MPU6050 Module Overview

The **MPU6050** is an **Inertial Measurement Unit (IMU)** sensor that combines a **3-axis accelerometer** and a **3-axis gyroscope** in a single chip. It is commonly used in applications such as motion tracking, gesture detection, and stabilization systems (e.g., drones, robots, and gaming controllers).

- **Accelerometer**: Measures acceleration in **x, y, and z axes**.
- **Gyroscope**: Measures angular velocity (rotation) in **x, y, and z axes**.
- **Temperature Sensor**: Measures the internal temperature of the chip.

The sensor communicates using the **I2C** protocol, allowing it to be easily interfaced with microcontrollers like **Arduino**.

How the Accelerometer Works (Piezoelectric Effect)

The **accelerometer** in the MPU6050 operates based on the **piezoelectric effect**, which is the ability of certain materials to generate an **electric charge** when subjected to **mechanical stress**.

- Inside the MPU6050, microscopic piezoelectric crystals deform when acceleration is applied.
- This deformation creates a proportional **electric charge**.
- The charge is then converted into a **digital signal** that represents acceleration in **g-forces (g)**.
- The MPU6050 can measure both **static acceleration** (like gravity) and **dynamic acceleration** (like motion and vibrations).

Selectable Accelerometer Measurement Ranges

The MPU6050 accelerometer supports **four different sensitivity ranges**, which can be selected **programmatically** by configuring the **ACCEL_CONFIG** register.

Range Selection	Sensitivity (LSB/g)	Measurement Range
±2g	16384 LSB/g	-2g to +2g
±4g	8192 LSB/g	-4g to +4g
±8g	4096 LSB/g	-8g to +8g
±16g	2048 LSB/g	-16g to +16g

- **Lower range (±2g)** → **Higher precision**, suitable for applications requiring fine movements.
- **Higher range (±16g)** → **Lower precision**, but can detect faster and stronger movements.

Difference Between an Accelerometer and a Gyroscope

Feature	Accelerometer	Gyroscope
Measures	Linear acceleration (motion in x, y, z)	Angular velocity (rotation in x, y, z)
Principle	Piezoelectric effect (mechanical stress → electric charge)	Vibrating MEMS structure (Coriolis effect)
Unit	**g** (gravitational force)	**degrees per second** (°/s)
Use Case	Detecting movement, tilt, and orientation	Measuring rotation, stability, and angular motion
Example	Smartphone screen rotation, pedometer	Drone stabilization, VR head tracking

- **Accelerometer detects movement** (e.g., walking, tilting a phone).
- **Gyroscope detects rotation** (e.g., turning a steering wheel, rotating a drone).

For **accurate motion tracking**, **both** accelerometers and gyroscopes are often used **together**, such as in the **MPU6050** module.

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