

SENSOR TUTORIAL

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Outline

- Android sensor structure
- Android sensor type
- Sensor program structure
- Sensor Example 1
- Practice
- Sensor Example 2
- Sensor Example 3
- Q&A
- Homework
- Reference

Android sensor structure

體系可分為四個層次

用戶空間	Java应用程序	
	Java Framework框架层	<i>SensorManager.java</i> <i>SensorService.java</i>
	JNI	<i>android_hardware_SensorManager.cpp</i> <i>com_android_server_SensorService.cpp</i>
	硬件抽象层	<i>sensors.cpp</i>
内核空间	G-sensor设备驱动程序	<i>bma220_driver.c</i>
硬件	G-sensor重力感应器	

Android sensor structure

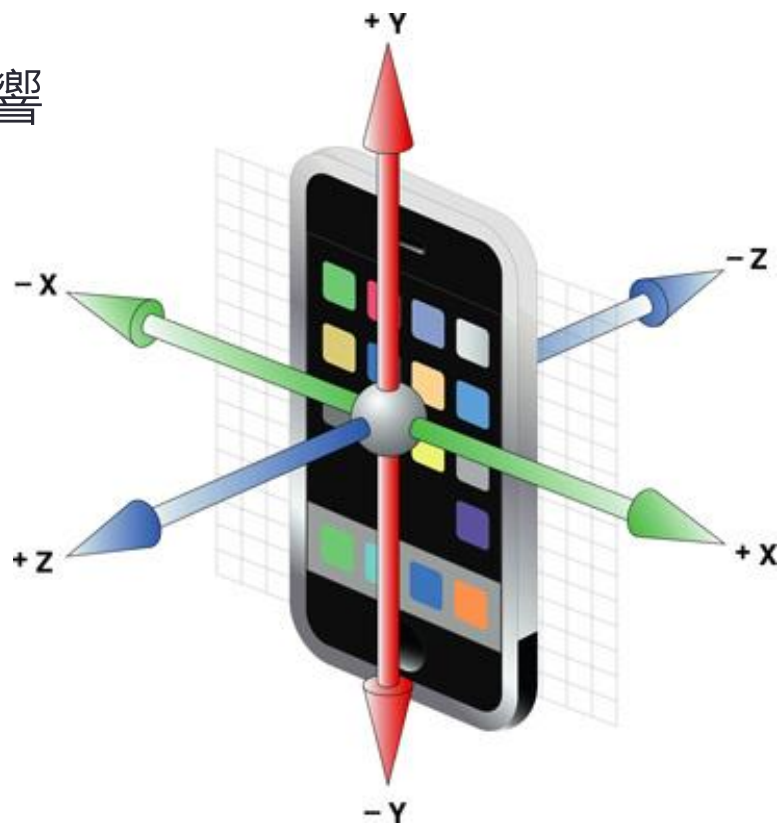
- 第四層：Java Application layer
撰寫程式碼的地方
- 第三層：Android Java Framework layer
各種class component interface
- 第二層：Android 標準函式庫 (JNI)
整個架構體系的配角，溝通窗口
- 第一層：硬體驅動層
與底層硬體設備做溝通

Android sensor

- #define SENSOR_TYPE_ACCELEROMETER //加速度
- #define SENSOR_TYPE_MAGNETIC_FIELD //磁力
- #define SENSOR_TYPE_ORIENTATION //方向
- #define SENSOR_TYPE_GYROSCOPE //陀螺儀
- #define SENSOR_TYPE_LIGHT //光線感應
- #define SENSOR_TYPE_PRESSURE //壓力
- #define SENSOR_TYPE_TEMPERATURE //溫度
- #define SENSOR_TYPE_PROXIMITY //接近
- #define SENSOR_TYPE_GRAVITY //重力
- #define SENSOR_TYPE_LINEAR_ACCELERATION //線性加速度
- #define SENSOR_TYPE_ROTATION_VECTOR //旋轉矢量

Android sensor

- `#define SENSOR_TYPE_ACCELEROMETER` //加速度
 - 最為廣泛使用的Sensor
- 手機平放時，因地心引力影響
 - X軸為0
 - Y軸為0
 - Z軸為9.81



