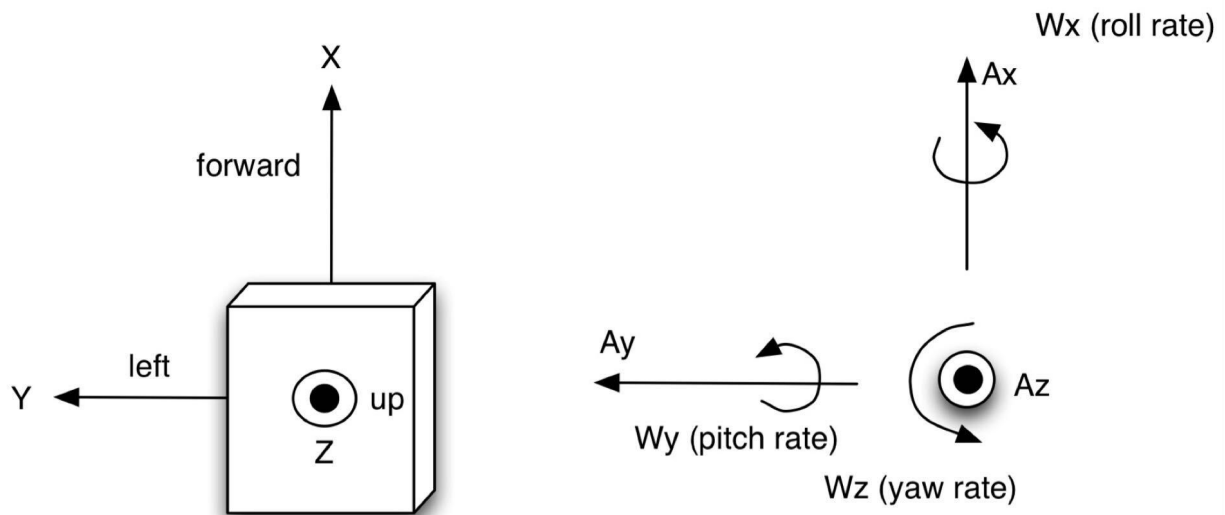


# IMU Reference

## Body Reference Frame Conventions



**Ax, Ay, Az** = accelerations along the corresponding axes (measures Normal force)  
**Wx, Wy, Wz** = rotation rates about the corresponding axes (right-hand rule)

The camera's optical axis is aligned with the x-axis.

## Data Formats

**IMU Measurements** (raw 10 bit ADC values):

- $7 \times N$  numpy array (holding  $N$  samples)

$[Time\_Stamps \quad Ax \quad Ay \quad Az \quad Wx \quad Wy \quad Wz]$

Time\_Stamps in unix time.

**Vicon Measurements:**

- $3 \times 3 \times N$  numpy array (holding  $N$  rotation matrices)
- $1 \times N$  numpy array of time stamps (unix time)

**Images:**

- $M \times N \times 3 \times K$  numpy array (holding  $K$  RGB images)
- $1 \times K$  numpy array of time stamps (unix time)

## Raw ADC Value Conversion to Physical Units

The equation to convert from the raw A/D values to physical units is

$$\begin{aligned}\text{value} &= (\text{raw} - \text{bias}) \times \text{scale\_factor} \\ \text{scale\_factor} &= \text{Vref}/1023/\text{sensitivity}\end{aligned}$$

The A/D converter was 10 bit, so the maximum value is 1023. The reference voltage for the A/D converter when collecting the data was  $\text{Vref} = 3.3 \text{ V} = 3300 \text{ mV}$ . The sensitivity for accelerometers is measured in  $\text{mV/g}$  and for gyroscopes in  $\text{mV/deg/sec}$ . At 3300 mV reference voltage, you can see from the data sheets that the accelerometer sensitivities should be  $330 \text{ mV/g}$ , while the gyroscope sensitivities should be  $3.33 \text{ mV/deg/sec} = 3.33 \times 180/\pi \text{ mV/rad/sec}$ .