Sensors and what they do:

Accelerometer: which direction is down towards the Earth (by measuring gravity) or how fast the board is accelerating in 3D space

Gyroscope: measure spin and twist

Magnetometer: sense where the strongest magnetic force is coming from, generally used to detect magnetic north

Range:

Accelerometer: ±2/±4/±8/±16 g at 1.6 Hz to 6.7KHz update rate

Gyroscope: ±125/±250/±500/±1000/±2000 dps at 12.5 Hz to 6.7 kHz

Precision:

For all sensors, there was a general precision within +/- 1% to 0.1%

Sensitivity:

***Couldn’t find sensitivity for this model T-T

Sensor units:

Each sensor measures data that must be converted from raw digital values to real-world units using the sensor's sensitivity.

Accelerometer:

Acceleration (m/s^2) = raw value/sensitivity
Unit: m/s^2

Gyroscope:

Angular velocity = raw value/sensitivity
Unit: °/s or radians

Magnetometer:

Magnetic Field (nT) = raw value x sensitivity
Units: nanoTesla

Orientation:

Accelerometer:

Accelerometer gives the **tilt** of the CubeSat relative to the local gravity. From the accelerometer readings, you can compute the **pitch** and **roll** angles using the following formulas:

$$\text{Pitch} = \text{atan2}(a_y, \sqrt{a_x^2 + a_z^2})$$

$$\text{Roll} = \text{atan2}(-a_x, a_z)$$

Magnetometer:

The **yaw (heading)** is calculated from the magnetometer readings by using the magnetic field data along the X and Y axes:

$$\text{Heading (Yaw)} = \text{atan2}(m_y, m_x)$$

Noise

Sources of Noise:

- Accelerometer: Noise sources include vibrations and thermal fluctuations that can introduce errors in the acceleration measurement.
- Gyroscope: Drift is the main source of error, where the gyroscope's reading gradually deviates over time. This can cause incorrect angular velocity measurements.
- Magnetometer: Magnetic field interference from nearby electronics or metal components can distort the magnetic readings.

Mitigation Strategies:

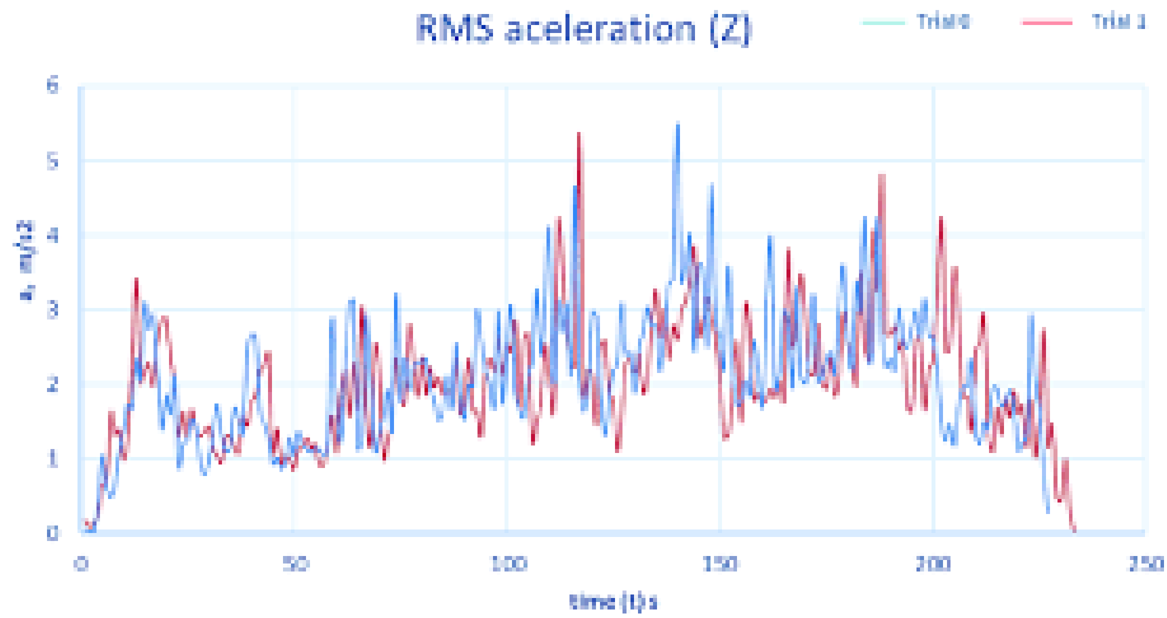
- Calibration: Perform sensor calibration to account for offsets and scale errors in the sensors.
- Filtering: Apply low-pass filters to smooth out high-frequency noise (e.g., vibrations).
- Sensor Fusion: Use algorithms like Complementary Filters or Kalman Filters to combine accelerometer, gyroscope, and magnetometer data and reduce noise and drift, especially for orientation calculations.

