VIII. Mobile Devices Hardware: Sensors

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1. Sensors

- Almost all smartphones and tablets have multiple sensors. These are most often hardware components, but sometimes they can also be software. Hardware sensors are built into the smartphone or tablet, and software sensors typically use data from one or more hardware sensors and are sometimes called "virtual" or "synthetic" sensors.

- Both types of sensors can provide raw data with extremely high precision and accuracy, which are then used by purpose-built applications or games.

1. Sensors

2. Main groups of sensors

The sensors used in mobile devices can generally be divided into three categories:

Motion sensors

➡ They measure acceleration forces and rotational forces along three axes. This category includes accelerometers, gravity sensors, gyroscopes, and rotation vector sensors.

Environmental sensors

➡ They measure various environmental parameters such as temperature and air pressure, illumination and humidity. This category includes barometers, photometers and thermometers.

2. Main groups of sensors

Position sensors

- They determine the physical position of the mobile device and are of two types: orientation sensors and magnetometers.
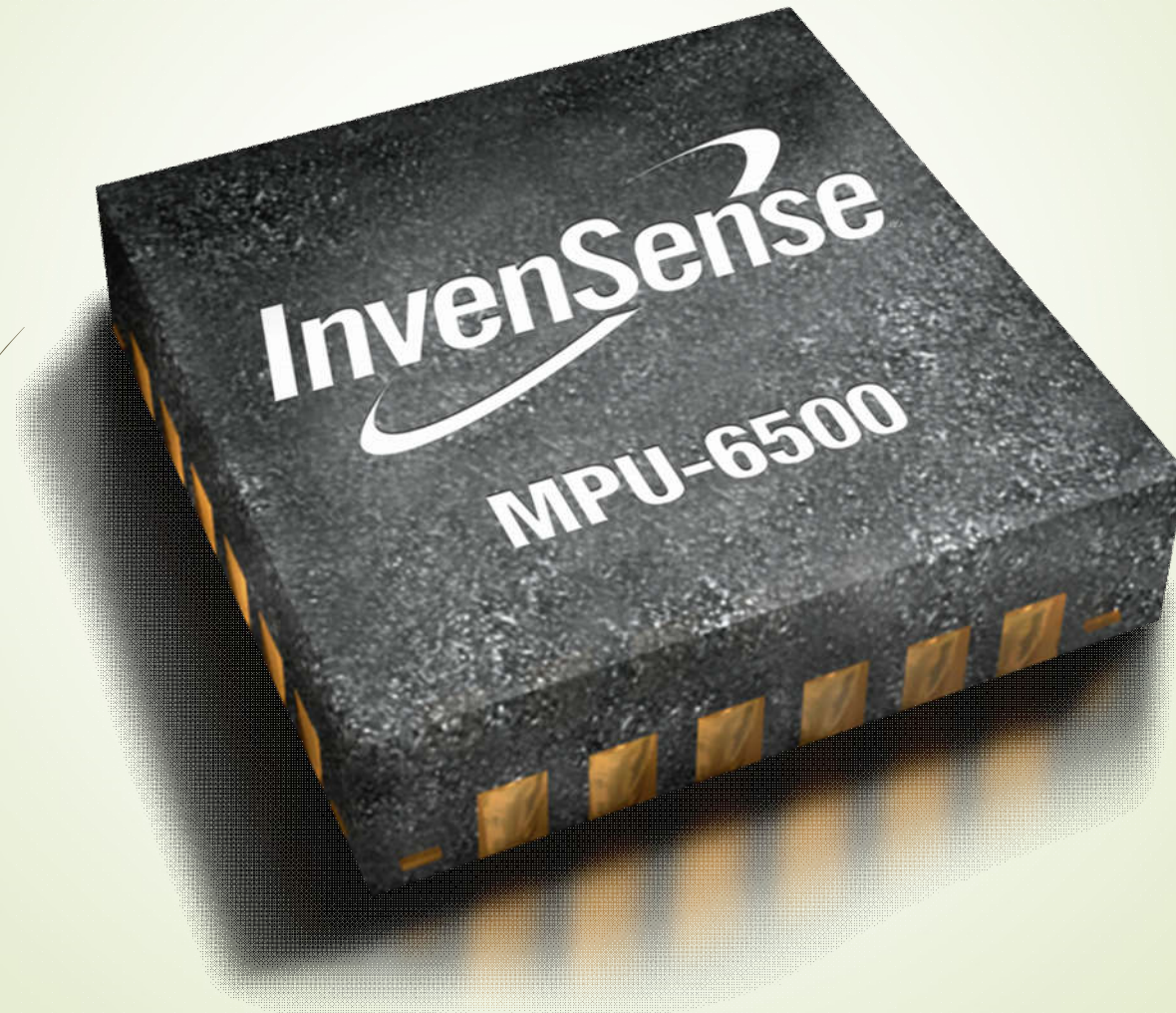
3. Main sensors

