ThreadSQL:TMYThreadSQL;
ThreadGrid:TGrid;
ThreadPlot:TMyPlot;
MyImu:array[1..100] of TMydata;
MyRec:TrecData;
My3d:TMy3d;
GyroAng:TImuAngle;
iniFilePath:String;
procedure ReadIniCfg();
procedure WriteIniCfg();
procedure CreateCleint();
procedure PreModel();
procedure PlotAcc();
procedure PlotGyro();
procedure PlotAccD();
procedure PlotGyroD();
procedure PlotNorm();
procedure PlotMag();
procedure PlotMagH();
procedure Teamp_Press();
procedure SumPlot();
procedure PlotLineGraph(Graph: TLineSeries; Data:Real);
procedure SetZero();
procedure startGrid();
procedure DataToSQL(aX,aY,aZ,aN,gR,gP,gY,mgX,mgY,mgZ,mgH,temp,press,Alti:Single);
procedure ShowDataSQl();
procedure ThreadSqlStart();
procedure EndThreadSQL();
procedure Thread3dStart();
procedure EndThread3d();
```

```
    procedure ThreadPlotStart();
    procedure EndThreadPlot();
    procedure AddMessage(AMessage: string; AlignRight: boolean);
    procedure RunMqtt();
    procedure CallMqtt();
    procedure recMyData();
    procedure recDataStart();
    procedure recDataStop();
    function FloatToStr2(Data: Single): String;
    procedure StartClent();
    procedure StopClient();
    procedure ThreadModelStop();

    //-------------Cal Data-----------------------------//
    function LpFilter(k, OldVal, InputVal:Single):Single;
    function HpFilter(k, OldVal, InputVal:Single):Single;
    function CalMovingAvg(DataIn:Integer; var DataBuff:TMovingAvgBuffer):Integer;

    function CallGyroForce(NewData:TGyro):TGyroForce;
    function ChkNoMove(OldVal, NewVal:Integer):Boolean;
    function ChkNoMove2(AccNorm:Single):Boolean;
    procedure AddLog(AMessage: string);
    procedure callini();
    procedure reCheck();
  public
    { Public declarations }
  end;

var
  Form1: TForm1;
  lastData:String;
  ImuData:String;
  Norm:String;
  AccNoMoveCount:Integer;

implementation

const
  ChatChannel = 'sensor1';


{$R *.fmx}

procedure TForm1.Teamp_Press; // Plot Temp
```

```
begin
  PlotLineGraph(TempS,StrToFloat(tempData.TempX));
  PlotLineGraph(PressS,StrToFloat(tempData.PressX));
end;

procedure TForm1.TestClick(Sender: TObject);
begin
recDataStart;
end;


procedure TForm1.Thread3dStart;
begin
 if My3d = nil then
 begin
 My3D := TMy3d.Create(False);
 end;
end;

procedure TForm1.ThreadModelStop;
begin
if MyModel <> nil then
begin
  MyModel.Terminate;
  MyModel.Free;
  MyModel := nil;
end;
end;

procedure TForm1.ThreadPlotStart;
begin
 if ThreadPlot = nil then
 ThreadPlot := TMyPlot.Create(False);
end;


procedure TForm1.ThreadSqlStart;
begin
 if ThreadSQL = nil then
   ThreadSQL := TMyThreadSQL.Create(False);
end;

procedure TForm1.Timer1Timer(Sender: TObject);
var
```

```
 Sl:TStringList;
 Data:String;
 i:Integer;
begin
Application.ProcessMessages;
RunMqtt;
Memo2.Lines.Add(','+accData.aX+','+accData.aY+','+accData.aZ+','+gyroData.gyroX+','+gyroData
.gyroY+','+gyroData.gyroZ);
end;

procedure TForm1.TMSMQTTClient1ConnectedStatusChanged(ASender: TObject;
  const AConnected: Boolean; AStatus: TTMSMQTTConnectionStatus);
begin
  if AConnected then
  begin
    TMSMQTTClient1.Subscribe(ChatChannel);
  end
  else begin
     case AStatus of
       csConnectionRejected_InvalidProtocolVersion,
       csConnectionRejected_InvalidIdentifier,
       csConnectionRejected_ServerUnavailable,
       csConnectionRejected_InvalidCredentials,
       csConnectionRejected_ClientNotAuthorized:; // the connection is rejected by broker
       csConnectionLost:; // the connection with the broker is lost
       csConnecting:; // The client is trying to connect to the broker
       csReconnecting:; // The client is trying to reconnect to the broker
     end;
  end;

end;

procedure TForm1.TMSMQTTClient1PublishReceived(ASender: TObject;
  APacketID: Word; ATopic: string; APayload: TArray<System.Byte>);
var
  msg,orig: string;
  vp: integer;
  alright: boolean;
begin
  msg := TEncoding.UTF8.GetString(APayload);

  vp := pos('!', msg);

  if vp > 0 then
```

```
  begin
    orig := copy(msg,1,vp-1);
    alright := orig <> TMSMQTTClient1.ClientID;

    msg := copy(msg, vp + 1, Length(msg));
    AddMessage(msg, alright);
  end;
end;

procedure TForm1.WriteIniCfg;
var
  vIni:TIniFile;
begin
  vIni:=TIniFile.Create(iniFilePath);
  try
    vIni.WriteBool(CheckBox1.ClassName, 'CheckBox1.Checked', CheckBox1.IsChecked);
  finally
    vIni.Free;
  end;
end;

procedure TForm1.StartSQLClick(Sender: TObject);
begin
if Start.Enabled=True then
begin
 ShowMessage('Please Enable Start');
end
else
begin
ThreadSqlStart;
StartSQL.Enabled:=False;
StopSQL.Enabled:=True;
end;
end;

procedure TForm1.StopClick(Sender: TObject);
begin
StopClient;
EndThreadSQL;
//EndThread3d;
Timer1.Enabled:=False;
Start.Enabled:=True;
Stop.Enabled:=False;
if CheckBox1.IsChecked then
```

```
begin
  EndThreadSQL;
end;
end;

procedure TForm1.StopClient;
begin
if MyCleint <> nil then
begin
   MyCleint.Terminate;
   MyCleint.Free;
   MyCleint:=nil;
end;
end;

procedure TForm1.StopSaveClick(Sender: TObject);
begin
recDataStop;
StopSave.Enabled:=False;
SaveData.Enabled:=True;
end;

procedure TForm1.StopSQLClick(Sender: TObject);
begin
StopSQL.Enabled:=False;
EndThreadSQL;
StartSQL.Enabled:=true;
SQLStat.Text:='SQL is Stop';
end;

procedure TForm1.SumPlot; // All Plot Data
begin
 PlotAccD();
 PlotGyroD();
 PlotNorm();
 PlotMag();
 PlotMagH();
 Teamp_Press();
end;

procedure TForm1.SaveDataClick(Sender: TObject);
var
 Buff:String;
 I,x:integer;
```

