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| Android Tutorial – Part 6 |

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| 6-24-2018 |



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# Introduction

This is the part six of the android tutorial series. It is a continuation from last week. In order to follow this successfully, it is required to have,

* A basic understanding given about android in last session.
* The environment set up.
* The project created during last tutorial, opened in Android Studio.
* AVD or an Actual device ready for app deployment.

To catch up, in the last session (Android Tutorial Part 5),

* Navigation Drawer implementation
* Adding dependencies to app’s Gradle build file
* Adding drawer to an activity
* Adding a custom menu resource
* Adding a drawable resource to app
* Changing app themes
* Changing tool bar – adding a toggle button
* FrameLayout in Android
* Fragments in android
* Sensor Framework in Android
* Listing down the sensors available in device
* Using Accelerometer sensor in the app
* Vibrating the device through app

<https://github.com/nadee158/android_tutorial_part_5.git>

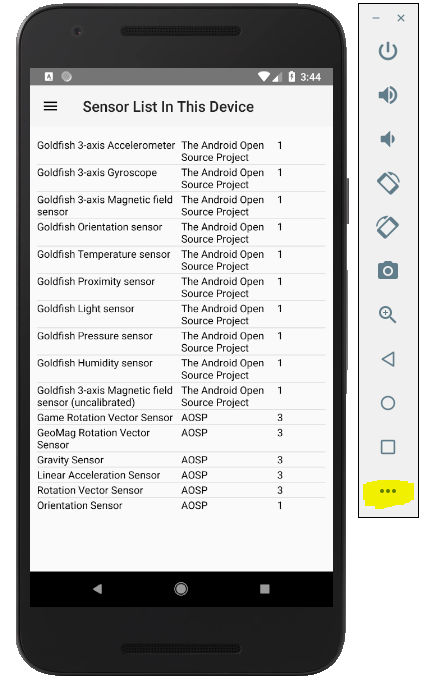
With that knowledge in hand, in this session below areas will be covered,

# Android Emulator to Test Sensors

The Android Emulator provides almost all the capabilities of a real Android device. It provides the facility to simulate incoming phone calls and text messages, specify the location of the device, simulate different network speeds, **simulate rotation and other hardware sensors**, access the Google Play Store, and much more.

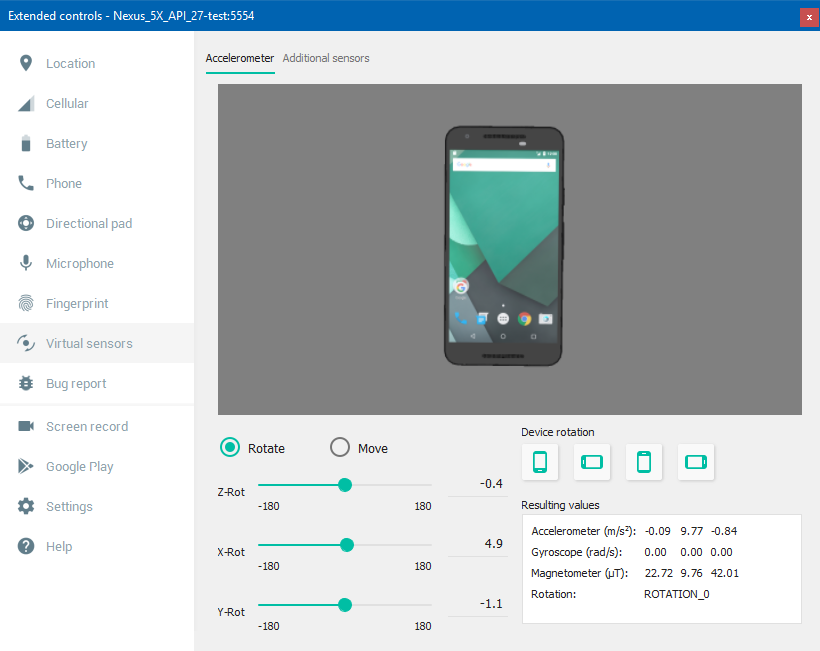
Not all devices contains all the sensors available to android, but the Emulator usually contains many sensors.

After running the app to list the sensors in the emulator, below was the output;



Because the Android emulator is a simulated device, all the available sensors are virtual sensors. "Goldfish" is the name of the emulator's Linux kernel.

In order to access the sensors of the Android Emulator;

1. Click the More button (three horizontal dots) on the emulator's control panel. The Extended Controls window appears, then Click Virtual Sensors  
   

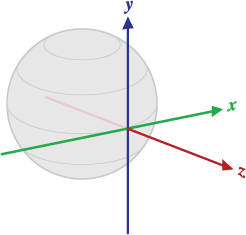
# Android Motion Sensors

In the previous tutorial, we looked in to the sensor framework in Android. Also a demonstration was done on the Accelerometer Sensor. In the next sections, let’s look into other most commonly used sensors and a demonstration of their usage.

The **rotation vector sensor** and the **gravity sensor** are the **most frequently** used sensors for **motion detection and monitoring**.

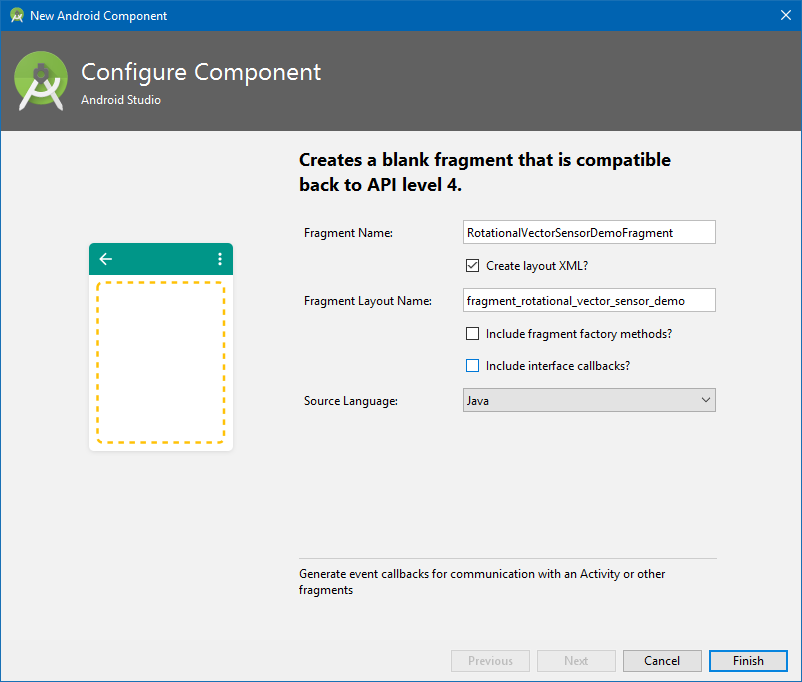
## The Rotational Vector Sensor (Sensor.TYPE\_ROTATION\_VECTOR)