Accelerometer

- It measures the force of acceleration that is applied to the device in m/s^2 along three physical axes (x, y and z), including the force of gravity.

- It is most often used to determine the type of movement (eg, shake, tilt the device, etc.).

Accelerometer

3. Main sensors

Gravity sensor

- This sensor measures the force of gravity that is applied to the device in m/s ^{2} along all physical axes (x, y and z).

- It is most often used to determine the type of movement (scrambling, tilting, etc.).

3. Main sensors

Linear acceleration

- It measures the force of acceleration that is applied to the device in m/s^2 along all physical axes (x, y and z) but without the force of gravity.
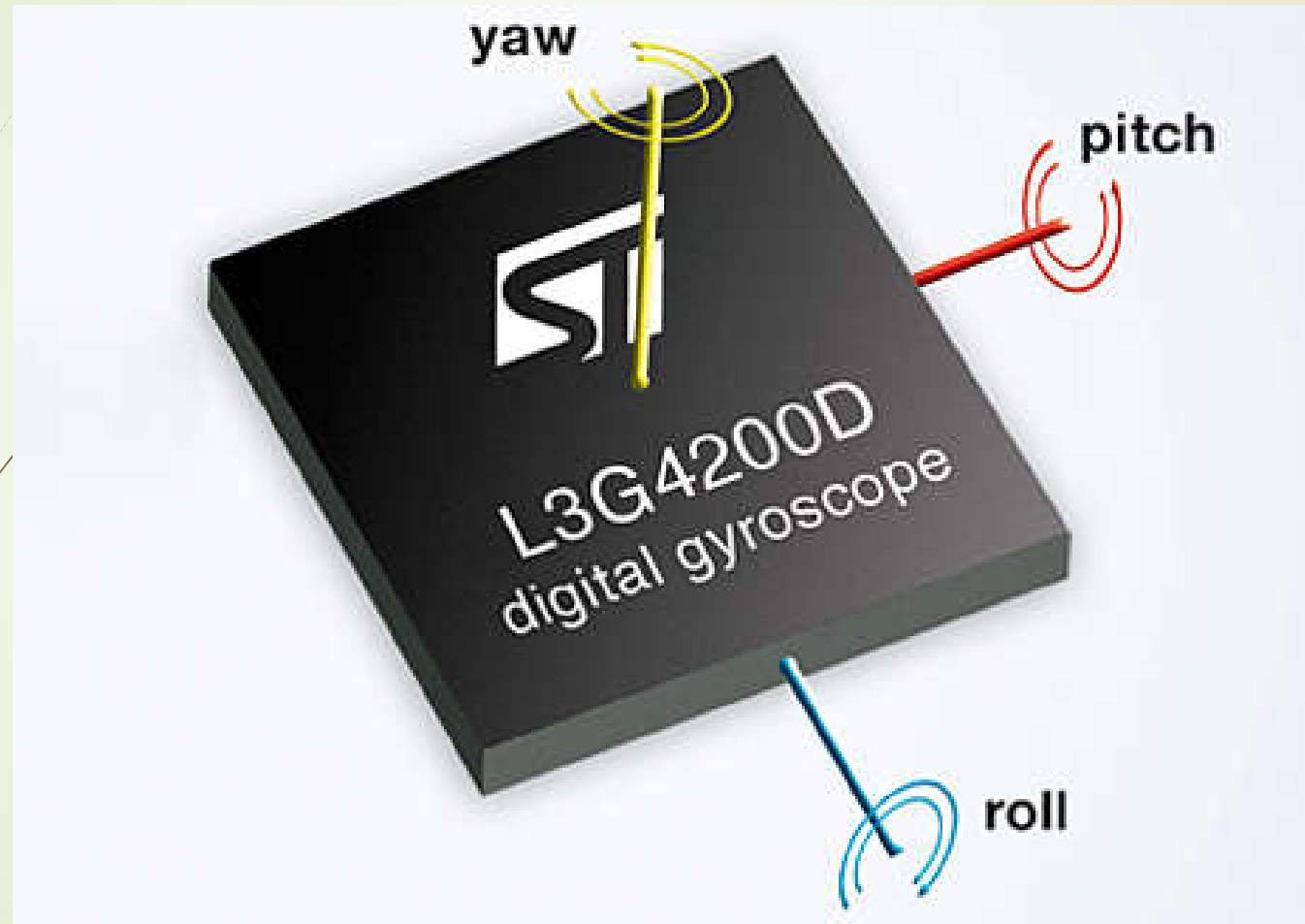
- Used to monitor acceleration along a single axis.