```
 S:String;
begin
if Start.Enabled=True then
begin
 ShowMessage('Please Enable Start');
end
else
begin
recDataStart;
SaveData.Enabled:=False;
StopSave.Enabled:=True;
end;
end;

procedure TForm1.SetZero;
begin
ImuData:='0';
accData.aX:='0';
accData.aY:='0';
accData.aZ:='0';
accData.rq:='0';
gyroData.gyroX:='0';
gyroData.gyroY:='0';
gyroData.gyroZ:='0';
magData.magX:='0';
magData.magY:='0';
magData.magZ:='0';
magData.magH:='0';
tempData.TempX:='0';
tempData.PressX:='0';
Norm := '0';
lastData:='0';
MyData.accX:=0;
MyData.accY:=0;
MyData.accZ:=0;
MyData.accNorm:=0;
Mydata.gyroR:=0;
Mydata.gyroP:=0;
Mydata.gyroY:=0;
end;

procedure TForm1.ShowDataSQl;
begin
```

```
DataToSQL(StrToFloat(Form1.accData.aX),StrToFloat(Form1.accData.aY),StrToFloat(Form1.accD
ata.aZ),StrToFloat(Form1.accData.rq),

StrToFloat(Form1.gyroData.gyroX),StrToFloat(Form1.gyroData.gyroY),StrToFloat(Form1.gyroDa
ta.gyroZ),

StrToFloat(Form1.magData.magX),StrToFloat(Form1.magData.magY),StrToFloat(Form1.magDat
a.magZ),StrToFloat(Form1.magData.magH),
 StrToFloat(Form1.tempData.TempX),StrToFloat(Form1.tempData.PressX),StrToFloat(lastData));
end;

procedure TForm1.StartClent;
begin
 if MyCleint = nil then
  MyCleint := TClientRead.create(false);
end;

procedure TForm1.StartClick(Sender: TObject);
begin
if IdTCPClient1.Connected=False then
begin
  ShowMessage('Please Connect The Sever');
end
else
begin
  Start.Enabled:=False;
  Stop.Enabled:=True;
  StartClent;
  //ThreadSqlStart;
  Timer1.Enabled:=True;
  //Thread3dStart;
  if CheckBox1.IsChecked then
  begin
    ThreadSqlStart;
  end
  else
  begin
    EndThreadSql;
  end;
end;
end;

procedure TForm1.startGrid;
```

```
begin

end;

procedure TForm1.AddLog(AMessage: string);
begin
  if Memo1.Lines.Count > 100 then
    begin
      Memo1.Lines.Clear;
      Application.ProcessMessages; //without this, scrollbars will show wrong size/position
    end;
  Memo1.Lines.Add(AMessage);
  Memo1.GoToTextEnd;
end;

procedure TForm1.AddMessage(AMessage: string; AlignRight: boolean);
var
  li: Tlistboxitem;
begin
  li := Tlistboxitem.Create(self);
  li.StyledSettings := li.StyledSettings - [TStyledSetting.Other];
  li.Text := AMessage;
  li.Height := 22;
    li.VertTextAlign := TTextAlign.Trailing;

  if AlignRight then
    li.TextAlign := TTextAlign.Trailing
  else
    li.TextAlign := TTextAlign.Leading;
  listbox1.AddObject(li);
end;

function TForm1.CallGyroForce(NewData: TGyro): TGyroForce;
var
 NewAngle:TImuAngle;
 NewForce:TGyroForce;
begin

 NewAngle.AngX.NewData:=GyroAng.AngX.OldData+
   (NewData.X*SAMPLING_TIME );
 //GyroAng.AngX.OldData:=NewAngle.AngX.NewData;

 NewAngle.AngY.NewData:=GyroAng.AngY.OldData+
   (NewData.Y*SAMPLING_TIME);
```

```
 //GyroAng.AngY.OldData:=NewAngle.AngY.NewData;

 NewAngle.AngZ.NewData:=GyroAng.AngZ.OldData+
   (NewData.Z*SAMPLING_TIME );
 //GyroAng.AngZ.OldData:=NewAngle.AngZ.NewData;

 NewAngle.AngX.NewData:=DegToRad(NewAngle.AngX.NewData);
 NewAngle.AngY.NewData:=DegToRad(NewAngle.AngY.NewData);
 NewAngle.AngZ.NewData:=DegToRad(NewAngle.AngZ.NewData);

 NewForce.FX:=1/
  (Sqrt(1+(Cot(NewAngle.AngX.NewData)*Cot(NewAngle.AngX.NewData))*
   (Sec(NewAngle.AngY.NewData)*Sec(NewAngle.AngY.NewData))));

if NewAngle.AngX.NewData<0 then
NewForce.FX:=(-1)*NewForce.FX;

 NewForce.FY:=1/
  Sqrt(1+(Cot(NewAngle.AngY.NewData)*Cot(NewAngle.AngY.NewData))*
   ((Sec(NewAngle.AngX.NewData)*Sec(NewAngle.AngX.NewData))));

if NewAngle.AngY.NewData<0 then
NewForce.FY:=(-1)*NewForce.FY;

 NewForce.FZ:=Sqrt(1-(NewForce.FX*NewForce.FX)-(NewForce.FY*NewForce.FY));

 Result:=NewForce;
end;


procedure TForm1.callini;
begin
 iniFilePath:=ExtractFilePath(ParamStr(0)) + 'cfg.ini';  // application exe
 if not FileExists(iniFilePath) then
  WriteIniCfg   // Set Object Config as Default
 else
  ReadIniCfg;
end;

procedure TForm1.CallMqtt;
begin
  TMSMQTTClient1.BrokerHostName := 'broker.mqttdashboard.com';
  TMSMQTTClient1.Connect();
  memo2.Lines.Add('Connect');
```

```
end;

function TForm1.CalMovingAvg(DataIn: Integer;
  var DataBuff: TMovingAvgBuffer): Integer;
var
 i, SumIn:Integer;
begin
 SumIn:=0;
 for i := 1 to MOVIVE_AVG_LEN do
  begin
   if i<MOVIVE_AVG_LEN then
    DataBuff.Data[i]:=DataBuff.Data[i+1]    // Shift Data
   else
    DataBuff.Data[i]:=DataIn; // Last Data  = Data input

