COMP4336/9336 Lab 5

Sensors 2

Lab Objectives

- Learn how to work with gyroscope of mobile phones.
- Learn how to work with magnetometer of mobile phones.
- Learn how to capture the rotation of mobile phone via gyroscope.
- Learn how to extract heading from magnetometer.
- Learn how to obtain declination angle based on current position and calculate true north heading.

Preparation

- Consider the preparation section of lab 4.
- The below calculation shows how you can compute *magnetic* heading from x and y values of the magnetometer.

```
Direction (x>0) = 270 + [arcTAN(y/x)] *180/ π
Direction (x<0) = 90 + [arcTAN(y/x)] *180/ π
Direction (x=0, y>0) = 0
Direction (x=0, y<0) = 180
```

Note: Here the x and y axis use for "right" and "forward" direction respectively.

Note: You need to multiply with 180/π only if arctan is calculated in *radian* otherwise (if arctan is expressed in *degrees*) you do not need this multiplication. Once you magnetic heading, you can obtain *true* heading by adding *declination angle* to it (see lecture notes).

- You can get the *declination angle* of your location via *GeomagneticField* class. The constructor of this class needs your location as:

```
GeomagneticField geoField;
 geoField = new GeomagneticField(
 Double.valueOf(loc.getLatitude()).floatValue(),
 Double.valueOf(loc.getLongitude()).floatValue(),
 Double.valueOf(loc.getAltitude()).floatValue(),
 System.currentTimeMillis()
 );
```

Where *loc* is your location that can be obtained from the GPS of mobile phone (consider to lab3)

More details:

http://developer.android.com/reference/android/hardware/GeomagneticField.html

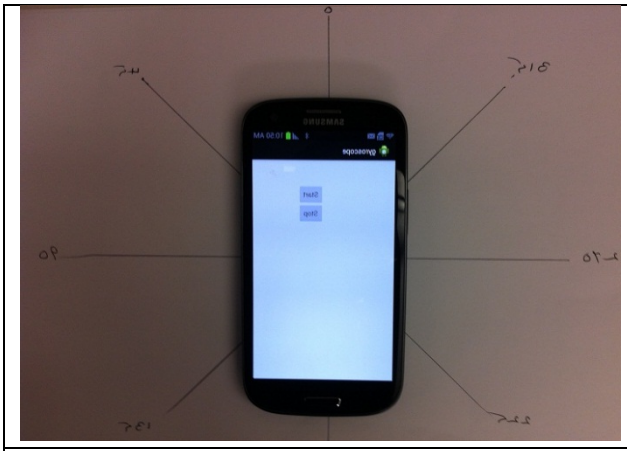
- The gyroscope provides the angular rotation speeds for all three axes. To get the actual orientation those speed values need to be integrated over time. For that you can multiply the angular speeds with the time interval between the last and the current sensor output. This gives a rotation increment. The sum of all rotation increments (integration) results in the absolute orientation of the device.

Note: You can use *event.timestamp* from sensor for integration.

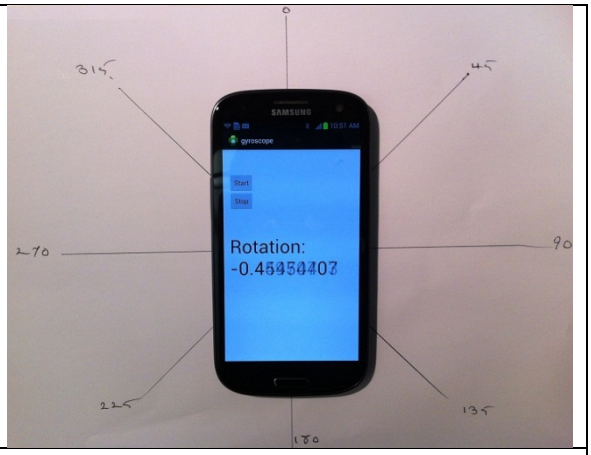
Lab Tasks

Task1: Working with gyroscope 1
Read the gyroscope data continuously.
Develop an Android application which would be able to give you the rate of rotation around the x, y and z axis and display the values on the screen continuously. Try to understand the meaning of these data by moving the mobile phone in different directions.