* The **rotational vector sensor** is particularly versatile and can be used for a wide range of motion-related tasks, such as
  + Detecting gestures.
  + Monitoring angular change.
  + Monitoring relative orientation changes.
* The rotational vector sensor is ideal if you are developing
  + a game,
  + an augmented reality application
  + a 2-dimensional or 3-dimensional compass
  + or a camera stabilization app
* In most cases, using this sensor is a **better choice** than using the **accelerometer** and **geomagnetic field sensor** or the **orientation sensor**.
* The rotation vector represents the orientation of the device as a combination of an angle and an axis, in which the device has rotated through an angle θ around an axis (x, y, or z).
* The three elements of the rotation vector are expressed as follows:

* + The magnitude of the rotation vector is equal to.
  + The direction of the rotation vector is equal to the direction of the axis of rotation.
* The three elements of the rotation vector are equal to the last three components of a unit quaternion (cos(θ/2), x\*sin(θ/2), y\*sin(θ/2), z\*sin(θ/2)).
* Elements of the rotation vector are unitless.
* The x, y, and z axes are defined in the same way as the acceleration sensor.
* The reference coordinate system is defined as a direct orthonormal basis as shown below;  
  
* This coordinate system has the following characteristics:
  + X is defined as the vector product Y x Z.
    - It is tangential to the ground at the device's current location and points approximately East.
  + Y is tangential to the ground at the device's current location and points toward the geomagnetic North Pole.
  + Z points toward the sky and is perpendicular to the ground plane
* Below is a demonstration of the usage of **Sensor.TYPE\_ROTATION\_VECTOR**

Using the rotation vector sensor, let’s create a fragment whose background color changes when it's rotated by a specific angle.

* Turn the background yellow every time its rotation along the Z-axis is more than 45°,
* Turn the background white when its rotation is between -10° and 10°,
* Turn the background blue when its rotation is less than -45°

1. Create a new “**Fragment**” to display the data retrieved from the
   1. Right click on “**java/lk.uok.mit.fragment**”, select “**New**”🡪”**Fragment**”🡪”**Fragment (Blank)**”  
      
   2. Fill the details as shown below;  
      
      1. Fragment Name:- **RotationalVectorSensorDemoFragment**
      2. Check create layout XML option
      3. Fragment Layout Name:- **fragment\_rotational\_vector\_sensor\_demo**
      4. **Uncheck both “Include fragment factory methods” and “include interface callback”**
      5. Source Language:-Java
2. Add a **menu item** to the **drawer** to access the new “**RotationalVectorSensorDemoFragment**”
   1. Open the “**drawer\_view.xml**” inside “**res/menu**” folder and add a new menu item with id “**nav\_rotational\_vector\_sensor\_demo**” like below;  
      *<?***xml version="1.0" encoding="utf-8"***?>*<**menu xmlns:android="http://schemas.android.com/apk/res/android"**>  
       <**group android:checkableBehavior="single"**>  
       <**item  
       android:id="@+id/nav\_send\_message"  
       android:title="Send Message"** />  
       <**item  
       android:id="@+id/nav\_hello\_world"  
       android:title="Message List"** />  
       <**item  
       android:id="@+id/nav\_accelerometer\_demo"  
       android:title="Accelerometer Demo"** />  
       <**item  
       android:id="@+id/nav\_rotational\_vector\_sensor\_demo"  
       android:title="Rotational Vector Sensor Demo"** />  
       </**group**>  
      </**menu**>
3. Add an entry to the switch case statement inside “**NavigationItemSelectedListener**” inside “**MainActivity**”
   1. Open “**MainActivity**” inside “**java**” folder

Modify the “**setNavigationItemSelectedListene**r(” method of “**NavigationView**” inside “**onCreate**” method like shown below;  
 *//get a reference to the navigation view* NavigationView navigationView = findViewById(R.id.***nav\_view***);  
 navigationView.setNavigationItemSelectedListener(  
 **new** NavigationView.OnNavigationItemSelectedListener() {  
 @Override  
 **public boolean** onNavigationItemSelected(MenuItem menuItem) {  
 *// set item as selected to persist highlight* menuItem.setChecked(**true**);  
 *// close drawer when item is tapped* **mDrawerLayout**.closeDrawers();  
 *// Add code here to update the UI based on the item selected  
 //to determine which menu item is clicked, add a switch* Intent intent = **null**;  
 FragmentTransaction ft =**null**;  
 **switch** (menuItem.getItemId()) {  
 **case** R.id.***nav\_send\_message***:  
 *//navigate to SendMessageActivity* intent = **new** Intent(**context**, SendMessageActivity.**class**);  
 startActivity(intent);  
 **break**;  
 **case** R.id.***nav\_hello\_world***:  
 *//Navigate to HelloWorldActivity* intent = **new** Intent(**context**, HelloWorldActivity.**class**);  
 startActivity(intent);  
 **break**;  
 **case** R.id.***nav\_accelerometer\_demo***:  
 *//Open the AccelerometerDemoFragment  
 // Begin the transaction* ft = getSupportFragmentManager().beginTransaction();  
 *// Replace the contents of the container with the new fragment* ft.replace(R.id.***fragment\_content***, **new** AccelerometerDemoFragment());  
 *// or ft.add(R.id.content\_frame, new MainFragment());  
 // Complete the changes added above* ft.commit();  
 **break**;  
 **case** R.id.***nav\_rotational\_vector\_sensor\_demo***:  
 *//Open the RotationalVectorSensorDemoFragment  
 // Begin the transaction* ft = getSupportFragmentManager().beginTransaction();  
 *// Replace the contents of the container with the new fragment* ft.replace(R.id.***fragment\_content***, **new** RotationalVectorSensorDemoFragment());  
 *// or ft.add(R.id.content\_frame, new MainFragment());  
 // Complete the changes added above* ft.commit();  
 **break**;  
 }  
 **return true**;  
 }  
 });  
}

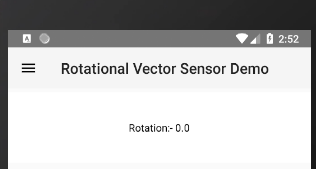
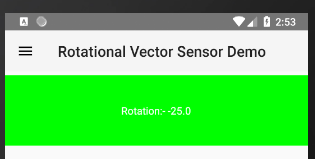
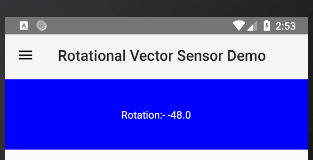
1. Modify the “**fragment\_accelerometer\_demo.xml**” to display the three values that could be retrieved from the Rotational Vector Sensor,
   1. Open the **fragment\_rotational\_vector\_sensor\_demo.xml**  file inside “**res/layout**” folder and add the code below;  
      <**RelativeLayout xmlns:android="http://schemas.android.com/apk/res/android"  
       xmlns:tools="http://schemas.android.com/tools"  
       android:id="@+id/main\_content\_rotation"  
       android:layout\_width="match\_parent"  
       android:layout\_height="match\_parent"  
       tools:context="lk.uok.mit.fragment.RotationalVectorSensorDemoFragment"**>  
        