   SumIn:=SumIn+DataBuff.Data[i];

  end;
 Result:=Round(SumIn/MOVIVE_AVG_LEN);
end;

procedure TForm1.CheckBox1Change(Sender: TObject);
begin
if CheckBox1.IsChecked =true then
begin
StartSQL.Enabled:=False;
StopSQL.Enabled:=False;
end
else
begin
StartSQL.Enabled:=True;
StopSQL.Enabled:=False;
EndThreadSQL;
end
end;

function TForm1.ChkNoMove(OldVal, NewVal: Integer): Boolean;
var
 AbsDiff:Integer;
begin
 AbsDiff:=abs(NewVal-OldVal);
 if AbsDiff<=1 then     // Stationary State threshold
  begin
   AccNoMoveCount:=AccNoMoveCount+1;    // Waiting for long time
```

```
   if 20<AccNoMoveCount then     // wait for 20*Sampling time
    begin
     AccNoMoveCount:=0;
     Result:=True;
    end
   else
     Result:=False;
  end
 else
  begin
   AccNoMoveCount:=0;
   Result:=False;
  end;
end;

function TForm1.ChkNoMove2(AccNorm: Single): Boolean;
var
 AbsNorm:Single;
begin
 AbsNorm:=abs(AccNorm-ACC_NORM_VAL);
 if AbsNorm<3 then     // Stationary State threshold
  begin
   AccNoMoveCount:=AccNoMoveCount+1;    // Waiting for long time
   if 20<AccNoMoveCount then     // wait for 20*Sampling time
    begin
     AccNoMoveCount:=0;
     Result:=True;
    end
   else
     Result:=False;
  end
 else
  begin
   AccNoMoveCount:=0;
   Result:=False;
  end;
end;

procedure TForm1.ConnectClick(Sender: TObject);
begin
try
 IdTCPClient1.Connect;
Except
  ShowMessage('Fail Connection');
```

```
end;
end;

procedure TForm1.CreateCleint;
begin
if MyCleint = nil then
  MyCleint := TClientRead.create(false);
end;


procedure TForm1.DataToSQL(aX, aY, aZ, aN, gR, gP, gY, mgX, mgY, mgZ, mgH, temp,
  press, Alti: Single);
begin
  Form1.FDTable1.Append;      // Insert at last
  Form1.FDTable1DateTime.Value:=Now;
  Form1.FDTable1accelerationX.Value:=aX;
  Form1.FDTable1accelerationY.Value:=aY;
  Form1.FDTable1accelerationZ.Value:=aZ;
  Form1.FDTable1accelerationNorm.Value:=aN;
  //
  Form1.FDTable1GyroX.Value:=gR;
  Form1.FDTable1GyroY.Value:=gP;
  Form1.FDTable1GyroZ.Value:=gY;
  //
  Form1.FDTable1MagnetoX.Value:=mgX;
  Form1.FDTable1MagnetoY.Value:=mgY;
  Form1.FDTable1MagnetoZ.Value:=mgZ;
  Form1.FDTable1magHorizDirection.Value:=mgH;
  //
  Form1.FDTable1Temperature.Value:=temp;
  Form1.FDTable1Pressure.Value:=press;
  //
  Form1.FDTable1Altitude.Value:=Alti;
  Form1.FDTable1.Post;
end;

procedure TForm1.DisconnectClick(Sender: TObject);
begin
  IdTCPClient1.Disconnect;
end;


procedure TForm1.EndThread3d;
begin
```

```
if My3d <> nil then
begin
  My3d.Terminate;
  My3d.Free;
  My3d := nil;
end;
end;

procedure TForm1.EndThreadPlot;
begin
  if ThreadPlot <> nil then
  begin
    ThreadPlot.Terminate;
    ThreadPlot.Free;
    ThreadPlot := nil;
  end;
end;

procedure TForm1.EndThreadSQL;
begin
  if ThreadSQL <> nil then
  begin
   ThreadSQL.Terminate;
   ThreadSQL.Free;
   ThreadSQL:=nil;
   SQLStat.Text:='SQL is Stop';
  end;
end;

function TForm1.FloatToStr2(Data: Single): String;
begin
  Result:= Format('%0.2f', [Data]);
end;

procedure TForm1.FormClose(Sender: TObject; var Action: TCloseAction);
begin
ThreadModelStop;
EndThreadSQL;
EndThreadPlot;
recDataStop;
EndThread3d;
StopClient;
Timer1.Enabled:=False;
Application.Terminate;
```

```
end;

procedure TForm1.FormCreate(Sender: TObject);
var
  I:Integer;
begin
IdTCPClient1.Host := Edit1.Text;
IdTCPClient1.Port := StrToInt(Edit2.Text);
PreModel;
SetZero;
ThreadPlotStart;
callMqtt;
Thread3dStart;
MyDataPath:=ExtractFilePath(Application.Name)+'MyFile.txt';
//WebBrowser1.Navigate(EditWeb.Text);
Disconnect.Enabled:=False;
Stop.Enabled:=False;
StopSQL.Enabled:=False;
StopSave.Enabled:=False;
callini;
reCheck;
end;

procedure TForm1.FormDestroy(Sender: TObject);
begin
WriteIniCfg;
end;

procedure TForm1.FormKeyDown(Sender: TObject; var Key: Word; var KeyChar: Char;
  Shift: TShiftState);
begin
if (Key = 27) and (ssShift in Shift) then
begin
  Application.Terminate;
end;

end;

//---------------------cal HP---------------------------------//
function TForm1.HpFilter(k, OldVal, InputVal: Single): Single;
var
 Ans:Single;
begin
 Ans:=(k*OldVal)+((1-k)*InputVal);
```

```
 Result:=Ans;
end;


procedure TForm1.IdTCPClient1Connected(Sender: TObject);
begin
Connect.Enabled:=False;
Disconnect.Enabled:=True;
end;

procedure TForm1.IdTCPClient1Disconnected(Sender: TObject);
begin
Connect.Enabled:=True;
Disconnect.Enabled:=False;
end;

procedure TForm1.IdTCPClient1Status(ASender: TObject; const AStatus: TIdStatus;
  const AStatusText: string);
begin

end;

//---------------------cal LP---------------------------------//
function TForm1.LpFilter(k, OldVal, InputVal: Single): Single;
var
 Ans:Single;
begin
 Ans:=(k*InputVal)+((1-k)*OldVal);
 Result:=Ans;
end;


procedure TForm1.PlotAcc; //Plot Acc
begin
  PlotLineGraph(AccX, StrToFloat(accData.aX));
  PlotLineGraph(AccY, StrToFloat(accData.aY));
  PlotLineGraph(AccZ, StrToFloat(accData.aZ));
end;

procedure TForm1.PlotAccD; //Plot Acc
begin
  PlotLineGraph(AccXD, StrToFloat(accData.aX));
  PlotLineGraph(AccYD, StrToFloat(accData.aY));
  PlotLineGraph(AccZD, StrToFloat(accData.aZ));
```