Android sensor

- #define SENSOR_TYPE_LIGHT //光線感應
- 主要用於LCD自動亮度功能、
根據採樣到的光線強度調整LCD的亮度



Android sensor

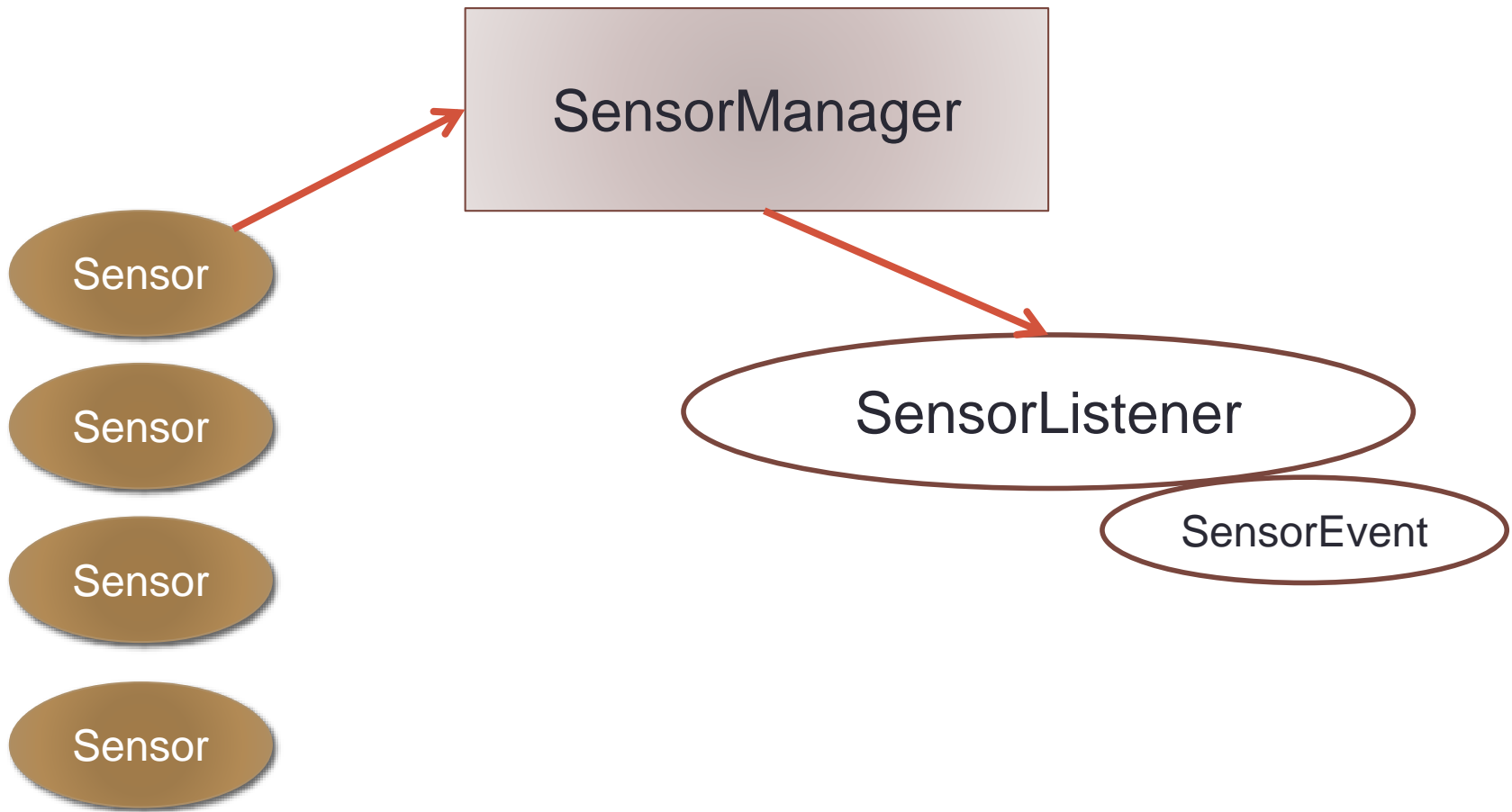
- #define SENSOR_TYPE_PROXIMITY //接近
- 可用於接聽電話時自動關閉LCD以節省電量



Sensor program structure

- **Sensor**
 - representing a sensor.
- **SensorManager**
 - lets you access the device's sensors.
- **SensorEventListener**
 - Used for receiving notifications from the SensorManager.
- **SensorEvent**
 - This class represents a Sensor event and holds information.