       <**TextView  
       android:id="@+id/textViewRotation"  
       android:layout\_width="wrap\_content"  
       android:layout\_height="wrap\_content"  
       android:layout\_centerVertical="true"  
       android:layout\_centerHorizontal="true"  
       android:text="Rotation"** />  
        
      </**RelativeLayout**>
      1. Give an id to the main layout and the text view
2. Modify the “**RotationalVectorSensorDemoFragment**” inside java, to acquire the rotation vector sensor and get sensor data from it to determine the rotation of the device along z axis
   1. Modify the “**onCreateView**” method inside “**RotationalVectorSensorDemoFragment**” and add the text to display on title bar as shown below;  
      @Override  
      **public** View onCreateView(LayoutInflater inflater, ViewGroup container,  
       Bundle savedInstanceState) {  
       *//set the text appear in title bar* getActivity().setTitle(**"Rotational Vector Sensor Demo"**);  
       *// Inflate the layout for this fragment* **return** inflater.inflate(R.layout.***fragment\_rotational\_vector\_sensor\_demo***, container, **false**);  
      }
   2. Add below class variables to the class, to refer to the sensor manager, text view and the main relative layout of the layout  
      *//to hold the reference to sensor manager***private** SensorManager **sensorManager**;  
      *//to refer to the main RelativeLayout layout of the fragment***private** View **mainView**;  
      *//to refer to the text view to display measured acceleration in X axis***private** TextView **textViewRotation**;  
      *//to keep the time in milliseconds on which the UI was updated last time***private long lastUpdate**;
   3. Override the “**onViewCreated**” of the RotationalVectorSensorDemoFragment class to initialize the sensor manager and the text view  
      @Override  
      **public void** onViewCreated(@NonNull View view, @Nullable Bundle savedInstanceState) {  
       **super**.onViewCreated(view, savedInstanceState);  
       *//initialize the parent layout* **mainView** = view.findViewById(R.id.***main\_content\_rotation***);  
       *//set green as the background color at startup* **mainView**.setBackgroundColor(Color.***GREEN***);  
        
       *//initialize the sensor manager* **sensorManager** = (SensorManager) getContext().getSystemService(Context.***SENSOR\_SERVICE***);  
        
       *//initialize the the text view to disply the rotation data* **this**.**textViewRotation** = view.findViewById(R.id.***textViewRotation***);  
      }
   4. Implement the “**android.hardware.SensorEventListener**” to “**RotationalVectorSensorDemoFragment**”  
      **public class** AccelerometerDemoFragment **extends** Fragment **implements** SensorEventListener
   5. Override the “**onSensorChanged**” and “**onAccuracyChanged**” methods as shown below  
      @Override  
      **public void** onSensorChanged(SensorEvent event) {  
       *//check if the sensor type is ACCELEROMETER* **if** (event.**sensor**.getType() == Sensor.***TYPE\_ROTATION\_VECTOR***) {  
       *//if yes, write a method to get its data and display* displayRotationVectorSensorData(event);  
       }  
      }  
        
      @Override  
      **public void** onAccuracyChanged(Sensor sensor, **int** accuracy) {  
        
      }
   6. Override the “**onResume**” and “**onPause**” methods of the “**RotationalVectorSensorDemoFragment**” class as shown below; this is to subscribe/unsubscribe as a listener to sensor events and to lock/unlock orientation of the screen  
      *//subscribe to listening to sensor events if the fragment execution resumed/started*@Override  
      **public void** onResume() {  
       **super**.onResume();  
       *//lock to portrait* getActivity().setRequestedOrientation(ActivityInfo.***SCREEN\_ORIENTATION\_PORTRAIT***);  
       *// register this class as a listener for the orientation and  
       // accelerometer sensors* **boolean** isAvaialable=**sensorManager**.registerListener(**this**,  
       **sensorManager**.getDefaultSensor(Sensor.***TYPE\_ROTATION\_VECTOR***),  
       SensorManager.***SENSOR\_DELAY\_NORMAL***);  
       **if**(!(isAvaialable)){  
       Toast.*makeText*(getContext(),  
       **"TYPE ROTATION VECTOR sensor is not available in this device!"**,  
       Toast.***LENGTH\_LONG***).show();  
       }  
      }  
        
        
        
      *//unsubscribe from listening to sensor events if the fragment execution is paused*@Override  
      **public void** onPause() {  
       **super**.onPause();  
       *//unlock orientation* getActivity().setRequestedOrientation(ActivityInfo.***SCREEN\_ORIENTATION\_FULL\_SENSOR***);  
       **sensorManager**.unregisterListener(**this**);  
      }
   7. Write a method to display rotation vector sensor data  
      As it was mentioned earlier too, The rotation vector sensor combines raw data generated by the **gyroscope**, **accelerometer**, and **magnetometer** to create a **quaternion**.   
      Consequently, the values array of its **SensorEvent** object has the following **five elements**:
      1. The **X, Y, Z**, and **W** components of the **quaternion**
      2. **A heading accuracy**

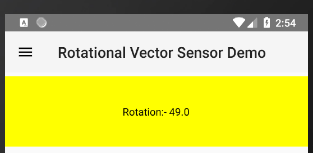
We can convert the **quaternion** into a **rotation matrix**, a 4x4 matrix, by using the **getRotationMatrixFromVector()** method of the **SensorManager** class.

* + 1. Method name:- **displayRotationVectorSensorData**
    2. Return Type:-**void**
    3. Parameters:-**“** **android.hardware.SensorEvent”**
    4. Access modifier**:- private**

**private void** displayRotationVectorSensorData(SensorEvent sensorEvent){  
 *//convert the quaternion into a rotation matrix, a 4x4 matrix,  
 // by using the getRotationMatrixFromVector() method of the SensorManager class* **float**[] rotationMatrix = **new float**[16];  
 SensorManager.*getRotationMatrixFromVector*(rotationMatrix, sensorEvent.**values**);  
  
 *//remap the coordinate system of the rotation matrix. rotate the rotation matrix such that the Z-axis of the new coordinate system  
 // coincides with the Y-axis of the original coordinate system.  
  
 // Remap coordinate system* **float**[] remappedRotationMatrix = **new float**[16];  
 SensorManager.*remapCoordinateSystem*(rotationMatrix,  
 SensorManager.***AXIS\_X***,  
 SensorManager.***AXIS\_Z***,  
 remappedRotationMatrix);  
  
  
 *//convert the rotation matrix into an array of orientations, specifying the rotation of the device along the Z, X, and Y axes.  
 // To do so, use the getOrientation() method of the SensorManager class.  
  