```
end;

procedure TForm1.PlotGyro; //Plot Gyro
begin
  PlotLineGraph(GyroX, StrToFloat(gyroData.gyroX));
  PlotLineGraph(GyroY, StrToFloat(gyroData.gyroY));
  PlotLineGraph(GyroZ, StrToFloat(gyroData.gyroZ));
end;

procedure TForm1.PlotGyroD; //Plot Gyro
begin
  PlotLineGraph(GyroXD, StrToFloat(gyroData.gyroX));
  PlotLineGraph(GyroYD, StrToFloat(gyroData.gyroY));
  PlotLineGraph(GyroZD, StrToFloat(gyroData.gyroZ));
end;

procedure TForm1.PlotLineGraph(Graph: TLineSeries; Data: Real);
var
 tmpX:Double;
begin
 with Graph do
  begin
    if XValues.Count<100 then
     begin
      Add(Data);
     end
    else
     begin
      tmpX:=XValues[1]-XValues[0];
      Delete(0);
      AddXY( XValues.Last+tmpX, Data,'',clTeeColor);
     end;
  end;
end;

procedure TForm1.PlotMag; // Plot Mag
begin
 PlotLineGraph(MagX, StrToFloat(magData.magX));
 PlotLineGraph(MagY, StrToFloat(magData.magY));
 PlotLineGraph(MagZ, StrToFloat(magData.magZ));
end;

procedure TForm1.PlotMagH; // Plot MagH
begin
```

```
PlotLineGraph(MagH, StrToFloat(magData.magH));
end;

procedure TForm1.PlotNorm; // Plot AccSQRT
begin
PlotLineGraph(AccSQRTD, StrToFloat(accData.rq));
end;

procedure TForm1.PreModel;
begin
if MyModel = nil then
  MyModel := TModel.Create(False);
end;

procedure TForm1.ReadIniCfg;
var
  vIni:TIniFile;
begin
  vIni:=TIniFile.Create(iniFilePath);
  try
   CheckBox1.IsChecked:=vIni.ReadBool(CheckBox1.ClassName, 'CheckBox1.Checked', False);
  finally
   vIni.Free;
  end;
end;

procedure TForm1.recDataStart;
begin
if MyRec = nil then
  MyRec := TrecData.Create(False);
end;

procedure TForm1.recDataStop;
begin
if MyRec <> nil then
begin
  Myrec.Free;
  Myrec.Terminate;
  Myrec := nil;
end;
end;

procedure TForm1.reCheck;
begin
```

```
if CheckBox1.IsChecked then
begin
  StartSQL.Enabled:=False;
  StopSQL.Enabled:=False;
  ShowMessage('Start With SQL');
end
else
begin
  StartSQL.Enabled:=True;
  StopSQL.Enabled:=False;
end;
end;

procedure TForm1.recMyData;
var
i:Integer;
begin
   for  i := 1 to 100 do
  begin
//  sleep(100);
  MyImu[i].accX:=StrToFloat(accData.aX);
  MyImu[i].accY:=StrToFloat(accData.aY);
  MyImu[i].accZ:=StrToFloat(accData.aZ);
  MyImu[i].accNorm:=StrToFloat(accData.rq);
  MyImu[i].gyroR:=StrToFloat(gyroData.gyroX);
  MyImu[i].gyroP:=StrToFloat(gyroData.gyroY);
  MyImu[i].gyroY:=StrToFloat(gyroData.gyroZ);
  MyImu[i].magX:=StrToFloat(magData.magX);
  MyImu[i].magY:=StrToFloat(magData.magY);
  MyImu[i].magZ:=StrToFloat(magData.magZ);
  end;
end;

procedure TForm1.ReFreshClick(Sender: TObject);
begin
TMSFMXWebBrowser1.Navigate(EditWeb.Text);
end;

procedure TForm1.RunMqtt;
begin
  TMSMQTTClient1.Publish(ChatChannel, TMSMQTTClient1.ClientID+'!'+ memo2.Lines.Text);
  memo2.Lines.Clear;
end;
```

```
{ TClientRead }

procedure TClientRead.Execute;
var
 Sl:TStringList;
 Data:String;
begin
  inherited;
  try
  repeat
  Application.ProcessMessages;
  Form1.IdTCPClient1.Socket.WriteLn('b'+#13#10);
  Form1.Edit3.Text:=Form1.IdTCPClient1.Socket.ReadLn;
  Form1.AddLog(Form1.Edit3.text);
  Sl:=TStringList.Create;
  Sl.CommaText:=Form1.Edit3.Text;  //Extrax string
   if Sl.Count = 14 then
   begin
   Form1.accData.aX:=Sl[0];
   Form1.accData.aY:=Sl[1];
   Form1.accData.aZ:=Sl[2];
   Form1.accData.rq:=Sl[3];
   Form1.gyroData.gyroX:=Sl[4];
   Form1.gyroData.gyroY:=Sl[5];
   Form1.gyroData.gyroZ:=Sl[6];
   Form1.magData.magX:=Sl[7];
   Form1.magData.magY:=Sl[8];
   Form1.magData.magZ:=Sl[9];
   Form1.magData.magH:=Sl[10];
   Form1.tempData.TempX:=Sl[11];
   Form1.tempData.PressX:=Sl[12];
   lastData:=Sl[13];
   end;
 if Assigned(Sl) then
 FreeAndNil(Sl);
 Form1.recMyData;
 until Terminated;
  Except
    ShowMessage('Please Connecte The Sever!');
  end;

end;

{ TModel }
```

```
procedure TModel.Execute;
begin
  inherited;
  repeat
  Application.ProcessMessages;
  Form1.PlotAcc();
  Form1.PlotGyro();
  Sleep(100);
  until Terminated;
end;

{ TMyThreadSQL }

procedure TMyThreadSQL.DataToSQL(aX, aY, aZ, aN, gR, gP, gY, mgX, mgY, mgZ, mgH,
  temp, press, Alti: Single);
begin
  Form1.FDTable1.Append;      // Insert at last
  Form1.FDTable1DateTime.Value:=Now;
  Form1.FDTable1accelerationX.Value:=aX;
  Form1.FDTable1accelerationY.Value:=aY;
  Form1.FDTable1accelerationZ.Value:=aZ;
  Form1.FDTable1accelerationNorm.Value:=aN;
  //
  Form1.FDTable1GyroX.Value:=gR;
  Form1.FDTable1GyroY.Value:=gP;
  Form1.FDTable1GyroZ.Value:=gY;
  //
  Form1.FDTable1MagnetoX.Value:=mgX;
  Form1.FDTable1MagnetoY.Value:=mgY;
  Form1.FDTable1MagnetoZ.Value:=mgZ;
  Form1.FDTable1magHorizDirection.Value:=mgH;
  //
  Form1.FDTable1Temperature.Value:=temp;
  Form1.FDTable1Pressure.Value:=press;
  //
  Form1.FDTable1Altitude.Value:=Alti;
  Form1.FDTable1.Post;
end;

procedure TMyThreadSQL.Execute;
begin
  inherited;
    inherited;
```

```
   Form1.SQLStat.Text:='SQL is Start';
   lastData:='0';
   repeat
   Application.ProcessMessages;
   Synchronize(ShowDataSQL);
   Sleep(5000);
   until Terminated;
end;

procedure TMyThreadSQL.ShowDataSQL;
begin

DataToSQL(StrToFloat(Form1.accData.aX),StrToFloat(Form1.accData.aY),StrToFloat(Form1.accD
ata.aZ),StrToFloat(Form1.accData.rq),