Sensor program structure



Sensor program structure

- 官方文件：
 - <http://developer.android.com/reference/android/hardware/Sensor.html>

Sensor Program example 1

- 將手機裡面所有可用的Sensor顯示出來

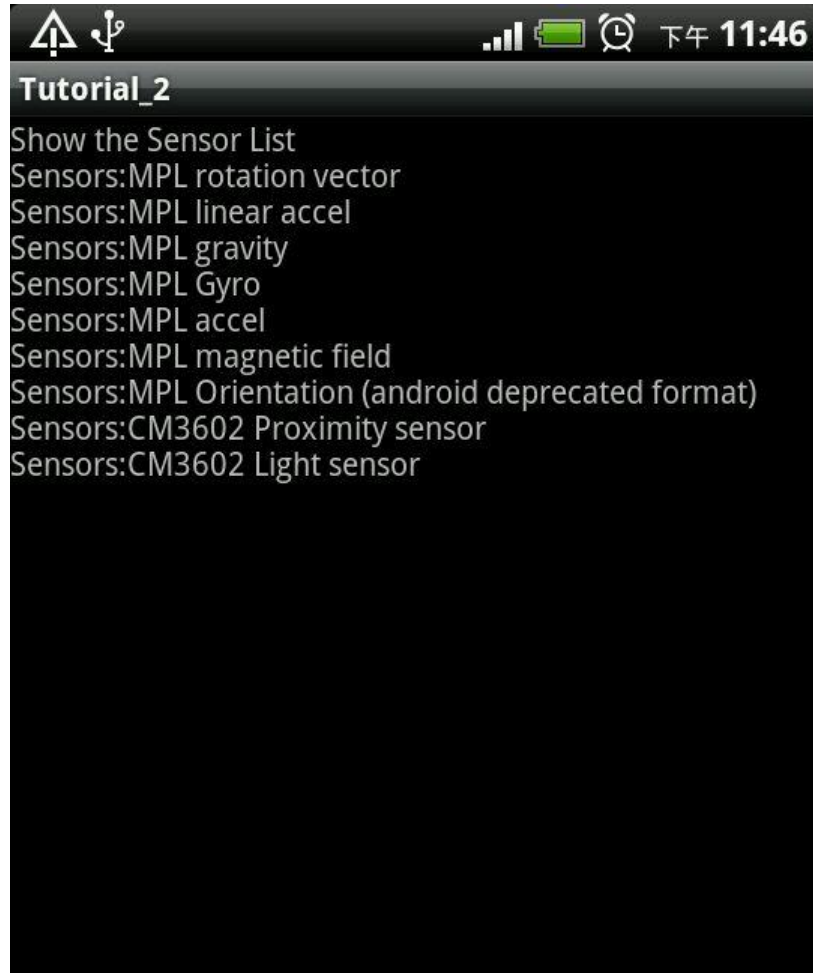
```
public class Tutorial_2Activity extends Activity {  
    /** Called when the activity is first created. */  
    @Override  
    public void onCreate(Bundle savedInstanceState) {  
        super.onCreate(savedInstanceState);  
        setContentView(R.layout.main);  
  
        /** new View to show Sensor List */  
        TextView sensorList = (TextView) findViewById(R.id.SensorTextView);  
  
        // get the sensor Service  
        // and get list of sensors the phone have  
        SensorManager mgr = (SensorManager) getSystemService(SENSOR_SERVICE);  
        List<Sensor> sensors = mgr.getSensorList(Sensor.TYPE_ALL);  
  
        /**show the SensorList on screen */  
        for (Sensor sensor : sensors) {  
            Log.d("Sensors", "" + sensor.getName());  
            sensorList.append("\nSensors:" + sensor.getName() );  
        }  
    }  
}
```