3. Main sensors

Gyroscope

- It measures the rotational speed of the device in rad /s (radius per second) around the three physical axes (x, y, and z).

- Typically used to detect rotational movements applied to the mobile device.
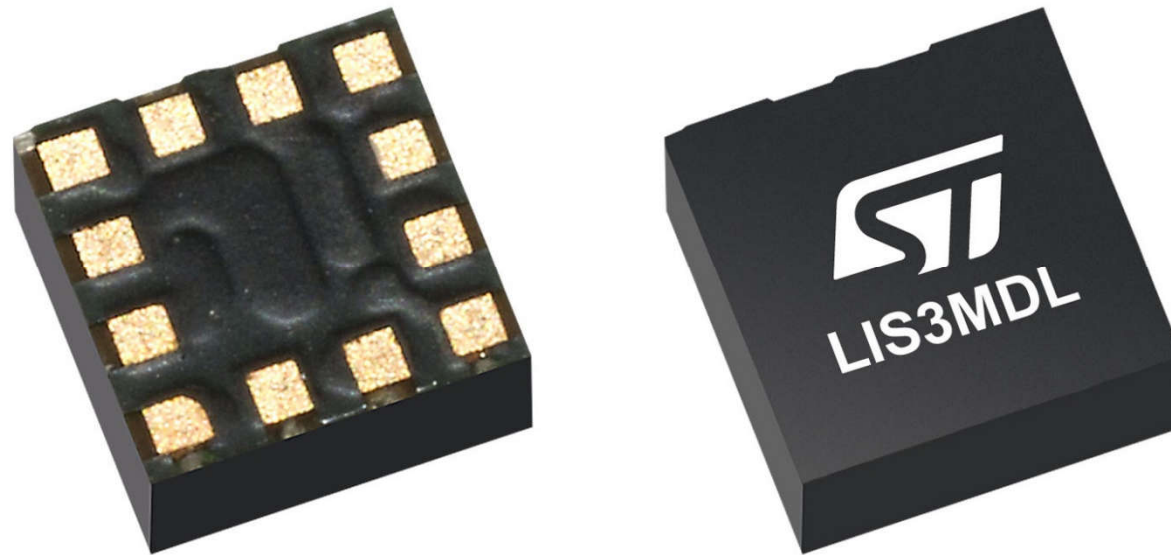
Gyroscope

3. Main sensors

Magnetic field sensor (geomagnetic sensor)

- This sensor measures the ambient magnetic field in microteslas (µT) along the three physical axes.