 // Convert to orientations* **float**[] orientations = **new float**[3];  
 SensorManager.*getOrientation*(remappedRotationMatrix, orientations);  
  
 *//By default, the orientations array contains angles in radians instead of degrees.  
 //use the following code to convert all its angles to degrees:* **for**(**int** i = 0; i < orientations.**length**; i++) {  
 orientations[i] = (**float**)(Math.*toDegrees*(orientations[i]));  
 }  
  
  
  
  
  
  
 *//change the background color of the activity based on the third element of the orientations array* **float** rotation=orientations[2];  
 **if**(rotation > 35) {  
 **this**.**textViewRotation**.setTextColor(Color.***BLACK***);  
 **mainView**.setBackgroundColor(Color.***YELLOW***);  
 } **else if**(rotation < -35) {  
 **this**.**textViewRotation**.setTextColor(Color.***WHITE***);  
 **mainView**.setBackgroundColor(Color.***BLUE***);  
 } **else if**((Math.*floor*(rotation) < 3) && (Math.*floor*(rotation)) > -1) {  
 **this**.**textViewRotation**.setTextColor(Color.***BLACK***);  
 **mainView**.setBackgroundColor(Color.***WHITE***);  
 } **else**{  
 **this**.**textViewRotation**.setTextColor(Color.***WHITE***);  
 **mainView**.setBackgroundColor(Color.***GREEN***);  
 }  
  
 *//get the current time n milliseconds* **long** curTime = System.*currentTimeMillis*();  
 **if** ((curTime - **lastUpdate**) > 500) {  
 *//set the last update to current update, as we are upsdaing now* **lastUpdate** = curTime;  
  
 **this**.**textViewRotation**.setPadding(10, 100, 10, 100);  
 **this**.**textViewRotation**.setText(**"Rotation:- "** + Math.*floor*(rotation));  
 }  
}

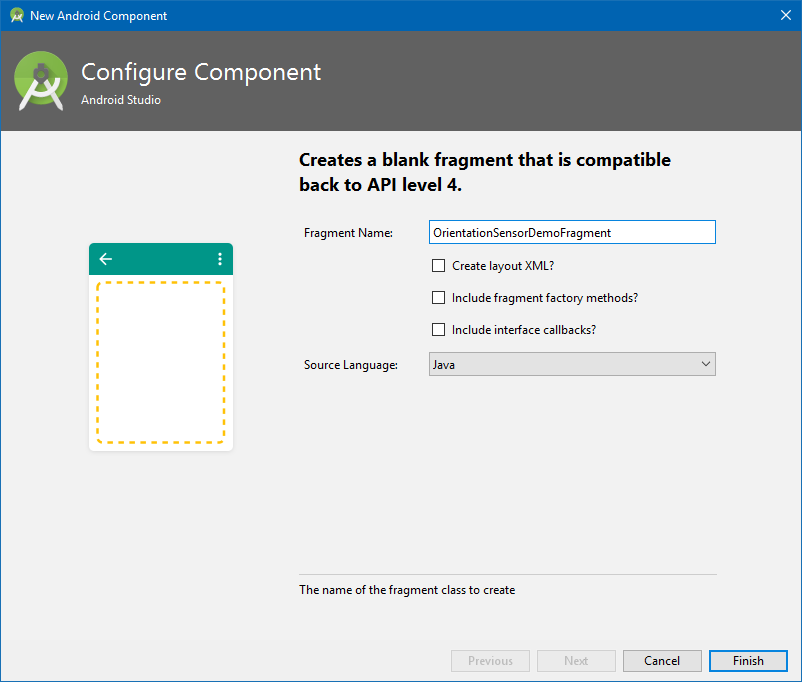
1. Now save everything and run the app and check, the output will look below;



## The Orientation Sensor (Sensor.TYPE\_ORIENTATION)

In order to see a practical usage of the sensors available in android, let’s build a simple compass by getting data from the orientation sensor available in Android.

1. Create a new “**Fragment**” to display the data retrieved from the
   1. Right click on “**java/lk.uok.mit.fragment**”, select “**New**”🡪”**Fragment**”🡪”**Fragment (Blank)**”  
      
2. Fill the details as shown below;  
   
   * 1. Fragment Name:- **OrientationSensorDemoFragment**
     2. Do **NOT** check create layout XML option, we will add custom view
     3. **Uncheck both “Include fragment factory methods” and “include interface callback”**
     4. Source Language:-Java
3. Add a **menu item** to the **drawer** to access the new “**OrientationSensorDemoFragment**”
   1. Open the “**drawer\_view.xml**” inside “**res/menu**” folder and add a new menu item with id “**nav\_orientation\_sensor\_demo**” like below;  
      *<?***xml version="1.0" encoding="utf-8"***?>*<**menu xmlns:android="http://schemas.android.com/apk/res/android"**>  
       <**group android:checkableBehavior="single"**>  
       <**item  
       android:id="@+id/nav\_send\_message"  
       android:title="Send Message"** />  
       <**item  
       android:id="@+id/nav\_hello\_world"  
       android:title="Message List"** />  
       <**item  
       android:id="@+id/nav\_accelerometer\_demo"  
       android:title="Accelerometer Demo"** />  
       <**item  
       android:id="@+id/nav\_rotational\_vector\_sensor\_demo"  
       android:title="Rotational Vector Sensor Demo"** />  
       <**item  
       android:id="@+id/nav\_orientation\_sensor\_demo"  
       android:title="Orientation Sensor Demo"** />  
       </**group**>  
      </**menu**>
4. Add an entry to the switch case statement inside “**NavigationItemSelectedListener**” inside “**MainActivity**”
   1. Open “**MainActivity**” inside “**java**” folder
   2. Modify the “**setNavigationItemSelectedListene**r(” method of “**NavigationView**” inside “**onCreate**” method like shown below;

*//get a reference to the navigation view*NavigationView navigationView = findViewById(R.id.***nav\_view***);  
navigationView.setNavigationItemSelectedListener(  
 **new** NavigationView.OnNavigationItemSelectedListener() {  
 @Override  
 **public boolean** onNavigationItemSelected(MenuItem menuItem) {  
 *// set item as selected to persist highlight* menuItem.setChecked(**true**);  
 *// close drawer when item is tapped* **mDrawerLayout**.closeDrawers();  
 *// Add code here to update the UI based on the item selected  
 //to determine which menu item is clicked, add a switch* Intent intent = **null**;  
 **switch** (menuItem.getItemId()) {  
 **case** R.id.***nav\_send\_message***:  
 *//navigate to SendMessageActivity* intent = **new** Intent(**context**, SendMessageActivity.**class**);  
 startActivity(intent);  
 **break**;  
 **case** R.id.***nav\_hello\_world***:  
 *//Navigate to HelloWorldActivity* intent = **new** Intent(**context**, HelloWorldActivity.**class**);  
 startActivity(intent);  
 **break**;  
 **case** R.id.***nav\_accelerometer\_demo***:  
 *//Open the AccelerometerDemoFragment  
 // Begin the transaction* FragmentTransaction ft = getSupportFragmentManager().beginTransaction();  
 *// Replace the contents of the container with the new fragment* ft.replace(R.id.***fragment\_content***, **new** AccelerometerDemoFragment());  
 *// or ft.add(R.id.content\_frame, new MainFragment());  
 // Complete the changes added above* ft.commit();  
 **break**;  
 **case** R.id.***nav\_rotational\_vector\_sensor\_demo***:  
 *//Open the RotationalVectorSensorDemoFragment  
 // Begin the transaction* ft = getSupportFragmentManager().beginTransaction();  
 *// Replace the contents of the container with the new fragment* ft.replace(R.id.***fragment\_content***, **new** RotationalVectorSensorDemoFragment());  
 *// or ft.add(R.id.content\_frame, new MainFragment());  
 // Complete the changes added above* ft.commit();  
 **break**;  
 **case** R.id.***nav\_orientation\_sensor\_demo***:  
 *//Open the OrientationSensorDemoFragment  
 // Begin the transaction* ft = getSupportFragmentManager().beginTransaction();  
 *// Replace the contents of the container with the new fragment* ft.replace(R.id.***fragment\_content***, **new** OrientationSensorDemoFragment());  
 *// or ft.add(R.id.content\_frame, new MainFragment());  
 // Complete the changes added above* ft.commit();  
 **break**;  
 }  
 **return true**;  
 }  
 });