Sensor Program example 1

- `getSystemService()` 是一個很重要的 API，是「Android 應用程式控制硬體」的起點。
- `getSensorList` 可藉由 `SensorManager` 取得 `Sensor` 的資訊

Sensor Program example 1

- 執行畫面：



Sensor Program example 2 (1/4)

- 簡易的 sensor program structure

```
private static Sensor sensor_acc;  
private static SensorManager sensorManager = null;
```

```
sensorManager = (SensorManager) getSystemService(SENSOR_SERVICE); //get the type of Service  
sensor_acc = sensorManager.getDefaultSensor(Sensor.TYPE_ACCELEROMETER);  
sensorManager.registerListener(mySensorListener,  
    sensor_acc,  
    SensorManager.SENSOR_DELAY_NORMAL); // Listener ACCELEROMETER start
```

```
private final SensorEventListener my = new SensorEventListener() {  
  
    @Override  
    public void onSensorChanged(SensorEvent event) {  
        // TODO Auto-generated method stub  
    }  
  
    @Override  
    public void onAccuracyChanged(Sensor sensor, int accuracy) {  
        // TODO Auto-generated method stub  
    }  
};
```

Sensor Program example 2 (2/4)

- Sensor不需要時一定要關掉 (Sensor不會自行 shut down)

```
/**
 * activity is started or restarted.
 */
public void onResume(){
    super.onResume();
    sensorManager.registerListener(mySensorListener, sensor_acc , sensorManager.SENSOR_DELAY_NORMAL);
    Toast.makeText(this, "onResume", Toast.LENGTH_LONG).show();
}

/**
 * activity is stoped or shadowing.
 */
public void onDestroy(){
    super.onDestroy();
    //sensorManager.unregisterListener(mySensorListener);
    Toast.makeText(this, "onDestroy", Toast.LENGTH_LONG).show();
}

/**
 * activity is shadowing.
 */
protected void onPause() {
    super.onPause();
    sensorManager.unregisterListener(mySensorListener);
    Toast.makeText(this, "onPause", Toast.LENGTH_LONG).show();
}
```


Sensor Program example 2 (3/4)

```
private void findViews() {
    x = (TextView) findViewById(R.id.x);
    y = (TextView) findViewById(R.id.y);
    z = (TextView) findViewById(R.id.z);
}

@Override
public void onSensorChanged(SensorEvent event) {
    now = event.timestamp;
    int type = event.sensor.getType();

    // *ACCELEROMETER sensor event
    if(type == Sensor.TYPE_ACCELEROMETER){
        accels = event.values.clone();
        if(timestamp!=0)
            dT = now - timestamp;
    }

    x.setText(accels[0]+".");
    y.setText(accels[1]+".");
    z.setText(accels[2]+".\n"+"Timediffer:"+dT*NS2S);
    timestamp = event.timestamp;
}
```

Sensor Program example 2 (4/4)

- Sensor Event

Fields		
public int	accuracy	The accuracy of this event.
public Sensor	sensor	The sensor that generated this event.
public long	timestamp	The time in nanosecond at which the event happened
public final float[]	values	The length and contents of the values array depends on which sensor type is being monitored (see also SensorEvent for a definition of the coordinate system used).

Sensor Program example 2

- 執行畫面：



Practice

- 將Program 2 增加 Shaking 功能

Shaking : 手機持續判斷上個time internal搜集到的加速度值
與此次的value進行數學運算得到force值

若是force值 > threshold值則為 Shaking

```
private static float threshold = 3.0f;
```

force 的計算公式 :

```
force = Math.abs(x + y + z - lastX - lastY - lastZ) / timeDiff;
```

Practice

- 執行畫面：

```
X: 0.8508307.  
Y: 2.9812005.  
Z: 9.653126.  
Timediffer:0.19702148  
+force:0.30656254
```

