

26/02/24

Demonstrating Visual-Inertial A&OD & On-Orbit Edge Computing

Progress summary

Updates

- **FSW development:**
 - **Onboard File Storage**
 - Single interface to SD Card
 - File Management Services for every logging tasks
 - Interface for telemetry downlink
 - **Camera interface**
 - Read and configure all 6 cameras
 - Access to camera's status, latest image and live feed
 - Storage of time stamped images of each camera is created
 - **IMU interface**
 - Sample sensor at pre-set frequency
 - Support Moving Averaging Filter for smoothing the data
 - **Jetson-PyCubed Inter-communication:**
 - Complete protocol spec
 - Helper library built for packet parsing and creation
 - Initial implementation to read and send messages done
 - **State Machine Manager**
 - Preliminary design, implementation in progress

Weekly Plan

- FSW development
 - PyCubed Configuration and Time Management & State Machines
 - Jetson-PyCubed command and control
 - Sun Vector module (processing, calibration)
 - Continue development on existing modules
- Estimation
 - MEKF for attitude estimation using IMU, magnetometer and sun sensor
 - Record time stamped sensor data to use in MEKF implementation.

65 days before May 1st

Blockers

Interface dependencies

- Mechanical:
 - Inertia measurements for the updated CAD model,
 - updated CAD of the CubeSat for test bed design

19/02/24

Demonstrating Visual-Inertial A&OD & On-Orbit Edge Computing

Progress summary

72 days before May 1st

Updates

- Vision:
 - Dataset download from 23 most salient regions
 - Landmark pruning for to identify ideal landmark size
 - Started hyperparameter tuning for LD
 - Looking into custom loss function focusing on pixel error
- Estimation integrated testing:
 - Generated camera vectors using landmark and satellite ground-truth through vector transformations
 - Tested batch optimizer to validate attitude estimation
 - Created small test setup to validate pixel to camera vector transformation
- Validation:
 - SIL environment setup between PyCubed and Simulation
 - First SIL test for detumbling control
 - Gyroscope noise analysis

Blockers

- Computing resources for LD training
 - [ECE Community Compute Clusters](#)
 - [Pittsburgh Supercomputing Center](#)
 - ROBO Cluster

Weekly Plan

- Vision
 - Continue training experiments with pruning
 - Continue dataset download
 - Tune hyperparameters and look into custom loss function
 - Working LD detector release by end of week
- Estimation
 - Continue development on batch optimiser
- FSW development
 - Work on PyCubed-Jetson communication
 - Finished PyCubed tasks for Alpha version

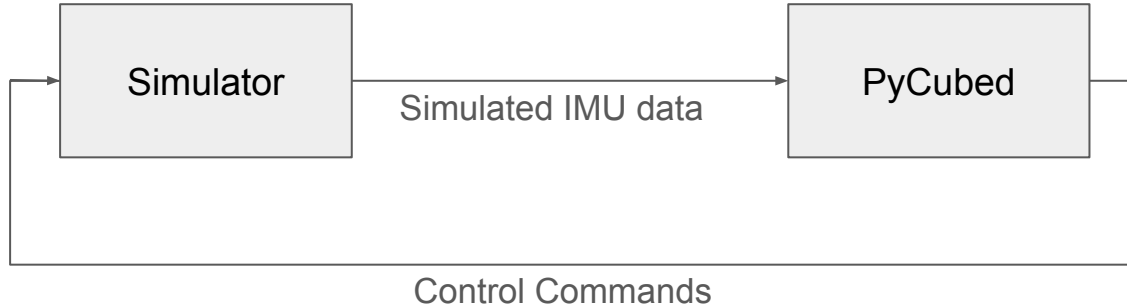
Interface dependencies

- Final CAD of the CubeSat for test bed design

Integrated testing

- Created small setup to test camera vector generation using image coordinates
- Verified transformation equations using actual x,y and depth information to find corresponding pixel coordinates and vice versa.
- Tested batch optimisation using groundtruth satellite ECEF and landmarks detected.
- Process
 - Get landmark lat long and convert to ECEF, get satellite groundtruth ECEF
 - Subtract the two vectors to get vector pointing from Landmark to satellite, invert to get vector from satellite to landmark
 - Convert this vector into camera frame to get camera vectors
 - Use ECI coordinates and these vectors as inputs to estimator