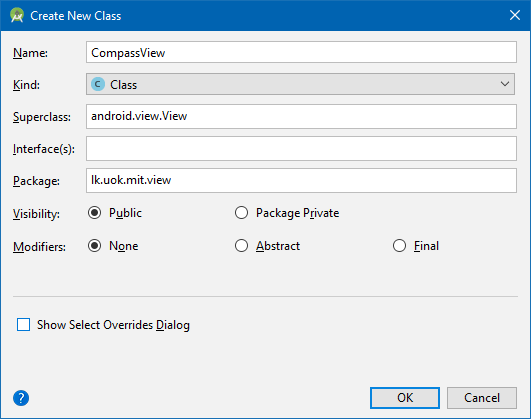
1. Using the Orientation sensor in Android, it is possible to get the angle between the magnetic north directions. E.g.:- 0=North, 90=East, 180=South, 270=West. Now we should create a custom view to get that direction data and draw the compass view.

## Create a Custom View in Android

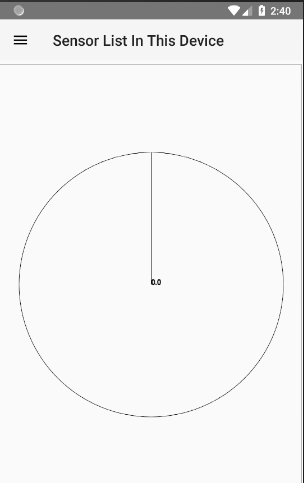
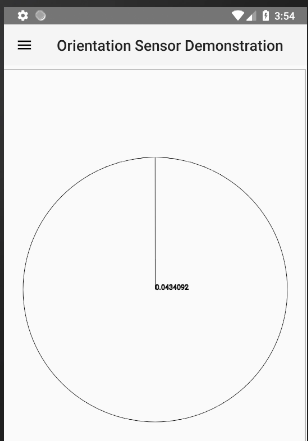
To recall from previous tutorials,

* The Android framework provides several default views.
* The base class of a view is the **View**.
* Views are responsible for **measuring**, **layouting** and **drawing themselves** and their **child elements** (in case of a **ViewGroup**).
* Views are also responsible for **saving their UI state** and **handling touch events**.
* Developers can also create custom views and use them in their application.
* It is possible to create custom views by:
  + Compound views - combining views with a default wiring
  + Custom views - creating our own views
    - by extending an **existing view**, e.g. Button, TextView
    - by extending the **View** class
* By extending the View class or one of its subclasses we can create our own custom view.
* For drawing view use the **onDraw()** method.
  + In this method you receive a **Canvas object** which allows you to perform drawing operations on it,
    - e.g. draw lines, circle, text or bitmaps.
  + If the view should be re-drawn you call the **invalidate()** method which triggers a call to the **onDraw()** method of this view.
* To draw Views typically the 2D Canvas API is used
* The layout manager calls the **onMeasure()** method of the view.
  + The view receives the layout parameter from the layout manager. A layout manager is responsible to determine the size of all its children.
* The view must call the **setMeasuredDimenstion(int, int)** method with the result

In order to create the compass, we will be creating our own view by extending the View class.

* 1. Right click on “java” folder and select “New”-->”Java Class”
  2. Fill the details as shown below;  
     
     1. Name:- **CompassView**
     2. Kind:- **Class**
     3. Superclass:- **android.view.View**
     4. Package:- **lk.uok.mit.view**
     5. Visibility:- **Public**
     6. Modifiers:- **None**
  3. To fix the compile errors shown, follow the steps shown below;
     1. Create a constructor to call the super class’s constructor;  
        ***public CompassView(Context context) {  
         super(context);  
        }***
     2. Override the **onDraw** method to define the information to be displayed on the view  
        ***@Override  
        protected void onDraw(Canvas canvas) {  
         super.onDraw(canvas);  
        }***
     3. In order to draw on the canvas provided inside the **onDraw** method, a “**android.graphics.Paint**” object is required (consider this as a pencil to draw on the canvas)  
        Declare a class variable to hold a reference to a pain object; and a variable to hold the position of the paint  
        ***//a class variable to refer to android.graphics.Paint object  
        private Paint paint;  
        //a class variable to store the position of the paint  
        private float position = 0;***
     4. Initialize the paint object on view creation – upon calling the constructor of the view  
        Write a method to initialize the pencil as shown below;
        1. Method Name:- **initializePaint()**
        2. Return Type:- **void**
        3. Access Modifier:- **private**
        4. **Logic:-**  
           ***private void initializePaint() {  
            //initialize a paint object  
            this.paint = new Paint();  
            //set the attributes of the paint object  
            this.paint.setAntiAlias(true);  
            this.paint.setStrokeWidth(2);  
            this.paint.setTextSize(25);  
            this.paint.setStyle(Paint.Style.STROKE);  
            this.paint.setColor(Color.BLACK);  
           }***
        5. Call this method inside the constructor:-  
           ***public CompassView(Context context) {  
            super(context);  
            this.initializePaint();  
           }***
     5. Write a method to allow to update the position of the paint;
        1. Method Name:- **initializePaint()**
        2. Return Type:- **void**
        3. Access Modifier:- **private**
        4. **Logic:-  
           *public void updatePaintPosition(float position) {  
            //set the passed position to the position of paint  
            this.position = position;  
           //call invalidate to force to redraw the view based on new position  
           //this allows the wiew to get update based on new position  
            invalidate();  
           }***
        5. Modify the **onDraw()** method inside “**CompassView**” to draw the compass view base on the position (the angle) as shown below;

*//override the onDraw method to define the information to be displayed on the view*@Override  
**protected void** onDraw(Canvas canvas) {  
 **super**.onDraw(canvas);  
 *//get the pont along X axis as half from the raw measured width of this view* **int** xPoint = getMeasuredWidth() / 2;  
 *//get the pont along Y axis as half from the raw measured height of this view* **int** yPoint = getMeasuredHeight() / 2;  
  