StrToFloat(Form1.gyroData.gyroX),StrToFloat(Form1.gyroData.gyroY),StrToFloat(Form1.gyroDa
ta.gyroZ),

StrToFloat(Form1.magData.magX),StrToFloat(Form1.magData.magY),StrToFloat(Form1.magDat
a.magZ),StrToFloat(Form1.magData.magH),
 StrToFloat(Form1.tempData.TempX),StrToFloat(Form1.tempData.PressX),StrToFloat(lastData));
end;

{ TMyPlot }

procedure TMyPlot.Execute;
begin
  inherited;
  repeat
  Application.ProcessMessages;
  Sleep(100);
  Synchronize(Form1.SumPlot);
  until Terminated;
end;

{ TrecData }

procedure TrecData.Execute;
var
 Buff:String;
 I,x:integer;
begin
  inherited;
  i:=0;
```

```
  AssignFile(Form1.MyDataFile,'RecordIMU\'+FormatDateTime('hh_nn_ss',
Now)+Form1.MyDataPath); {Assigns the Filename}
  ReWrite(Form1.MyDataFile); {Create a new file }
 Buff:='No, Time, AccX, AccY, AccZ, AccNorm, GyroY, GyroZ';
 Writeln(Form1.MyDataFile, Buff);
  repeat
   Application.ProcessMessages;
   Inc(i);
   Sleep(100);
   Form1.MyData.accX:=StrToFloat(Form1.accData.aX);
   Form1.MyData.accY:=StrToFloat(Form1.accData.aY);
   Form1.MyData.accZ:=StrToFloat(Form1.accData.aZ);
   Form1.MyData.accNorm:=StrToFloat(Form1.accData.rq);
   Form1.MyData.gyroR:=StrToFloat(Form1.gyroData.gyroX);
   Form1.MyData.gyroP:=StrToFloat(Form1.gyroData.gyroY);
   Form1.MyData.gyroY:=StrToFloat(Form1.gyroData.gyroZ);
//
Form1.Memo3.Lines.Add(FloatToStr(Form1.MyData.accX)+','+FloatToStr(Form1.MyData.accY)+'
'+FloatToStr(Form1.MyData.accZ));
   Buff := IntToStr(i)+','+FormatDateTime('dd-mm-yyyy hh:nn:ss',
Now)+','+Form1.FloatToStr2(Form1.MyImu[i].accX)+','+Form1.FloatToStr2(Form1.MyImu[i].acc
Y)+','+Form1.FloatToStr2(Form1.MyImu[i].accy)+','+Form1.FloatToStr2(Form1.MyImu[i].accNor
m)

+','+Form1.FloatToStr2(Form1.MyImu[i].gyroR)+','+Form1.FloatToStr2(Form1.MyImu[i].gyroP)+'
,'+Form1.FloatToStr2(Form1.MyImu[i].gyroY);
   Writeln(Form1.MyDataFile, Buff);
  until Terminated;
  Closefile(Form1.MyDataFile); {Closes file }  //save
end;

{ Tmy2d }

procedure Tmy3d.callSig;
var
 Sl:TStringList;
 Data:String;
 i:Integer;
begin
  Application.ProcessMessages;
  Form1.Model3D1.Position.X := StrToFloat(Form1.accData.aX);
  Form1.Model3D1.Position.Y := StrToFloat(Form1.accData.aY);
  Form1.Model3D1.Position.Z := StrToFloat(Form1.accData.aZ);
  Form1.Model3D1.RotationAngle.X := StrToFloat(Form1.gyroData.gyroX);
```

```
  Form1.Model3D1.RotationAngle.Y := StrToFloat(Form1.gyroData.gyroY);
  Form1.Model3D1.RotationAngle.Z := StrToFloat(Form1.gyroData.gyroZ);
end;

procedure Tmy3d.Execute;
begin
  inherited;
  repeat
  Application.ProcessMessages;
  Sleep(100);
  Synchronize(callSig);
  until Terminated;
end;

end.
```

10. โปรแกรม Arduino

```
#include "SPI.h"
#include "Ethernet.h"

/*
  by MohammedDamirchi
  Home
*/
#include <MPU9250_asukiaaa.h>
#include <Adafruit_BMP280.h>
//#include <Wire.h>
//#include <SPI.h>

byte mac[] = {0xDE, 0xAD, 0xBE, 0xEF, 0xFE, 0xED};
EthernetServer server(80);
int v;
float voltage;
```

```
int trigPin = 2;  //Assign D2 as trigPin
int echoPin = 4;  //Assign D4 as echoPin
long duration;
float distance;

Adafruit_BMP280 bme; // I2C
MPU9250_asukiaaa mySensor;
float aX, aY, aZ, aSqrt, gX, gY, gZ, mDirection, mX, mY, mZ;



void setup() {
  //  pinMode(trigPin, OUTPUT);
  //  pinMode(echoPin, INPUT);
  Serial.begin(115200); //Set Serial Communication
  Ethernet.begin(mac);  //
  server.begin();         //Start Arduino as Server role
  Serial.print("Arduino as Server Role IPaddress: ");  Serial.println(Ethernet.localIP());

  //  Serial.begin(115200);
  while (!Serial);

#ifdef _ESP32_HAL_I2C_H_ // For ESP32
  Wire.begin(SDA_PIN, SCL_PIN);
  mySensor.setWire(&Wire);
#else
  Wire.begin();
  mySensor.setWire(&Wire);
#endif

  bme.begin();
```

```
  mySensor.beginAccel();
  mySensor.beginGyro();
  mySensor.beginMag();

  // You can set your own offset for mag values
  // mySensor.magXOffset = -50;
  // mySensor.magYOffset = -55;
  // mySensor.magZOffset = -10;
}

void loop() {
  EthernetClient client = server.available(); //Wait connection from TCP/IP
  if (client) {
    Serial.println("Hi...New Client");
    while (client.connected()) {
      while (client.available()) {
        char data = client.read();
        Serial.println(data);
        switch (data) {
          case 'a':                    // data='a'--> Do nothing
            Serial.print("");
            client.println(""); //Arduino as Server send data to LabVIEW as Client
            break;
          case 'b':      // data='b' Read voltage from A0 and send back to LabVIEW
            if (mySensor.accelUpdate() == 0) {
              aX = mySensor.accelX();
              aY = mySensor.accelY();
              aZ = mySensor.accelZ();
              aSqrt = mySensor.accelSqrt();
              Serial.print(String(aX)); Serial.print(",");
```

