

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

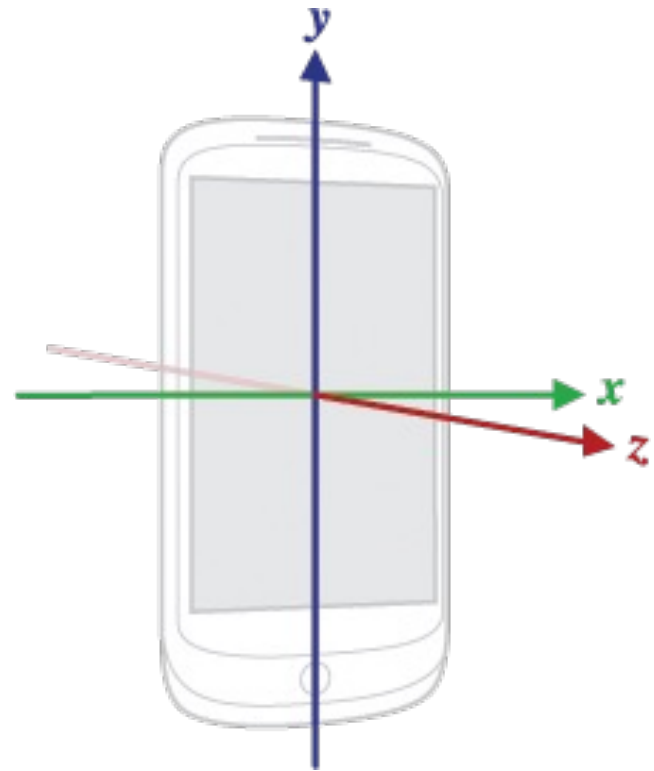
Sensor Coordinate System

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

X – Left to right

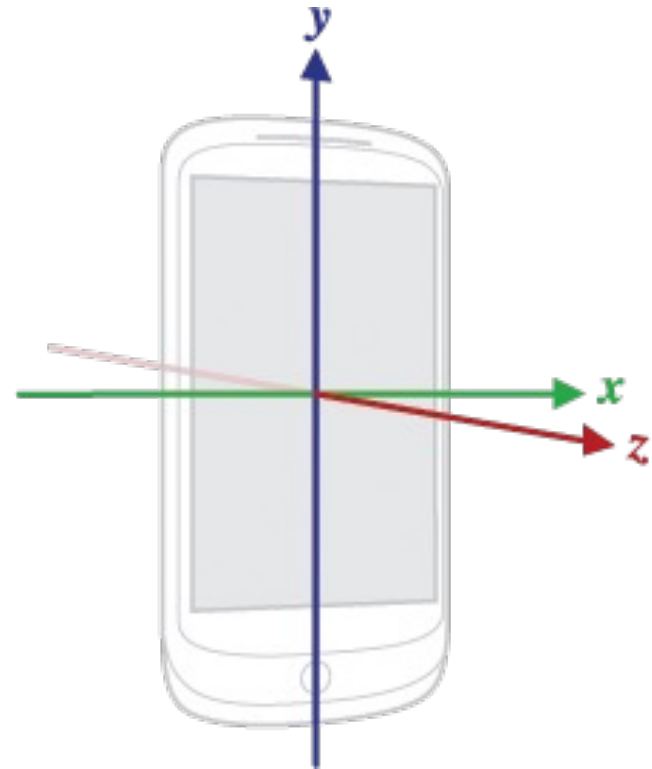
Y – Bottom to top

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

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		



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Rotate Move

