

CMSC436: Programming Handheld Systems

Sensors

Today's Topics

Sensor & SensorManager

SensorEvent & SensorEventListener

Filtering sensor values

Example applications

Sensors

Hardware devices that measure the physical environment

Motion

Position

Environment

Some Example Sensors

Motion - 3-axis Accelerometer

Position - 3-axis Magnetic field

Environment - Pressure

Sensor Types

int TYPE_MOTION_DETECT

int TYPE_GRAVITY

int TYPE_AMBIENT_TEMPERATURE

int TYPE_ACCELEROMETER

int TYPE_ALL

Some Sensor Methods

float getResolution()

float getPower()

int getReportingMode()

int getMinDelay()

float getMaximumRange()

SensorEvent

Represents a Sensor event

Data includes

- Sensor type

- Time-stamp

- Accuracy

- Sensor-specific measurement data

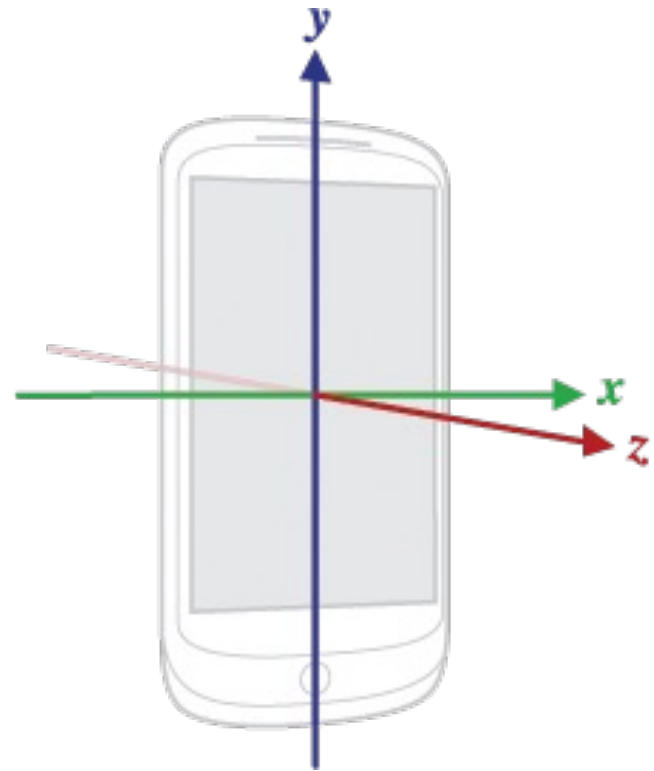
Sensor Coordinate System

When default orientation is portrait & the device is lying flat, face-up on a table, axes run