```
  Serial.print(String(aY)); Serial.print(",");
  Serial.print(String(aZ)); Serial.print(",");
  Serial.print(String(aSqrt)); Serial.print(",");
  //-----------------------------------------------//
  client.print(String(aX)); client.print(",");
  client.print(String(aY)); client.print(",");
  client.print(String(aZ)); client.print(",");
  client.print(String(aSqrt)); client.print(",");
}

if (mySensor.gyroUpdate() == 0) {
  gX = mySensor.gyroX();
  gY = mySensor.gyroY();
  gZ = mySensor.gyroZ();
  client.print(String(gX)); client.print(",");
  client.print(String(gY)); client.print(",");
  client.print(String(gZ)); client.print(",");
  //-----------------------------------------------//
  Serial.print(String(gX)); Serial.print(",");
  Serial.print(String(gY)); Serial.print(",");
  Serial.print(String(gZ)); Serial.print(",");
}

if (mySensor.magUpdate() == 0) {
  mX = mySensor.magX();
  mY = mySensor.magY();
  mZ = mySensor.magZ();
  mDirection = mySensor.magHorizDirection();
  Serial.print(String(mX)); Serial.print(",");
  Serial.print(String(mY)); Serial.print(",");
```

```
    Serial.print(String(mZ)); Serial.print(",");
    Serial.print(String(mDirection)); Serial.print(",");
    //-------------------------------------------------//
    client.print(String(mX)); client.print(",");
    client.print(String(mY)); client.print(",");
    client.print(String(mZ)); client.print(",");
    client.print(String(mDirection)); client.print(",");
  }

  //  Serial.print("\tTemperature(*C): ");
  Serial.print(bme.readTemperature()); Serial.print(",");
  //-------------------------------------------------//
  client.print(bme.readTemperature()); client.print(",");

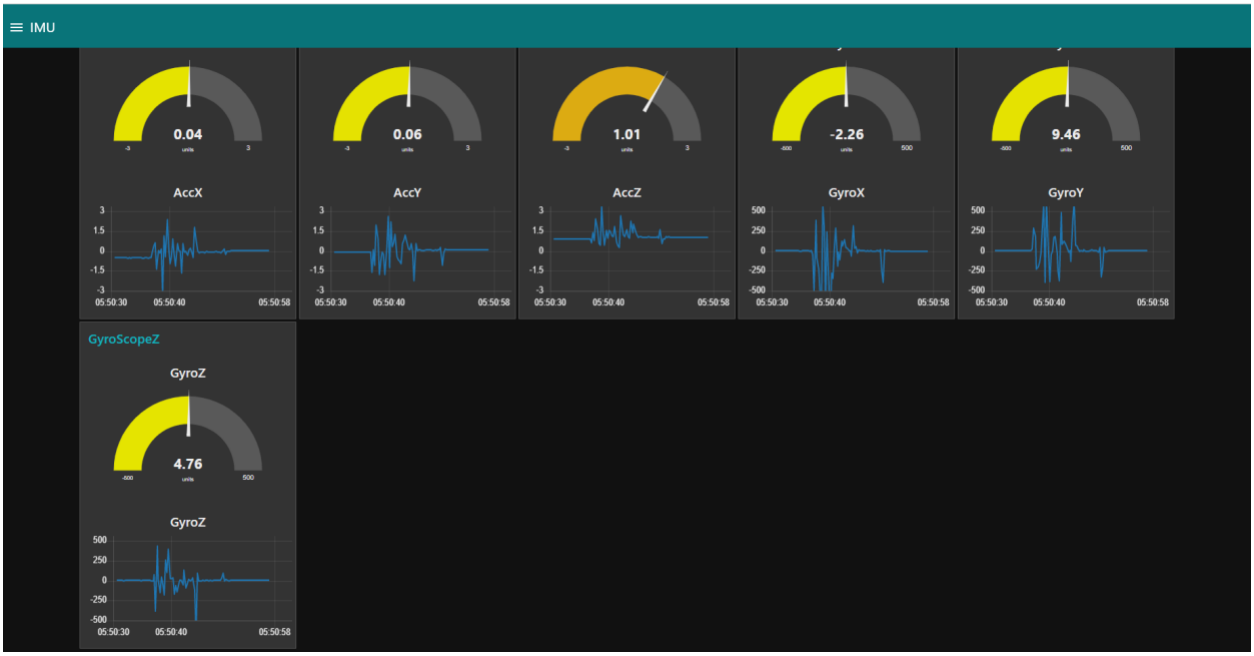
  //  Serial.print("\tPressure(Inches(Hg)): ");
  Serial.print(bme.readPressure() / 3377); Serial.print(",");
  //-------------------------------------------------//
  client.print(bme.readPressure() / 3377); client.print(",");


  //  Serial.print("\tApproxAltitude(m): ");
  Serial.print(bme.readAltitude(1013.25)); // this should be adjusted to your local forcase
  //-----------------------------------------//
  client.print(bme.readAltitude(1013.25)); // this should be adjusted to your local forcase

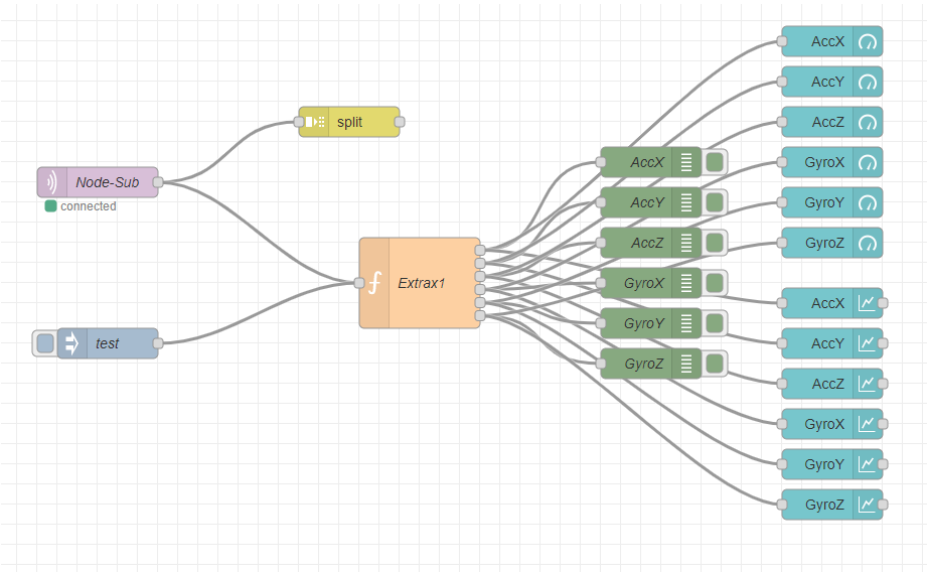
  Serial.println(""); // Add an empty line
  //-----------------------------------------//
  client.println("");
  break;
}
```