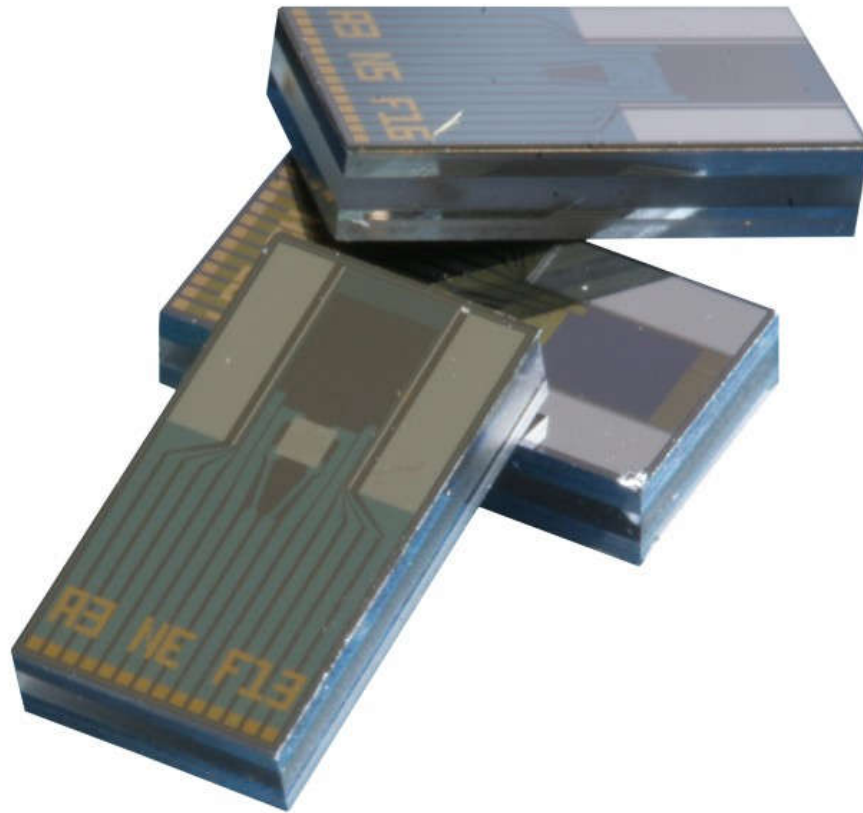- Used by the compass type app.

Magnetic field sensor

3. Main sensors

Light sensor

- This sensor measures the level of ambient light (illuminance) in lux.
- Most often used to control the brightness of the screen.

Light sensor

3. Main sensors

Proximity sensor

- This sensor measures the proximity of an object in centimeters to the screen of the mobile device.

- This sensor is usually used to determine if the mobile device is near the user's ear to turn off the screen during a call.

Sensor for proximity

3. Main sensors

Atmpspheric pressure sensor (barometer)

- It measures ambient air pressure in hectopascals (hPa) or millibars (mbar).

- Used to monitor the change in atmospheric pressure.

- Counting becomes 25 per second.

- Together with the user's location information, it can be used to determine the altitude with an accuracy of 50 cm.

3. Main sensors

Ambient temperature sensor

- This sensor was first used in the Samsung Galaxy S4 smartphone.

- It serves to determine the air temperature through a small hole in the base of the smartphone.

- Makes it possible to edit the error in the pressure value caused by the change in air temperature.

3. Main sensors

Relative humidity sensor

- It measures the ambient relative humidity in percent.

- used to read the dew point and the absolute and relative humidity.

- This sensor was first used in the Samsung Galaxy S4 smartphone.