 *//get the max value of wither X or Y points we got above* **float** maxLengthOfCanvas = Math.*max*(xPoint, yPoint);  
 *//calculate radius based on maxLengthOfCanvas, make it 0.6 from the max length* **float** radius = (**float**) (maxLengthOfCanvas \* 0.6);  
  
 *//draw a circle on canvas based on the radius we calulated  
 // by taking X and Y points(the canter of canvas) as the center of circle  
 //The circle will be filled or framed based on the Style in the paint* canvas.drawCircle(xPoint, yPoint, radius, **paint**);  
  
 *//The rectangle will be filled or framed based on the Style in the paint  
 //draw a rectangle within 5 points the view* canvas.drawRect(0, 0, (getMeasuredWidth() - 5), (getMeasuredHeight() - 5), **paint**);  
  
 *//To display the indicator of the compass,  
 // we need to create a line inside circle from center to its radius  
 //the starting point of the radius will be the center of the circle  
 //the end point on the perimeter of the circle has to be calculated  
  
 // 3.143 is a good approximation for the circle* **float** PI\_CONSTANT = 3.143f;  
  
 *//calculate the end point along X axis based on the rotation degree* **float** xPointEnd = (**float**) (xPoint + radius \* Math.*sin*((-**position**) / 180 \* PI\_CONSTANT));  
  
 *//calculate the end point along Y axis based on the rotation degree* **float** yPointEnd = (**float**) (yPoint - radius \* Math.*cos*((-**position**) / 180 \* PI\_CONSTANT));  
  
 *//The drawLine method draws a line segment with the specified start and stop x,y coordinates,  
 // using the specified paint.  
 // @param xPoint The x-coordinate of the start point of the line  
 // @param yPoint The y-coordinate of the start point of the line  
 // @param xPointEnd The x-coordinate of the end point of the line  
 // @param yPointEnd The y-coordinate of the end point of the line  
 // @param paint The paint used to draw the line* canvas.drawLine(xPoint, yPoint, xPointEnd, yPointEnd, **paint**);  
  
 *//finally, at the center of the circle, draw the txt to disply the passed rotation value* canvas.drawText(String.*valueOf*(**position**), xPoint, yPoint, **paint**);  
}

1. Recall that we did not create a layout file for the “**OrientationSensorDemoFragment**”, now lets set the custom “**CompassView**” we created above as its layout
   1. Create a class variable of type CompassView to hold the reference;  
      *//to hold the reference to instance of the CompassView***private** CompassView **compassView**;
   2. Open the **OrientationSensorDemoFragment** inside java folder, it look like below now;  
      @Override  
      **public** View onCreateView(LayoutInflater inflater, ViewGroup container,  
       Bundle savedInstanceState) {  
       TextView textView = **new** TextView(getActivity());  
       textView.setText(R.string.***hello\_blank\_fragment***);  
       **return** textView;  
      }
   3. Remove the highlighted code segment above and add the code like below;  
      @Override  
      **public** View onCreateView(LayoutInflater inflater, ViewGroup container,  
       Bundle savedInstanceState) {  
       *//set the text appear in title bar* getActivity().setTitle(**"Orientation Sensor Demonstration"**);  
       *//create an instance of the CompassView and set it as the view* **this**.**compassView** = **new** CompassView(getActivity());  
       **return compassView**;  
      }
      1. Here, we have created an instance of the **lk.uok.mit.view.CompassView,** and returned it to set as the view of the **OrientationSensorDemoFragment**
2. Save everything, run the app and check, the output should be like below now;  
   
3. Above is the initial view of out “**CompassView**”, now we have to listen to the **Sensor.TYPE\_ORIENTATION** and update the compass view based on data retrieved from the sensor
   1. Open the **OrientationSensorDemoFragment** inside java folder
   2. Add below class variables to the class, to refer to the sensor manager, text view and the main relative layout of the layout  
      *//to hold the reference to sensor manager***private** SensorManager **sensorService**;  
      *//to hold the reference to instance of the CompassView***private** CompassView **compassView**;  
      *//to hold the reference to sensor***private** Sensor **sensor**;
   3. Override the “**onViewCreated**” of the **OrientationSensorDemoFragment** class to initialize the sensor manager and the text view  
      @Override  
      **public void** onViewCreated(@NonNull View view, @Nullable Bundle savedInstanceState) {  
       **super**.onViewCreated(view, savedInstanceState);  
       *//initialize the sensor manager* **this**.**sensorService** = (SensorManager) getContext().getSystemService(Context.***SENSOR\_SERVICE***);  
      }
   4. Implement the “**android.hardware.SensorEventListener**” to “**OrientationSensorDemoFragment**”  
      **public class** OrientationSensorDemoFragment **extends** Fragment **implements** SensorEventListener
   5. Override the “**onSensorChanged**” and “**onAccuracyChanged**” methods as shown below  
      @Override  
      **public void** onSensorChanged(SensorEvent event) {  
       *//check if the sensor type is TYPE\_ORIENTATION* **if** (event.**sensor**.getType() == Sensor.***TYPE\_ORIENTATION***) {  
       *//if yes, write a method to get its data and display  
       // angle between the magnetic north direction  
       // 0=North, 90=East, 180=South, 270=West* **float** azimuth = event.**values**[0];  
       **compassView**.updatePaintPosition(azimuth);  
       }  
      }  
        
      @Override  
      **public void** onAccuracyChanged(Sensor sensor, **int** accuracy) {  
        
      }
   6. Override the “**onResume**” and “**onPause**” methods of the “**RotationalVectorSensorDemoFragment**” class as shown below; this is to subscribe/unsubscribe as a listener to sensor events and to lock/unlock orientation of the screen  
      *//subscribe to listening to sensor events if the fragment execution resumed/started*@Override  
      **public void** onResume() {  
       **super**.onResume();  
       *//lock to portrait* getActivity().setRequestedOrientation(ActivityInfo.***SCREEN\_ORIENTATION\_PORTRAIT***);  
       *// register this class as a listener for the orientation and  
       // accelerometer sensors* **boolean** isAvaialable = **sensorService**.registerListener(**this**,  
       **sensorService**.getDefaultSensor(Sensor.***TYPE\_ORIENTATION***),  
       SensorManager.***SENSOR\_DELAY\_NORMAL***);  
       *//if the sensor is not available, disply the notification to the user* **if** (!(isAvaialable)) {  
       Toast.*makeText*(getContext(),  
       **"The Orientation sensor is not available in this device!"**,  
       Toast.***LENGTH\_LONG***).show();  
       }  
      }  
        
        
      *//unsubscribe from listening to sensor events if the fragment execution is paused*@Override  
      **public void** onPause() {  
       **super**.onPause();  
       *//unlock orientation* getActivity().setRequestedOrientation(ActivityInfo.***SCREEN\_ORIENTATION\_FULL\_SENSOR***);  
       *//unregister as a sensor listener* **sensorService**.unregisterListener(**this**);  
      }
4. Save everything, run the app and check;  
   