```
    }
    }
  }
}
```

12. Dashboard Node-RED



13 Flow Program Node-RED



14. โปรแกรม Node-RED Json


```
[
    {
        "id": "3f59ad1f848847bf",
        "type": "mqtt in",
        "z": "93d7d386ad906e5f",
        "name": "Node-Sub",
        "topic": "sensor1",
        "qos": "0",
        "datatype": "auto-detect",
        "broker": "b6494bf324dc4470",
        "nl": false,
        "rap": true,
        "rh": 0,
        "inputs": 0,
        "x": 240,
        "y": 260,
        "wires": [
            [
                "05253856ddb7d8ac",
                "582e7228efeec111"
            ]
        ]
    },
    {
        "id": "05253856ddb7d8ac",
        "type": "split",
        "z": "93d7d386ad906e5f",
        "name": "",
        "splt": ",",
        "spltType": "str",
        "arraySplt": "1",
        "arraySpltType": "len",
        "stream": false,
        "addname": "topic",
```

```
        "x": 490,
        "y": 200,
        "wires": [
            []
        ]
    },
    {
        "id": "582e7228efeec111",
        "type": "function",
        "z": "93d7d386ad906e5f",
        "name": "Extrax1",
        "func": "var outputMsgs = [];\nvar words = msg.payload.split(\",\");\n// for (var w in words) {\n// outputMsgs.push({ payload: words[w] });\n//  }\nvar text = { payload: words[0] };\nvar accx = { payload: words[1] };\nvar accy = { payload: words[2] };\nvar accz = { payload: words[3] };\nvar gyrox = { payload: words[4] };\nvar gyroy = { payload: words[5] };\nvar gyroz = { payload: words[6] };\n// var out7 = { payload: words[7] };\nreturn [accx, accy, accz, gyrox, gyroy, gyroz];",
        "outputs": 6,
        "noerr": 0,
        "initialize": "",
        "finalize": "",
        "libs": [],
        "x": 560,
        "y": 360,
        "wires": [
            [
                "dc8c1a544e5d054c",
                "11dbd3299518a2dc",
                "db28527f1995ea3d"
            ],
            [
                "701e22f6b6d89691",
                "12947342af2887e5",
                "3b88359673e778be"
            ],
            [
                "4d2a63447a04406b",
                "6a700b94e4945a6c",
```

```
            "8358be5c055d2cd5"
        ],
        [
            "03770943bf5b0886",
            "99442b9bb65d3d21",
            "16a87ab2cafbf5db"
        ],
        [
            "f4582acc9fcdf523",
            "7804686d71a76c1d",
            "0f7a39d3204d89b3"
        ],
        [
            "549c883b57d8e198",
            "ea62f7ded1aaded9",
            "c3ce7391b9cca130"
        ]
    ]
},
{
    "id": "dc8c1a544e5d054c",
    "type": "debug",
    "z": "93d7d386ad906e5f",
    "name": "AccX",
    "active": true,
    "tosidebar": true,
    "console": false,
    "tostatus": false,
    "complete": "payload",
    "targetType": "msg",
    "statusVal": "",
    "statusType": "auto",
    "x": 790,
    "y": 240,
    "wires": []
},
{
```

```
    "id": "701e22f6b6d89691",
    "type": "debug",
    "z": "93d7d386ad906e5f",
    "name": "AccY",
    "active": true,
    "tosidebar": true,
    "console": false,
    "tostatus": false,
    "complete": "payload",
    "targetType": "msg",
    "statusVal": "",
    "statusType": "auto",
    "x": 790,
    "y": 280,
    "wires": []
},
{
    "id": "4d2a63447a04406b",
    "type": "debug",
    "z": "93d7d386ad906e5f",
    "name": "AccZ",
    "active": true,
    "tosidebar": true,
    "console": false,
    "tostatus": false,
    "complete": "payload",
    "targetType": "msg",
    "statusVal": "",
    "statusType": "auto",
    "x": 790,
    "y": 320,
    "wires": []
},
{
    "id": "03770943bf5b0886",
    "type": "debug",
    "z": "93d7d386ad906e5f",
```

```
    "name": "GyroX",
    "active": true,
    "tosidebar": true,
    "console": false,
    "tostatus": false,
    "complete": "payload",
    "targetType": "msg",
    "statusVal": "",
    "statusType": "auto",
    "x": 790,
    "y": 360,
    "wires": []
},
{
    "id": "f4582acc9fcdf523",
    "type": "debug",
    "z": "93d7d386ad906e5f",
    "name": "GyroY",
    "active": true,
    "tosidebar": true,
    "console": false,
    "tostatus": false,
    "complete": "payload",
    "targetType": "msg",
    "statusVal": "",
    "statusType": "auto",
    "x": 790,
    "y": 400,
    "wires": []
},
{
    "id": "549c883b57d8e198",
    "type": "debug",
    "z": "93d7d386ad906e5f",
    "name": "GyroZ",
    "active": true,
    "tosidebar": true,
```

```
    "console": false,
    "tostatus": false,
    "complete": "payload",
    "targetType": "msg",
    "statusVal": "",
    "statusType": "auto",
    "x": 790,
    "y": 440,
    "wires": []
},
{
    "id": "ce85ab19d67a4932",
    "type": "inject",
    "z": "93d7d386ad906e5f",
    "name": "test",
    "props": [
        {
            "p": "payload"
        },
        {
            "p": "topic",
            "vt": "str"
        }
    ],
    "repeat": "",
    "crontab": "",
    "once": false,
    "onceDelay": 0.1,
    "topic": "",
    "payload": "0,1,2,3,4,5,6",
    "payloadType": "str",
    "x": 250,
    "y": 420,
    "wires": [
        [
            "582e7228efeec111"
        ]
```

```
    ]
},
{
    "id": "11dbd3299518a2dc",
    "type": "ui_gauge",
    "z": "93d7d386ad906e5f",
    "name": "",
    "group": "762a9c64e9042f0e",
    "order": 1,
    "width": 0,
    "height": 0,
    "gtype": "gage",
    "title": "AccX",
    "label": "units",
    "format": "{{value}}",
    "min": "-3",
    "max": "3",
    "colors": [
        "#00b500",
        "#e6e600",
        "#ca3838"
    ],
    "seg1": "",
    "seg2": "",
    "className": "",
    "x": 970,
    "y": 120,
    "wires": []
},
{
    "id": "12947342af2887e5",
    "type": "ui_gauge",
    "z": "93d7d386ad906e5f",
    "name": "",
    "group": "d45b44600d92c5d7",
    "order": 2,
    "width": 0,
```