Temperature sensor

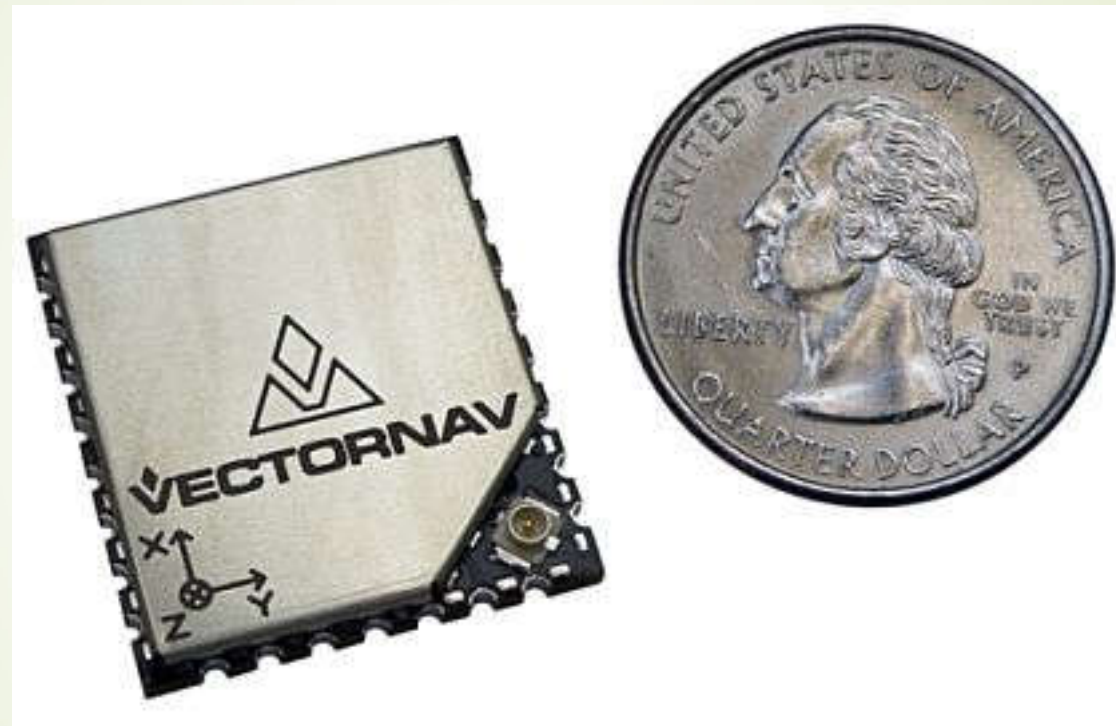- The sensor measures the temperature of the device in degrees Celsius.

3. Main sensors

Location sensor

- used to determine the location of the user's device using the GPS and/or GLONASS satellite navigation systems.

Location sensor

3. Main sensors

Image sensor (camera)

- Used when capturing images and recording video information.

- With modern mobile devices, they have at least two sensors - one located on the front (with weaker capabilities - for conducting video calls, creating selfies, etc.) and a second one located on the back of the device (with greater capabilities - for capturing high-quality photos and digital video in HD or 4K quality).

- It can be used for facial recognition of the user (authentication).

3. Main sensors

Microphone

- Primarily used to record audio information, but can serve to filter out ambient noise.

Hall sensor

- Used to automatically turn on/off the smartphone screen when opening/closing the protective cover.

3. Main sensors

Gesture recognition sensor

- This sensor was first used in the Samsung Galaxy S4 smartphone.

- It consists of two infrared light sources and a receiver between them.

- As the user's hand moves toward the screen, the receiver detects reflections of infrared light. When moving the hand in a horizontal direction, the receiver determines the change in the reflection times of the infrared light emitted by the left and right sources and determines the direction of movement.

3. Main sensors

Fingerprint recognition sensor

- Used for user authentication and improves operational security.

- It was first used in the Apple iPhone 5S smartphone.

- The sensor has been developed to recognize fingerprints at any angle, which further improves its performance.

3. Main sensors

3D sensor

- It is a sensor that continuously scans the surrounding space and creates an accurate virtual computer model.

- Similar to the Microsoft Kinect sensor, but much more compact.

- First used in the Google tablet Nexus 10.

Sensors in some mobile devices

Sensor \ Smartphone	LG G2	Sony Xperia ZL	HTC One	Samsung Galaxy S4	Samsung Galaxy Note 3	Apple iPhone 5S	Nokia Lumia 1020	Motorola DROID MAXX
Accelerometer	+	+	+	+	+	+	+	+
Barometer	-	+	-	+	+	-	+	+
Geomagnetic sensor	+	+	+	+	+	+	+	+
Sensor for fingerprint recognition	-	-	-	-	-	+	-	-
GPS	+	+	+	+	+	+	+	+
Gyroscope	+	+	+	+	+	+	+	+
Humidity sensor	-	-	-	+	+	-	-	-
Thermometer	-	-	-	+	+	-	-	-
Image sensor	+	+	+	+	+	+	+	+
Microphone	+	+	+	+	+	+	+	+
Proximity sensor	+	+	+	+	+	+	+	+
Light sensor	+	+	+	+	+	+	+	+
Gesture recognition sensor	-	-	-	+	+	-	-	-
Hall sensor	-	-	-	+	+	-	-	-