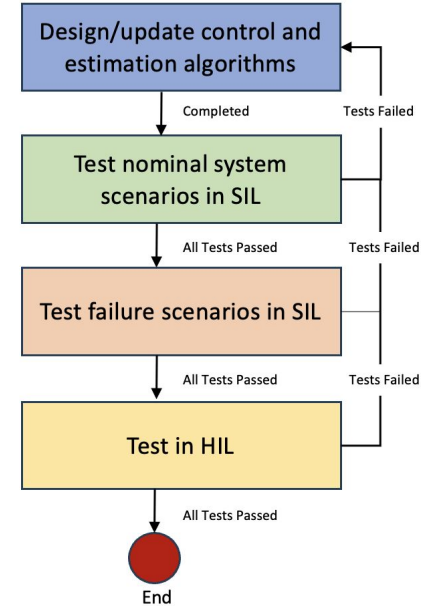
GNC Software Validation



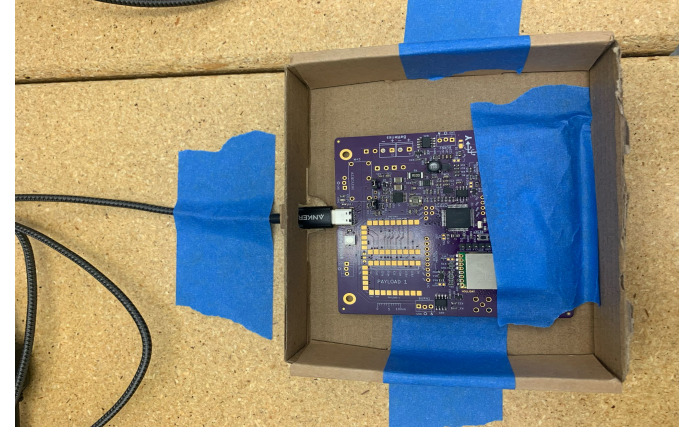
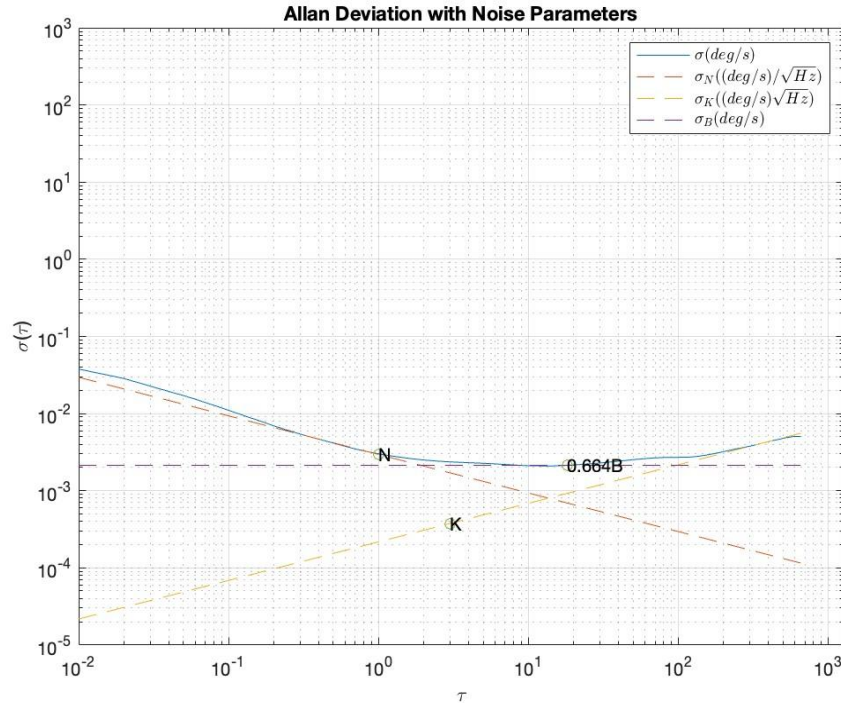
Software in Loop environment setup completed.

- Sensor readings generated in real-time on Simulator
- Readings are sent to PyCubed with Magnetic Control software running via Serial Communication
- Magnetic Control software processes the sensor readings and generates the control commands
- Simulator computes the next state for the satellite using the received control commands

Preliminary testing for Detumbling Control completed.



Gyroscope Noise Analysis



6 hours of datalogging of stationary IMU

- Allan variance for gyroscope noise parameter analysis, Parameters: N (angle random walk), K (rate random walk), B (bias instability)
- Helps us identify noise sources in stationary gyroscope data clusters
- Will be used for modelling the gyroscope accurately