Software 3/20/2026

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Agenda

- Intro to the pipeline & simulation software
  - Basilisk & Vizard (simulation platform)
  - ROS
  - Development for the PixelSat platform
- ADCS
  - Attitude determination, magnetometer
  - Attitude control, magnetorquers
- Designing the control system

Simulation & Pipeline

Simulation Software

Basilisk

- Astrodynamics framework for spacecraft simulation
- Allows us to emulate our sensors and modules
- Provides parameters to emulate various

Vizard

- Real-time visulization of Basilisk simulations
- Allows us to visually see alignment of satellite with ground sites (e.g. comms antennas)
- Can import CAD models to visualize PixelSat in space (minor)

ROS

- Robot Operating System
- Low-latency pub/sub messaging
- Used as our communication bridge between the simulator and the control software

Development for PixelSat

1. Clone https://github.com/pixelsat/simulation
2. Install ROS2 Jazzy (using RoboStack on Mac, build in WSL on Windows)
3. Install Basilisk and Vizard
   - `pip install bsk`
   - download Vizard from the website
4. View example programs in simulation/tests to observe the ROS message syntax
5. Read up about ROS implementation in C++, contribute to pixelsat/control
   - use branches, I don't want to waste my time with a merge headache

ACDS (Attitude Determination and Control System)

Attitude Determination

- **Magnetometer:** Measures the local geomagnetic field vector relative to the satellite as a vector S
- Frames of Reference
  - Sensor Frame (S): measured at the sensor
  - Body Frame (B_b): corrected for sensor orientation, found by $R_{bs}S$.
  - Inertial Frame (B_i): "true" magnetic field (obtained from WMM/IGRF using GPS, time info)
- **Determination:** Solve for the rotation matrix (or quaternion) R_{bi} such that $B_b = R_{bi}B_i$
  - NOTE: Cannot determine the orientation using the magnetic field alone

Attitude Control

- **Magnetorquer:** Generates a magnetic moment that interacts with the Earth's magnetic field to produce a torque
  - Will have 3 of these, one on each axis
  - $\boldsymbol{m} = N \cdot I \cdot A$ (vector pointing up from coil)
    - N=number of turns, A =cross-sectional area, I controlled via PWM
  - $\boldsymbol{\tau} = \boldsymbol{m} \times \boldsymbol{B}$ (orthogonal to magnetic moment & earth's magnetic field)

Designing the Control System

https://tinyurl.com/pixelsat1CS