- Temperature Compensation: Apply corrections using temperature data, which may affect sensor behavior.

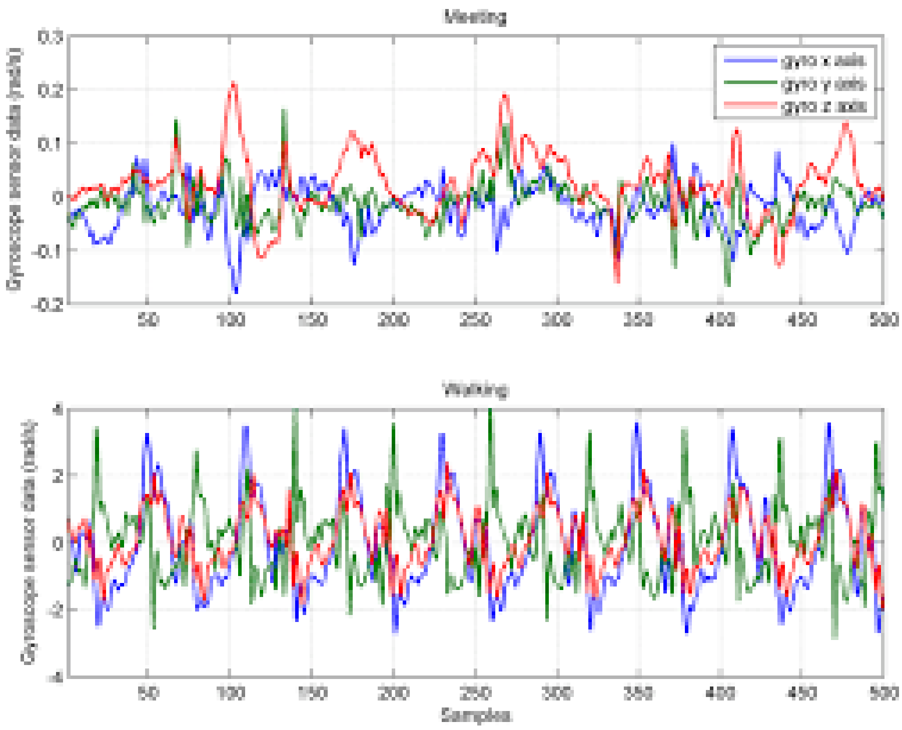
Plotting data:

All sensors are 3-axis

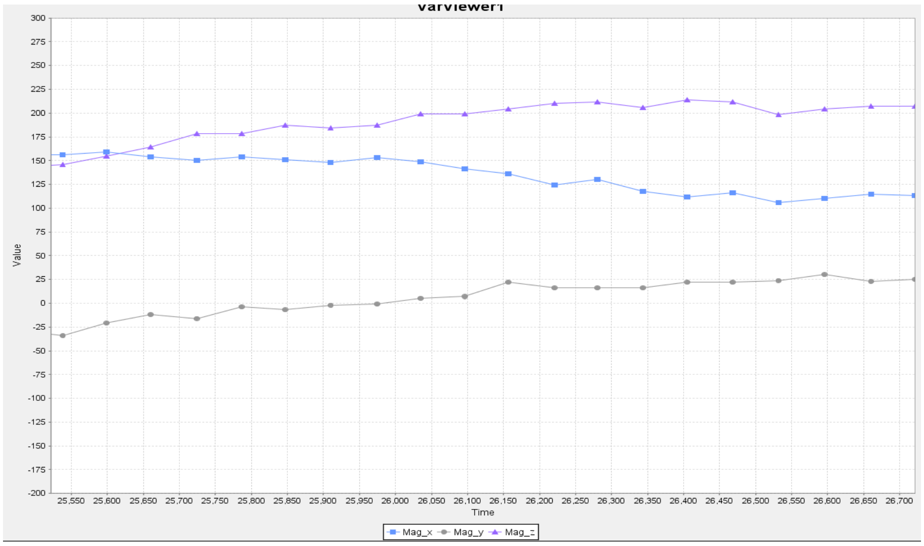
Accelerator:



Gyroscope:



Magnetometer:



Video:

This just shows a visual model of Accelerator and Gyroscope info:
https://www.youtube.com/watch?v=yqFfmwVufMo

The actual code is on this GitHub:
https://github.com/mattzzw/Arduino-mpu6050