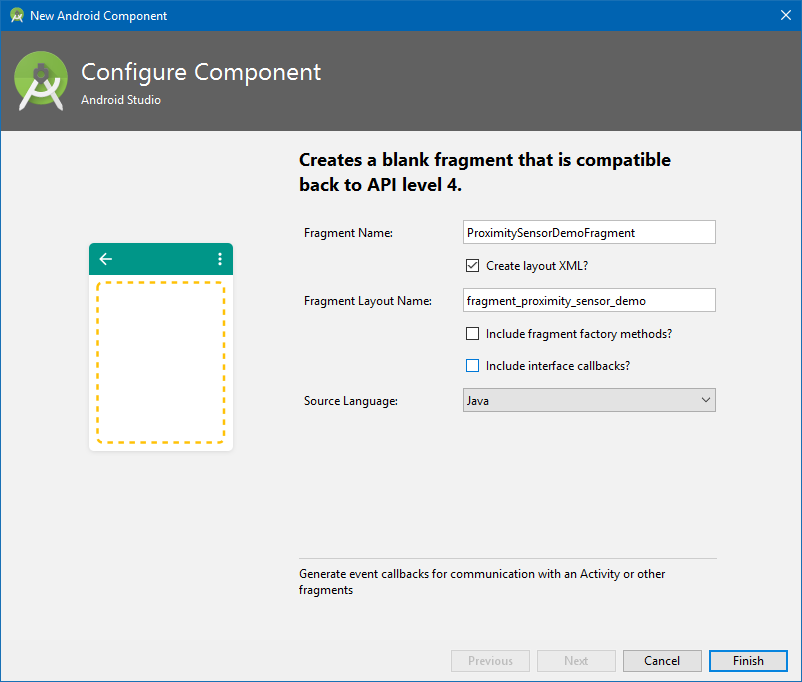
## The Proximity Sensor

If you have noticed, when a user takes a phone call using an android device, its touchscreen goes black when it's very close to the ear in order to avoid accidental touch events.

The phone determines whether or not it is close to the user’s ear by using the proximity sensor, which is a hardware sensor that can tell if an object is close to it.

Some proximity sensors can also tell how far away the object is, though their maximum range is usually only about 5 cm.

Create an activity whose background color changes to red every time you hover your hand over your device's proximity sensor.

1. Create a new “**Fragment**” to display the data retrieved from the
   1. Right click on “**java/lk.uok.mit.fragment**”, select “**New**”🡪”**Fragment**”🡪”**Fragment (Blank)**”  
      
   2. Fill the details as shown below;  
      
      1. Fragment Name:- **ProximitySensorDemoFragment**
      2. Check create layout XML option
      3. Fragment Layout Name:- **fragment\_proximity\_sensor\_demo**
      4. **Uncheck both “Include fragment factory methods” and “include interface callback”**
      5. Source Language:-Java
2. Add a **menu item** to the **drawer** to access the new “**RotationalVectorSensorDemoFragment**”
   1. Open the “**drawer\_view.xml**” inside “**res/menu**” folder and add a new menu item with id “**nav\_rotational\_vector\_sensor\_demo**” like below;  
      *<?***xml version="1.0" encoding="utf-8"***?>*<**menu xmlns:android="http://schemas.android.com/apk/res/android"**>  
       <**group android:checkableBehavior="single"**>  
       <**item  
       android:id="@+id/nav\_send\_message"  
       android:title="Send Message"** />  
       <**item  
       android:id="@+id/nav\_hello\_world"  
       android:title="Message List"** />  
       <**item  
       android:id="@+id/nav\_accelerometer\_demo"  
       android:title="Accelerometer Demo"** />  
       <**item  
       android:id="@+id/nav\_rotational\_vector\_sensor\_demo"  
       android:title="Rotational Vector Sensor Demo"** />  
       <**item  
       android:id="@+id/nav\_orientation\_sensor\_demo"  
       android:title="Orientation Sensor Demo"** />  
       <**item  
       android:id="@+id/nav\_proximity\_sensor\_demo"  
       android:title="Proximity Sensor Demo"** />  
       </**group**>  
      </**menu**>
3. Add an entry to the switch case statement inside “**NavigationItemSelectedListener**” inside “**MainActivity**”
   1. Open “**MainActivity**” inside “**java**” folder
   2. Modify the “**setNavigationItemSelectedListene**r(” method of “**NavigationView**” inside “**onCreate**” method like shown below;  
      **case R.id.*nav\_proximity\_sensor\_demo*:  
       *//Open the ProximitySensorDemoFragment  
       // Begin the transaction* ft = getSupportFragmentManager().beginTransaction();  
       *// Replace the contents of the container with the new fragment* ft.replace(R.id.*fragment\_content*, new ProximitySensorDemoFragment());  
       *// or ft.add(R.id.content\_frame, new MainFragment());  
       // Complete the changes added above* ft.commit();  
       break;**
4. Modify the “**fragment\_proximity\_sensor\_demo.xml**” to display the three values that could be retrieved from the Proximity Sensor,
   1. Open the **fragment\_proximity\_sensor\_demo.xml**  file inside “**res/layout**” folder and add the code below;  
      <**RelativeLayout xmlns:android="http://schemas.android.com/apk/res/android"  
       xmlns:tools="http://schemas.android.com/tools"  
       android:id="@+id/main\_content\_proximity"  
       android:layout\_width="match\_parent"  
       android:layout\_height="match\_parent"  
       tools:context="lk.uok.mit.fragment.RotationalVectorSensorDemoFragment"**>  
        
       <**TextView  
       android:id="@+id/textViewProximity"  
       android:layout\_width="wrap\_content"  
       android:layout\_height="wrap\_content"  
       android:layout\_centerVertical="true"  
       android:layout\_centerHorizontal="true"  
       android:text="Proximity"** />  
        
      </**RelativeLayout**>
      1. Give an id to the main layout and the text view
5. Modify the “**RotationalVectorSensorDemoFragment**” inside java, to acquire the rotation vector sensor and get sensor data from it to determine the rotation of the device along z axis
   1. Modify the “**onCreateView**” method inside “**RotationalVectorSensorDemoFragment**” and add the text to display on title bar as shown below;  
      @Override  
      **public** View onCreateView(LayoutInflater inflater, ViewGroup container,  
       Bundle savedInstanceState) {  
       *//set the text appear in title bar* getActivity().setTitle(**"Rotational Vector Sensor Demo"**);  
       *// Inflate the layout for this fragment* **return** inflater.inflate(R.layout.***fragment\_rotational\_vector\_sensor\_demo***, container, **false**);  
      }
   2. Add below class variables to the class, to refer to the sensor manager, text view and the main relative layout of the layout  
      *//to hold the reference to sensor manager***private** SensorManager **sensorManager**;  
      *//to refer to the main RelativeLayout layout of the fragment***private** View **mainView**;  
      *//to refer to the text view to display measured acceleration in X axis***private** TextView **textViewRotation**;  
      *//to keep the time in milliseconds on which the UI was updated last time***private long lastUpdate**;
   3. Override the “**onViewCreated**” of the RotationalVectorSensorDemoFragment class to initialize the sensor manager and the text view  
      @Override  
      **public void** onViewCreated(@NonNull View view, @Nullable Bundle savedInstanceState) {  
       **super**.onViewCreated(view, savedInstanceState);  
       *//initialize the parent layout* **mainView** = view.findViewById(R.id.***main\_content\_rotation***);  
       *//set green as the background color at startup* **mainView**.setBackgroundColor(Color.***GREEN***);  
        