Phone shaken

Sensor Program example 3

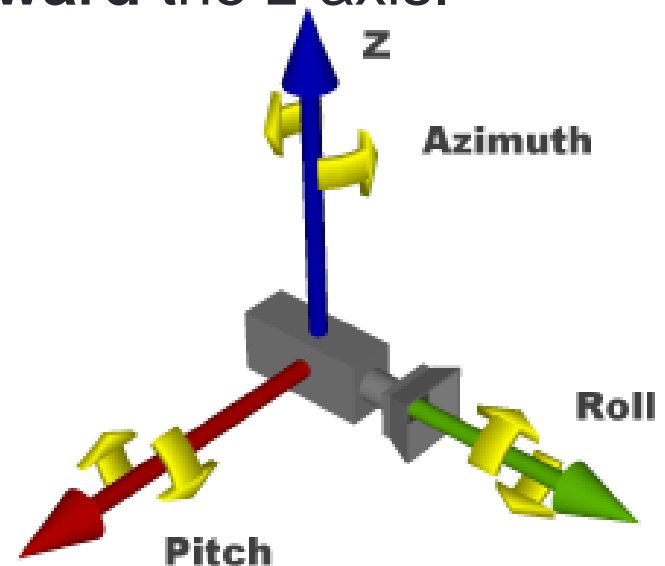
- 新增 TYPE_ORIENTATION Sensor
- 用途：可獲取手機的方向

- 方法一：使用SensorManager.getOrientation()
 與 TYPE_ACCELEROMETER
 TYPE_MAGNETIC_FIELD 兩個sensor

- 方法二：使用TYPE_ORIENTATION直接取得參數

Sensor Program example 3

- **Azimuth**, around the z-axis (0 to 359). 0=North, 90=East, 180=South, 270=West
- **Pitch**, rotation around x-axis (-180 to 180), with positive values when the z-axis moves **toward** the y-axis.
- **Roll**, rotation around y-axis (-90 to 90), with positive values when the x-axis moves **toward** the z-axis.



Sensor Program example 3

```
private static Sensor sensorAcc;  
private static Sensor sensorMag;
```

```
private void setListener() {  
  
    sensorManager = (SensorManager) getSystemService(SENSOR_SERVICE); //get the type of Service  
    sensorAcc = sensorManager.getDefaultSensor(Sensor.TYPE_ACCELEROMETER);  
    sensorMag = sensorManager.getDefaultSensor(Sensor.TYPE_MAGNETIC_FIELD);  
    sensorManager.registerListener(mySensorListener, sensorAcc, SensorManager.SENSOR_DELAY_NORMAL);  
    sensorManager.registerListener(mySensorListener, sensorMag, SensorManager.SENSOR_DELAY_NORMAL);  
  
}
```

```
@Override  
protected void onResume() {  
    super.onResume();  
    sensorManager.registerListener(mySensorListener, sensorAcc , SensorManager.SENSOR_DELAY_NORMAL);  
    sensorManager.registerListener(mySensorListener, sensorMag , SensorManager.SENSOR_DELAY_NORMAL);  
    Toast.makeText(this, "onResume", Toast.LENGTH_LONG).show();  
  
}
```


Sensor Program example 3

```
//Constants
private static final double RAD2DEG = 180/Math.PI;
private static final float NS2S = 1.0f / 1000000000.0f;
private float[] RotationMat = new float[9]; // Rotation Matrix
private float[] InclinationMat = new float[9]; // Inclination Matrix
```

@Override

```
public void onSensorChanged(SensorEvent event) {
    now = event.timestamp;

    int type = event.sensor.getType();

    /** MAGNETIC_FIELD */
    if(type == Sensor.TYPE_MAGNETIC_FIELD)
        mags = event.values.clone();

    /** ACCELEROMETER */
    if(type == Sensor.TYPE_ACCELEROMETER)
        accels = event.values.clone();

    SensorManager.getRotationMatrix(RotationMat, InclinationMat, accels, mags); //get RotationMatrix
    SensorManager.getOrientation(RotationMat, attitude); //get OrientationRadi

    x.setText(accels[0]+".");
    y.setText(accels[1]+".");
    z.setText(accels[2]+".\n"+"Timediffer:"+dT*NS2S+"\n"+force+"force
        +"\nAzimuth:"+attitude[0]*RAD2DEG
        +"\n Roll:"+attitude[1]*RAD2DEG
        +"\n Pitch:"+attitude[2]*RAD2DEG);
    timestamp = event.timestamp;
}
```

Additional Sensor example

- Use proximity sensor lock the home screen

- [Stack Overflow](#)
- [Android 官方文件](#)