Z-Rot 34.4

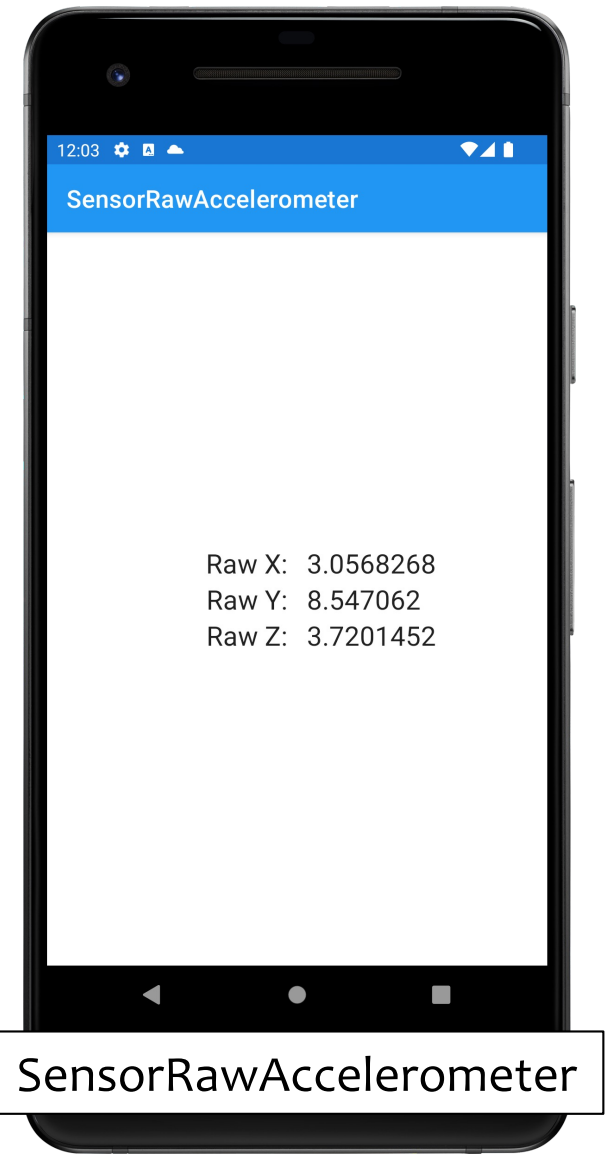
X-Rot -26.5

Y-Rot 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		



SensorRawAccelerometer

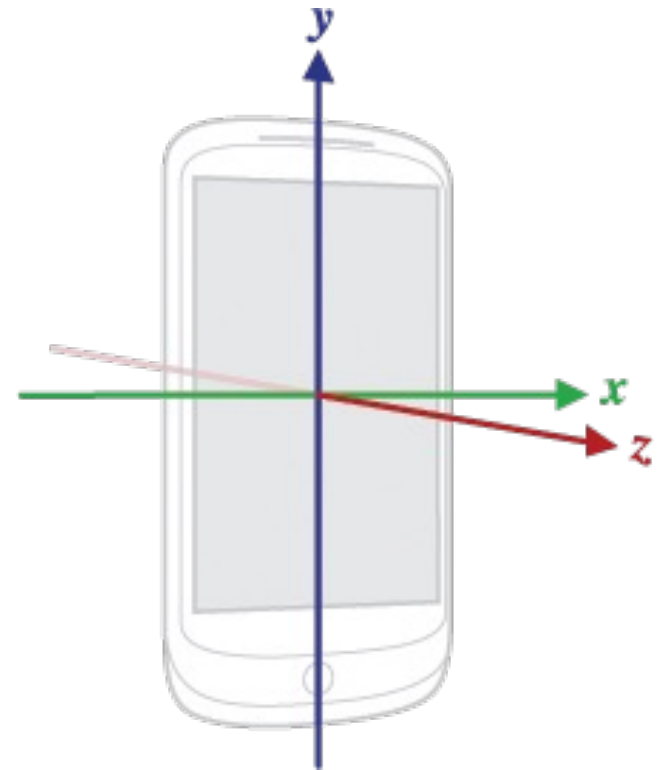
Accelerometer Values

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

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

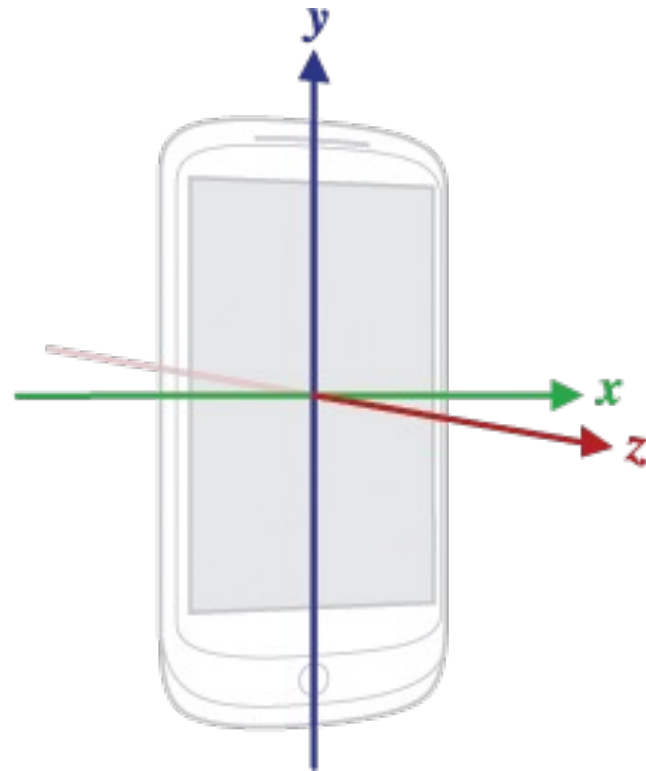
$$Y \approx 9.81 \text{ m/s}^2$$

