CENG4480 Embedded System Development and Applications
The Chinese University of Hong Kong
Laboratory 6: IMU (Inertial Measurement Unit)

Student ID:

2018 Fall

1 Introduction

In this exercise you will learn how to use IMU to measure the angle of an object and how to interface and read the IMU data via I2C channel by using Arduino controller board. In this exercise, we use a low cost IMU GY-801 module (see Figure 1) which based on MEMS (Micro Electro-Mechanical System) technology. GY-801 IMU module consists of 3-axis accelerometer ADXL345, 3-axis gyro L3G4200D, 3-axis compass HMC5883L and barometer BMP180. The Lab 4 platform is used to collect measurements from the accelerometers and gyros (see Figure 2).

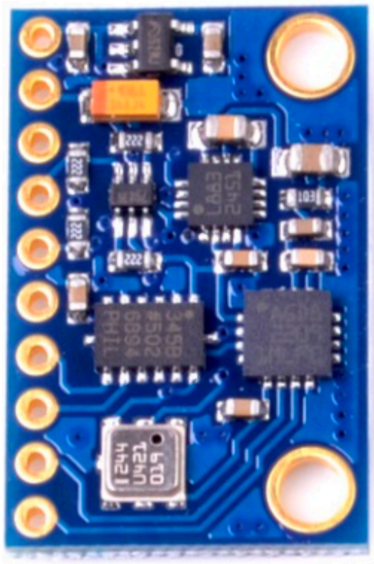


Figure 1: GY-801 IMU module

2 Objectives

By completing this lab session, you should know:

1) To learn how to interface IMU module to Arduino microcontroller via I2C.

2) To learn how to use IMU to measure the angle of an object.

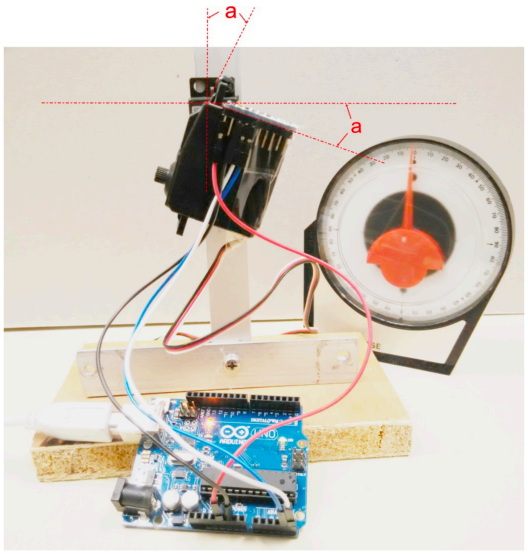


Figure 2: Experiment setup

3) To study the improvement of data stability by using Complement and Kalman filters.

3 Procedures

1) **Connect the IMU module to Arduino board**

Use dupont wires connect the VCC, GND, SDA, SDC of the IMU module to Arduino board as shown on Figure 3. (refer to sample)

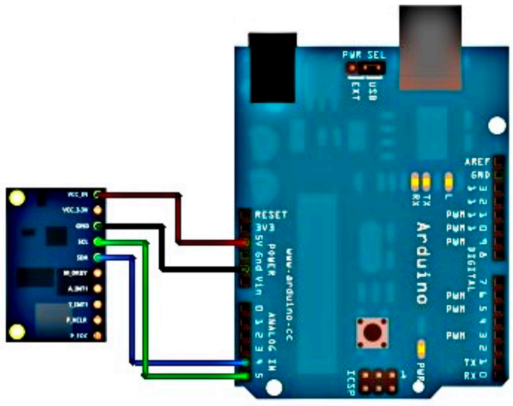


Figure 3: Connection of IMU module

2) **Upload the program Lab6.ino to Arduino board**

- Double click Lab6.ino
- Connect the USB cable from PC to Arduino board
- Observe the COM port number from Device Manager

- On the Arduino IDE **Tools**, **Serial Port** select the correct port number
- On the Arduino IDE **Tools**, **Board select** the **Arduino Uno**
- On the Arduino IDE press the Upload button
- Wait for the uploading program finish
- On the Arduino IDE **Tools**, select **Serial Monitor**, you should see the supposed window shown on Figure 4

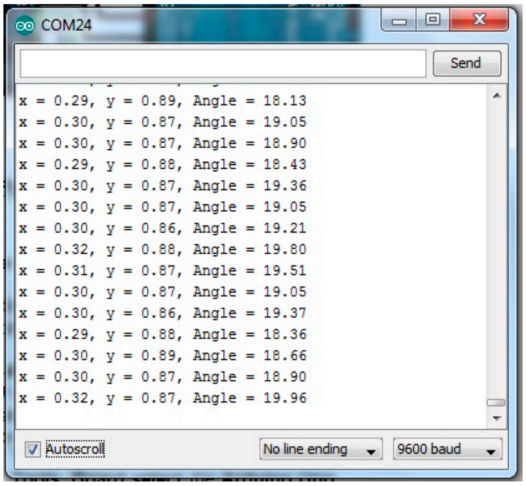
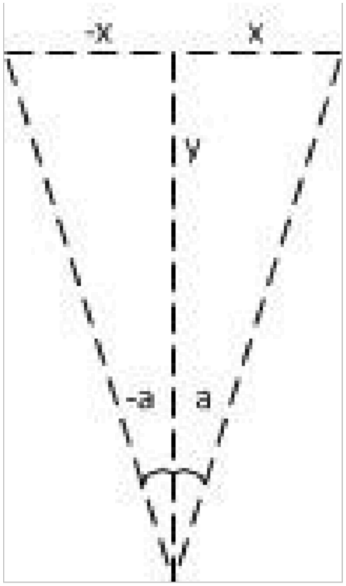


Figure 4: Serial Monitor.