X – Left to right

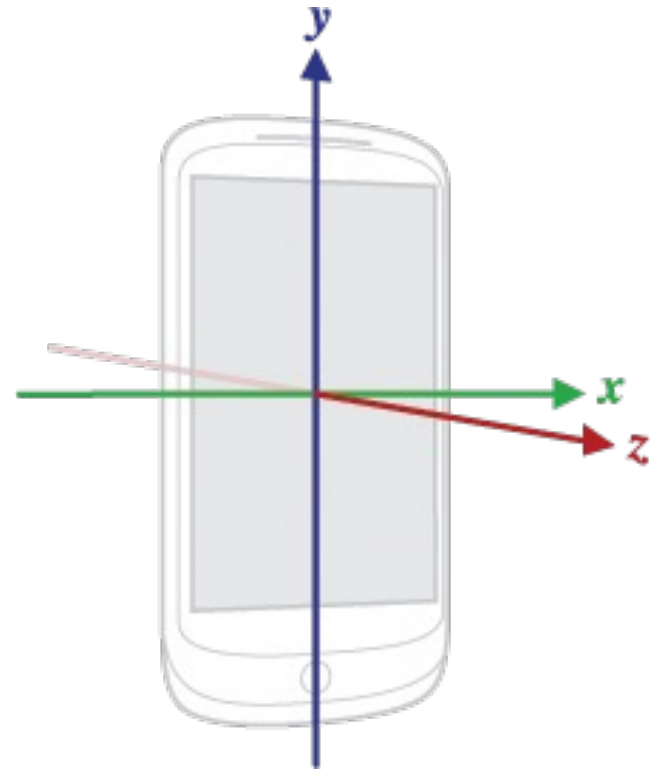
Y – Bottom to top

Z – Down to up



Sensor Coordinate System

Coordinate system
does not change when
device orientation
changes



SensorManager

System service that manages sensors

Get instance with

```
getSystemService(Context.SENSOR_SERVICE )
```

Access a specific sensor with

```
SensorManager.getDefaultSensor(int type)
```

Some Sensor Type Constants

Accelerometer - `Sensor.TYPE_ACCELEROMETER`

Magnetic field - `Sensor.TYPE_MAGNETIC_FIELD`

Pressure – `Sensor.TYPE_PRESSURE`

Some SensorManager Methods

```
open fun getSensorList(type: Int): MutableList<Sensor!>!
```

```
open fun getDefaultSensor(type: Int): Sensor!
```

SensorEventListener

Interface for SensorEvent callbacks

SensorEventListener

Called when a sensor's accuracy has changed

```
abstract fun onAccuracyChanged(  
    sensor: Sensor!, accuracy: Int): Unit
```

Accuracy Constants

SENSOR_STATUS_ACCURACY_HIGH

SENSOR_STATUS_ACCURACY_MEDIUM

SENSOR_STATUS_ACCURACY_LOW

SENSOR_STATUS_NO_CONTACT

SENSOR_STATUS_UNRELIABLE

SensorEventListener

Called when sensor values have changed

abstract fun onSensorChanged(event: SensorEvent!): Unit

Note: This method should not keep a reference to the SensorEvent

Registering for SensorEvents

Use the SensorManager to register/unregister for SensorEvents

Registering for SensorEvents

Register SensorEventListener for a given sensor

```
registerListener(listener: SensorEventListener!,  
                sensor: Sensor!, samplingPeriodUs: Int): Boolean
```

Registering for SensorEvents

Unregisters a listener for the sensors with which it is registered

```
unregisterListener(listener: SensorEventListener!,  
                  sensor: Sensor!): Unit
```

SensorRawAccelerometer

Displays the raw values read from the device's accelerometer

Pixel 2 API 31 - Extended Controls

Location
Displays
Cellular
Battery
Camera
Phone
Directional pad
Microphone
Fingerprint
Virtual sensors
Bug report
Record and Playback
Google Play
Settings
Help

Device Pose Additional sensors


Sensor values		
Accelerometer (m/s ²):	0.00	9.81 0.00
Gyroscope (rad/s):	0.00	0.00 0.00
Magnetometer (μT):	-12.49	0.00 0.00
Rotation:	ROTATION_0	