```
    "height": 0,
    "gtype": "gage",
    "title": "AccY",
    "label": "units",
    "format": "{{value}}",
    "min": "-3",
    "max": "3",
    "colors": [
        "#00b500",
        "#e6e600",
        "#ca3838"
    ],
    "seg1": "",
    "seg2": "",
    "className": "",
    "x": 970,
    "y": 160,
    "wires": []
},
{
    "id": "6a700b94e4945a6c",
    "type": "ui_gauge",
    "z": "93d7d386ad906e5f",
    "name": "",
    "group": "18af62378bfc9340",
    "order": 3,
    "width": 0,
    "height": 0,
    "gtype": "gage",
    "title": "AccZ",
    "label": "units",
    "format": "{{value}}",
    "min": "-3",
    "max": "3",
    "colors": [
        "#00b500",
        "#e6e600",
```

```
        "#ca3838"
    ],
    "seg1": "",
    "seg2": "",
    "className": "",
    "x": 970,
    "y": 200,
    "wires": []
},
{
    "id": "99442b9bb65d3d21",
    "type": "ui_gauge",
    "z": "93d7d386ad906e5f",
    "name": "",
    "group": "3f7ab6be951f07ef",
    "order": 4,
    "width": 0,
    "height": 0,
    "gtype": "gage",
    "title": "GyroX",
    "label": "units",
    "format": "{{value}}",
    "min": "-500",
    "max": "500",
    "colors": [
        "#00b500",
        "#e6e600",
        "#ca3838"
    ],
    "seg1": "",
    "seg2": "",
    "className": "",
    "x": 970,
    "y": 240,
    "wires": []
},
{
```

```
    "id": "7804686d71a76c1d",
    "type": "ui_gauge",
    "z": "93d7d386ad906e5f",
    "name": "",
    "group": "67da9534adb32455",
    "order": 5,
    "width": 0,
    "height": 0,
    "gtype": "gage",
    "title": "GyroY",
    "label": "units",
    "format": "{{value}}",
    "min": "-500",
    "max": "500",
    "colors": [
      "#00b500",
      "#e6e600",
      "#ca3838"
    ],
    "seg1": "",
    "seg2": "",
    "className": "",
    "x": 970,
    "y": 280,
    "wires": []
},
{
    "id": "ea62f7ded1aaded9",
    "type": "ui_gauge",
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    "order": 7,
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        "#ff7f0e",
        "#2ca02c",
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        "#d62728",
        "#ff9896",
        "#9467bd",
        "#c5b0d5"
    ],
    "outputs": 1,
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    "className": "",
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    "legend": "false",
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    "ymin": "-3",
    "ymax": "3",
    "removeOlder": 1,
    "removeOlderPoints": "1000",
    "removeOlderUnit": "60",
    "cutout": 0,
    "useOneColor": false,
    "useUTC": true,
    "colors": [
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      "#aec7e8",
      "#ff7f0e",
      "#2ca02c",
      "#98df8a",
      "#d62728",
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      "#9467bd",
      "#c5b0d5"
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    "useDifferentColor": false,
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    "wires": [
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  },
  {
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    "type": "ui_chart",
    "z": "93d7d386ad906e5f",
    "name": "",
    "group": "18af62378bfc9340",
    "order": 9,
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    "nodata": "",
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    "ymin": "-3",
    "ymax": "3",
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    "removeOlderPoints": "1000",
    "removeOlderUnit": "60",
    "cutout": 0,
    "useOneColor": false,
    "useUTC": true,
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      "#aec7e8",
      "#ff7f0e",
      "#2ca02c",
      "#98df8a",
      "#d62728",
      "#ff9896",
      "#9467bd",
      "#c5b0d5"
    ],
    "outputs": 1,
    "useDifferentColor": false,
    "className": "",
    "x": 970,
    "y": 460,
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```

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    "chartType": "line",
    "legend": "false",
    "xformat": "HH:mm:ss",
    "interpolate": "linear",
    "nodata": "",
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    "ymax": "500",
    "removeOlder": 1,
    "removeOlderPoints": "1000",
    "removeOlderUnit": "60",
    "cutout": 0,
    "useOneColor": false,
    "useUTC": true,
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        "#aec7e8",
        "#ff7f0e",
        "#2ca02c",
        "#98df8a",
        "#d62728",
        "#ff9896",
        "#9467bd",
        "#c5b0d5"
    ],
    "outputs": 1,
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```

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    ]
},
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    "chartType": "line",
    "legend": "false",
    "xformat": "HH:mm:ss",
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    "nodata": "",
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    "removeOlder": 1,
    "removeOlderPoints": "1000",
    "removeOlderUnit": "60",
    "cutout": 0,
    "useOneColor": false,
    "useUTC": true,
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        "#ff7f0e",
        "#2ca02c",
        "#98df8a",
```

```
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        "z": "93d7d386ad906e5f",
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        "nodata": "",
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        "ymin": "-500",
        "ymax": "500",
        "removeOlder": 1,
        "removeOlderPoints": "1000",
        "removeOlderUnit": "60",
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```

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        "#2ca02c",
        "#98df8a",
        "#d62728",
        "#ff9896",
        "#9467bd",
        "#c5b0d5"
    ],
    "outputs": 1,
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    "wires": [
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},
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    "birthPayload": "",
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    "disp": true,
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{
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    "type": "ui_group",
    "name": "accelerationY",
    "tab": "4b11d5cd7d4d9975",
    "order": 3,
    "disp": true,
    "width": "6",
    "collapse": false,
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},
{
    "id": "18af62378bfc9340",
    "type": "ui_group",
    "name": "accelerationZ",
```

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    "width": "6",
    "collapse": false,
    "className": ""
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    "type": "ui_group",
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    "tab": "4b11d5cd7d4d9975",
    "order": 5,
    "disp": true,
    "width": "6",
    "collapse": false,
    "className": ""
},
{
    "id": "67da9534adb32455",
    "type": "ui_group",
    "name": "GyroScopeY",
    "tab": "4b11d5cd7d4d9975",
    "order": 6,
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    "width": "6",
    "collapse": false,
    "className": ""
},
{
    "id": "78825f875df1d4cd",
    "type": "ui_group",
    "name": "GyroScopeZ",
    "tab": "4b11d5cd7d4d9975",
    "order": 7,
    "disp": true,
    "width": "6",
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