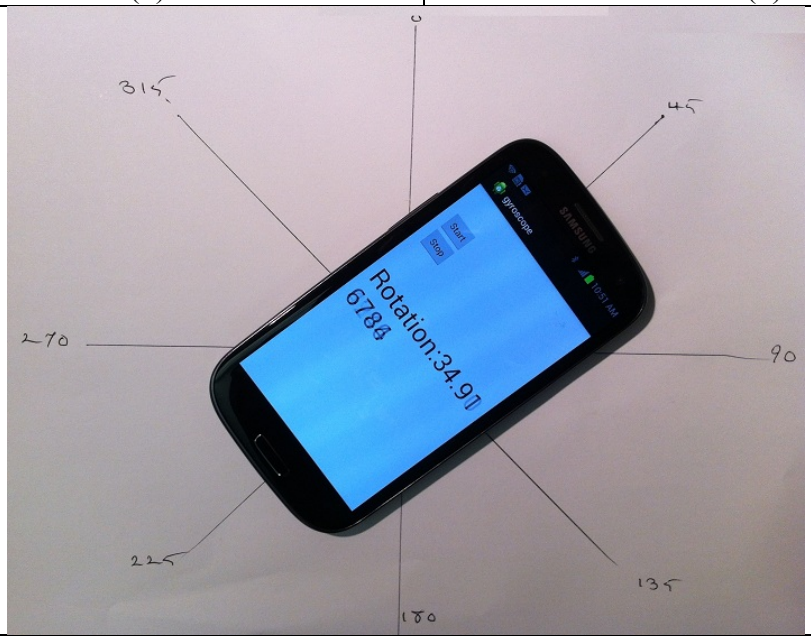
Task2: Working with gyroscope 2
Detect the angle of mobile phone.
Develop an Android application that would be able to display the angle of mobile phone when you rotate it on a flat surface. You have to provide a button to set the offset of current position to 0 at any arbitrary time. A scalar sheet would be given at the lab to compare your measured rotation via gyroscope and real changing in the angle (Figure1).



Task1(1)



Task1 (2)



Task1 (3)

Figure 1

Task3: Working with magnetometer 1
Read the magnetometer data continuously.

Develop an Android application which would be able to give you the geomagnetic field strength along the x, y and z axis and display the values on the screen continuously. Try to understand the meaning of these data.

Task4: Working with magnetometer 2
Compute heading from magnetometer x and y values.

Develop an Android application which would be able to compute heading from magnetometer x and y values while holding the phone horizontal. Resting the phone on the table and pointing to a known direction and observe error compared to ground truth.

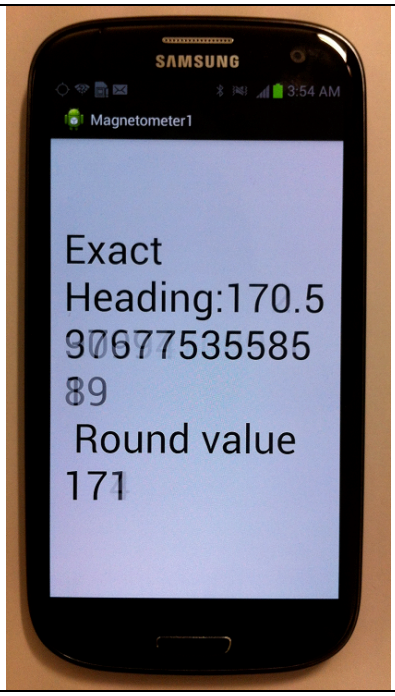


Figure 2

Task5: Working with magnetometer 3
Obtain the true north heading by getting rid of declination angle based on your position.

Extend the previous task in which can get the declination angle of your position and then add/subtract it from your calculated heading to obtain truth north heading. The application has to display the heading before and after subtracting.