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Rotate Move

Z-Rot -180 180 34.4

X-Rot -180 180 -26.5

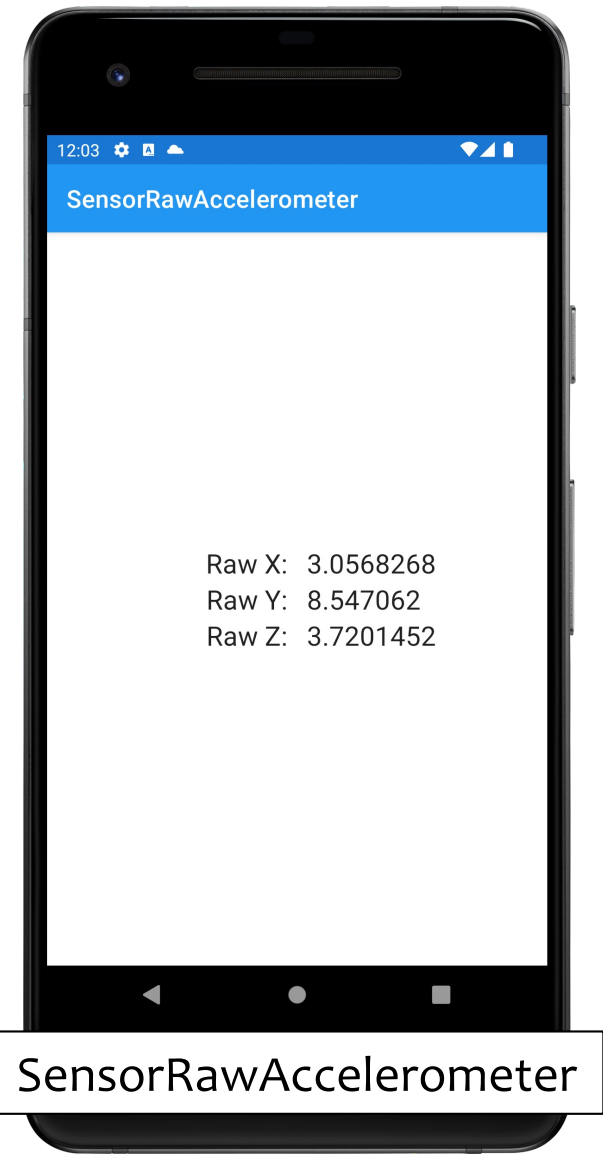
Y-Rot -180 180 31.8

Rotation



Sensor values

Accelerometer (m/s ²):	3.06	8.55	3.72
Gyroscope (rad/s):	0.00	0.00	0.00
Magnetometer (μT):	-8.76	6.00	-6.58
Rotation:	ROTATION_0		



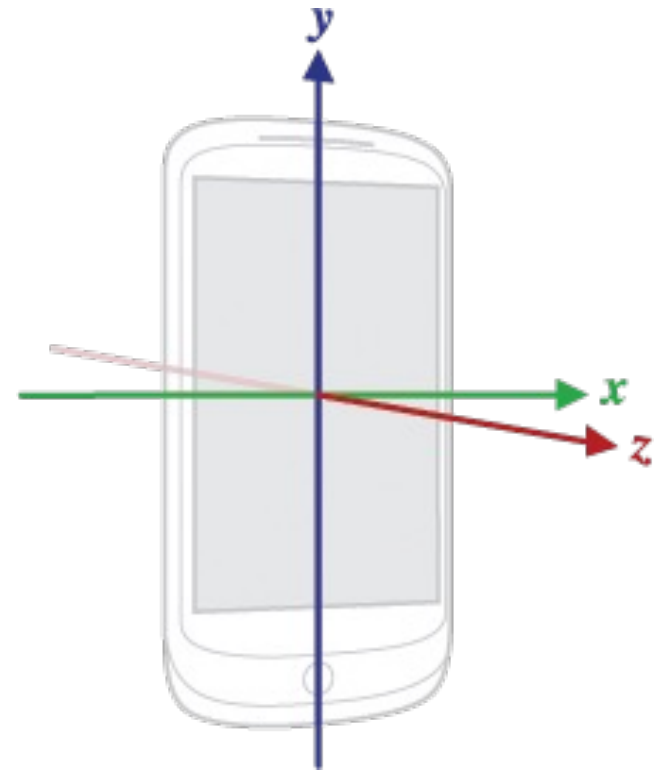
Accelerometer Values

If the device were standing straight up, the accelerometer would ideally report:

$$X \approx 0 \text{ m/s}^2$$

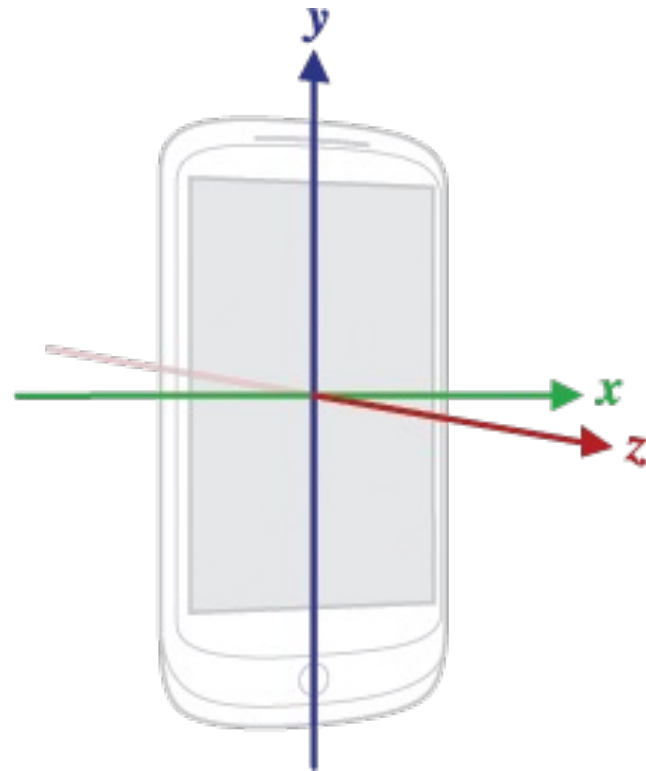
$$Y \approx 9.81 \text{ m/s}^2$$

$$Z \approx 0 \text{ m/s}^2$$



Accelerometer values

But these values will vary due to natural movements, non-flat surfaces, noise, etc.



Filtering Accelerometer Values

Two common transforms

Low-pass filter

High-pass filter

Low-Pass Filter

Deemphasize transient force changes

Emphasize constant force components



Carpenter's Level

High-Pass Filter

Emphasize transient force changes

Deemphasize constant force components



Percussion
Instrument

SensorFilteredAccelerometer

Applies both a low-pass and a high-pass filter to raw accelerometer values

Displays the filtered values

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Rotate Move

Z-Rot -180 180 0.0

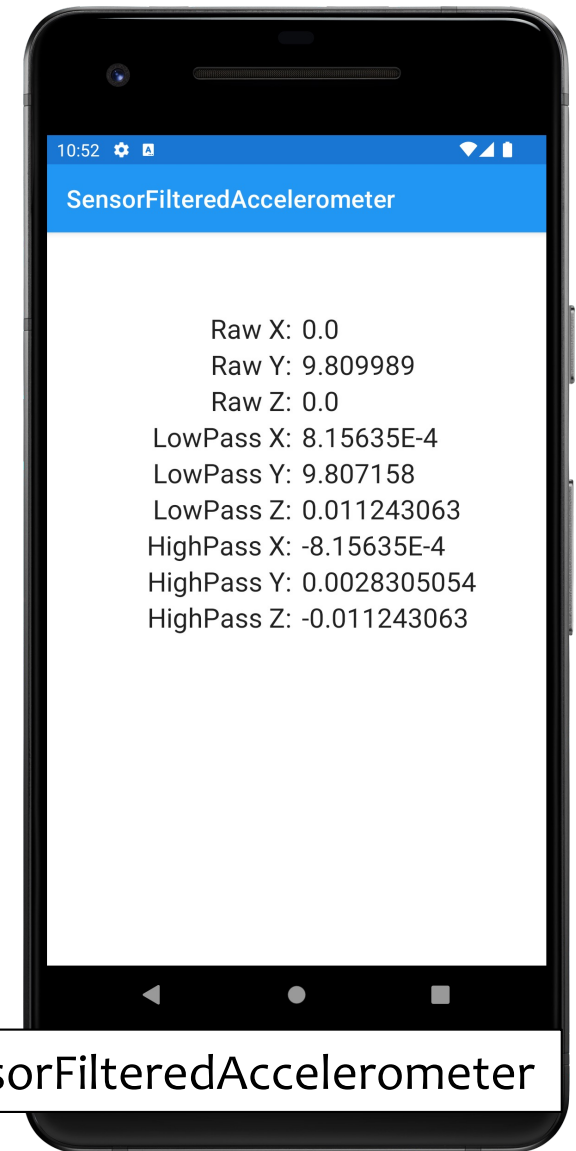
X-Rot -180 180 0.0

Y-Rot -180 180 0.0

Rotation

Sensor values

Accelerometer (m/s ²):	0.00	9.81	0.00
Gyroscope (rad/s):	0.00	0.00	0.00
Magnetometer (μT):	-12.49	0.00	0.00
Rotation:	ROTATION_0		