       *//initialize the sensor manager* **sensorManager** = (SensorManager) getContext().getSystemService(Context.***SENSOR\_SERVICE***);  
        
       *//initialize the the text view to disply the rotation data* **this**.**textViewRotation** = view.findViewById(R.id.***textViewRotation***);  
      }
   4. Implement the “**android.hardware.SensorEventListener**” to “**RotationalVectorSensorDemoFragment**”  
      **public class** AccelerometerDemoFragment **extends** Fragment **implements** SensorEventListener
   5. Override the “**onSensorChanged**” and “**onAccuracyChanged**” methods as shown below  
      @Override  
      **public void** onSensorChanged(SensorEvent event) {  
       *//check if the sensor type is ACCELEROMETER* **if** (event.**sensor**.getType() == Sensor.***TYPE\_ROTATION\_VECTOR***) {  
       *//if yes, write a method to get its data and display* displayRotationVectorSensorData(event);  
       }  
      }  
        
      @Override  
      **public void** onAccuracyChanged(Sensor sensor, **int** accuracy) {  
        
      }
   6. Override the “**onResume**” and “**onPause**” methods of the “**RotationalVectorSensorDemoFragment**” class as shown below; this is to subscribe/unsubscribe as a listener to sensor events and to lock/unlock orientation of the screen  
      *//subscribe to listening to sensor events if the fragment execution resumed/started*@Override  
      **public void** onResume() {  
       **super**.onResume();  
       *//lock to portrait* getActivity().setRequestedOrientation(ActivityInfo.***SCREEN\_ORIENTATION\_PORTRAIT***);  
       *// register this class as a listener for the orientation and  
       // accelerometer sensors* **boolean** isAvaialable=**sensorManager**.registerListener(**this**,  
       **sensorManager**.getDefaultSensor(Sensor.***TYPE\_ROTATION\_VECTOR***),  
       SensorManager.***SENSOR\_DELAY\_NORMAL***);  
       **if**(!(isAvaialable)){  
       Toast.*makeText*(getContext(),  
       **"TYPE ROTATION VECTOR sensor is not available in this device!"**,  
       Toast.***LENGTH\_LONG***).show();  
       }  
      }  
        
        
        
      *//unsubscribe from listening to sensor events if the fragment execution is paused*@Override  
      **public void** onPause() {  
       **super**.onPause();  
       *//unlock orientation* getActivity().setRequestedOrientation(ActivityInfo.***SCREEN\_ORIENTATION\_FULL\_SENSOR***);  
       **sensorManager**.unregisterListener(**this**);  
      }
   7. Write a method to display rotation vector sensor data  
      As it was mentioned earlier too, The rotation vector sensor combines raw data generated by the **gyroscope**, **accelerometer**, and **magnetometer** to create a **quaternion**.   
      Consequently, the values array of its **SensorEvent** object has the following **five elements**:
      1. The **X, Y, Z**, and **W** components of the **quaternion**
      2. **A heading accuracy**

We can convert the **quaternion** into a **rotation matrix**, a 4x4 matrix, by using the **getRotationMatrixFromVector()** method of the **SensorManager** class.

* + 1. Method name:- **displayRotationVectorSensorData**
    2. Return Type:-**void**
    3. Parameters:-**“** **android.hardware.SensorEvent”**
    4. Access modifier**:- private**

**private void** displayRotationVectorSensorData(SensorEvent sensorEvent){  
 *//convert the quaternion into a rotation matrix, a 4x4 matrix,  
 // by using the getRotationMatrixFromVector() method of the SensorManager class* **float**[] rotationMatrix = **new float**[16];  
 SensorManager.*getRotationMatrixFromVector*(rotationMatrix, sensorEvent.**values**);  
  
 *//remap the coordinate system of the rotation matrix. rotate the rotation matrix such that the Z-axis of the new coordinate system  
 // coincides with the Y-axis of the original coordinate system.  
  
 // Remap coordinate system* **float**[] remappedRotationMatrix = **new float**[16];  
 SensorManager.*remapCoordinateSystem*(rotationMatrix,  
 SensorManager.***AXIS\_X***,  
 SensorManager.***AXIS\_Z***,  
 remappedRotationMatrix);  
  
  
 *//convert the rotation matrix into an array of orientations, specifying the rotation of the device along the Z, X, and Y axes.  
 // To do so, use the getOrientation() method of the SensorManager class.  
  
 // Convert to orientations* **float**[] orientations = **new float**[3];  
 SensorManager.*getOrientation*(remappedRotationMatrix, orientations);  
  
 *//By default, the orientations array contains angles in radians instead of degrees.  
 //use the following code to convert all its angles to degrees:* **for**(**int** i = 0; i < orientations.**length**; i++) {  
 orientations[i] = (**float**)(Math.*toDegrees*(orientations[i]));  
 }  
  
  
  
  
  
  
 *//change the background color of the activity based on the third element of the orientations array* **float** rotation=orientations[2];  
 **if**(rotation > 35) {  
 **this**.**textViewRotation**.setTextColor(Color.***BLACK***);  
 **mainView**.setBackgroundColor(Color.***YELLOW***);  
 } **else if**(rotation < -35) {  
 **this**.**textViewRotation**.setTextColor(Color.***WHITE***);  
 **mainView**.setBackgroundColor(Color.***BLUE***);  
 } **else if**((Math.*floor*(rotation) < 3) && (Math.*floor*(rotation)) > -1) {  
 **this**.**textViewRotation**.setTextColor(Color.***BLACK***);  
 **mainView**.setBackgroundColor(Color.***WHITE***);  
 } **else**{  
 **this**.**textViewRotation**.setTextColor(Color.***WHITE***);  
 **mainView**.setBackgroundColor(Color.***GREEN***);  
 }  
  
 *//get the current time n milliseconds* **long** curTime = System.*currentTimeMillis*();  
 **if** ((curTime - **lastUpdate**) > 500) {  
 *//set the last update to current update, as we are upsdaing now* **lastUpdate** = curTime;  
  
 **this**.**textViewRotation**.setPadding(10, 100, 10, 100);  
 **this**.**textViewRotation**.setText(**"Rotation:- "** + Math.*floor*(rotation));  
 }  
}

1. Now save everything and run the app and check, the output will look below;

Source code for this tutorial part can be found in Git Repository given below: - <https://github.com/nadee158/android_tutorial_part_6.git>

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