- X is the accelerometer value on x-axis, y is the accelerometer value on y-axis the angle a can be calculated from arctangent of x,y
- In Arduino there is an atan2(y,x) function, the angle value shown in the window is the result of atan2(y,x) function



Platform Angle (Degree)	-50	-40	-30	-20	-10	0	10	20	30	40	50
X											
Y											
Angle=atan2(y,x) (Degree)											

3) **Record and fill the table for the platform in the different angle**

Question 1. Find the approximate offset angle of IMU from your results. (The offset of IMU is different from module to module)

4) **5. Study the improvement of data stability by using Complement and Kalman filters**

Complement and Kalman filters are commonly used in sensor fusion application. Sensor fusion is a set of adaptive algorithms for prediction and filtering. It takes advantage of different and complementary information coming from various sensors, combining it together in a smart way to optimize the performance of the system and enable new amazing applications [1].

For further details in theory of Complement and Kalman filter application in sensor fusion, you can refer to document in reference [1].

Procedures of experiment:

- In Lab5.ino uncomment the following codes: `Serial.print(", ");`
  ```
  Angy = 0.98*(Angy+GyroIN[0]*interval/1000)+0.02*Ayz;//complement filter
  kang = kalmanCalculate(Angy, GyroIN[0],interval); //kalman filter
  kang+=0.65; //adjust the offset
  Serial.print(kang);
  ```
- Upload the program to the Arduino board by pressing the Upload button
- Place the platform in horizontal position
- On the Arduino IDE Tools, select Serial Monitor, you should see the following window
- Wait around one minute to let the data stable
- Uncheck the **Autoscroll** box to stop the display from scrolling
- Copy 30 lines of data by pressing CTRL C on the keyboard
- Open Microsoft Excel and then paste the 30 lines data on the Excel table
- Press **Data**, **Text to Columns** and press **Next**
- Check the **Comma** check box then press **Next** and **Finish**
- Select all data in both A, B columns and press **Insert, Line**
- In your report, explain the effect of applying Complement and Kalman filters on the IMU angle data

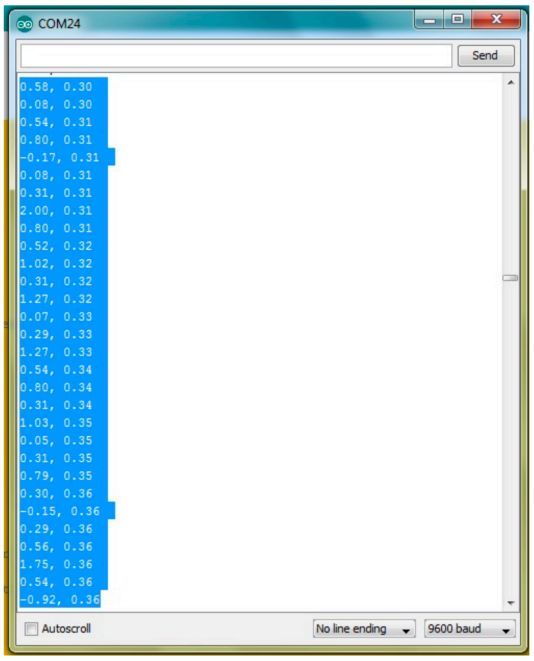
4 Reference

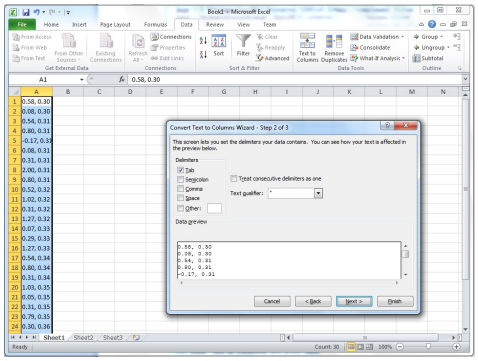
[1] http://www.mouser.hk/newproducts/applications.aspx?virtualdir=sensor_solutions_mems\%2F

[2] http://digitalcommons.calpoly.edu/cgi/viewcontent.cgi?article=1114\&context=aerosp

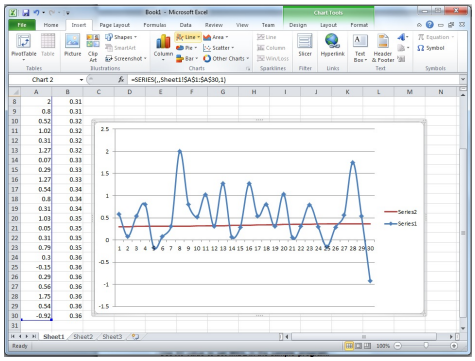
[3] http://www.instructables.com/id/Guide-to-gyro-and-accelerometer-with-Arduino-inclu/

[4] http://ozzmaker.com/2015/01/27/guide-interfacing-gyro-accelerometer-raspberry-pi-kalman-filter/


COM24
Send
0.58, 0.30
0.08, 0.30
0.54, 0.31
0.80, 0.31
-0.17, 0.31
0.08, 0.31
0.31, 0.31
2.00, 0.31
0.80, 0.31
0.52, 0.32
1.02, 0.32
0.31, 0.32
1.27, 0.32
0.07, 0.33
0.29, 0.33
1.27, 0.33
0.54, 0.34
0.80, 0.34
0.31, 0.34
1.03, 0.35
0.05, 0.35
0.31, 0.35
0.79, 0.35
0.30, 0.36
-0.15, 0.36
0.29, 0.36
0.56, 0.36
1.75, 0.36
0.54, 0.36
-0.92, 0.36
Autoscroll
No line ending
9600 baud



(a)



(b)