SensorFilteredAccelerometer

Pixel 2 API 31 - Extended Controls

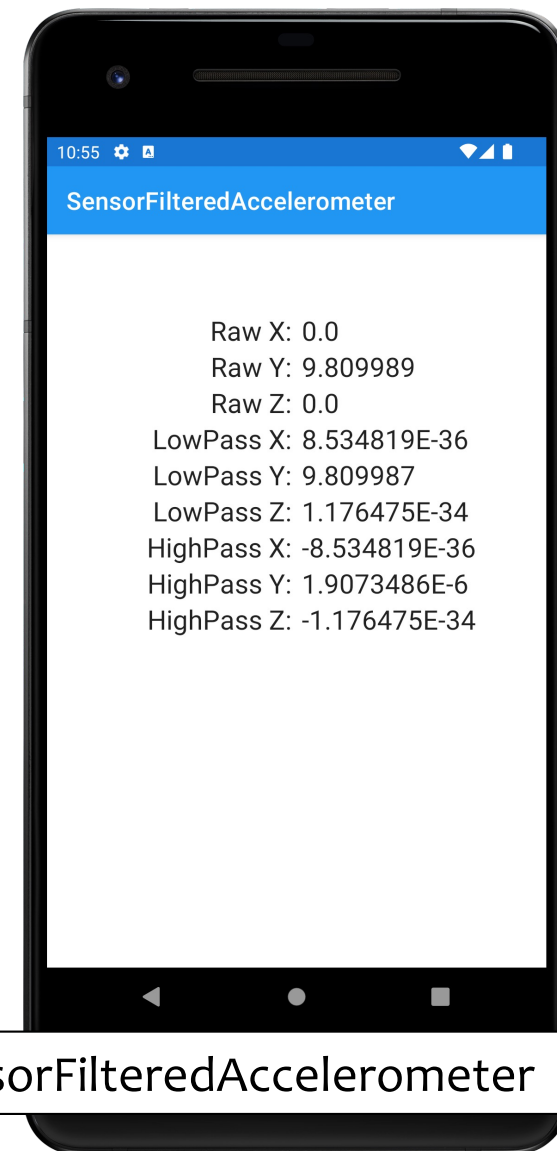
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Device Pose Additional sensors

Rotation

Sensor values

Accelerometer (m/s ²):	0.00	9.81	0.00
Gyroscope (rad/s):	0.00	0.00	0.00
Magnetometer (μT):	-12.49	0.00	0.00
Rotation:	ROTATION_0		



SensorFilteredAccelerometer


SensorCompass

Uses the device's accelerometer and magnetometer to orient a compass

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Rotate Move

Z-Rot: -180 180 0.0
 X-Rot: -180 180 -45.0
 Y-Rot: -180 180 0.0

Rotation

Sensor values


Accelerometer (m/s ²):	0.00	6.94	6.94
Gyroscope (rad/s):	0.00	0.00	0.00
Magnetometer (μT):	-12.49	0.00	0.00
Rotation:	ROTATION_180		



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Rotate Move

Z-Rot: -180 180 -45.0

X-Rot: -180 180 -45.0

Y-Rot: -180 180 0.0

Rotation

Sensor values

Accelerometer (m/s ²):	-4.91	4.90	6.94
Gyroscope (rad/s):	0.00	0.00	0.00
Magnetometer (μT):	-8.83	-8.83	-0.00
Rotation:	ROTATION_180		



Next Time

Maps & Location

Example Applications

SensorRawAccelerometer

SensorFilteredAccelerometer

SensorCompass