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



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

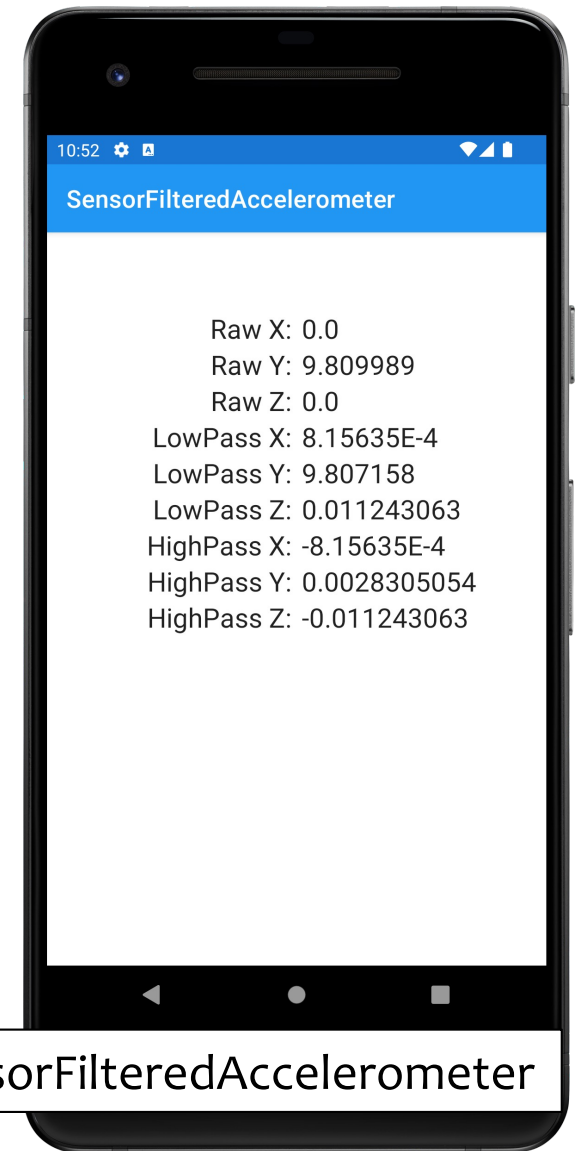
X-Rot -180 180 0.0

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

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Rotate Move

X -7 7 -2.1

Y -4 4 -0.7

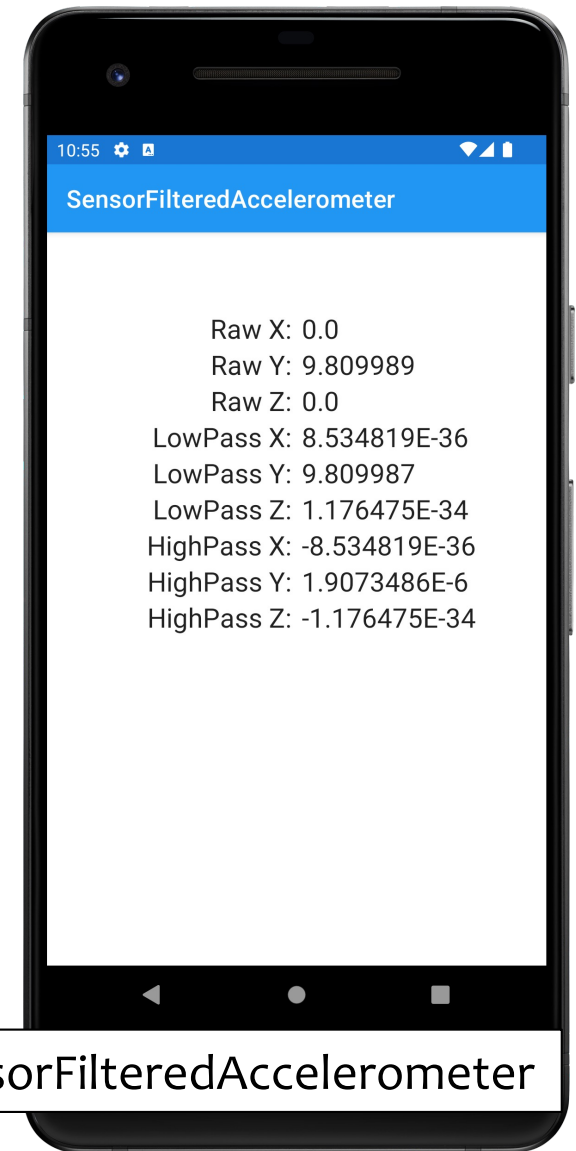
Z -4 4 0.8

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