Final Project

due on April 24th, 2023

Create a complete closed-loop attitude dynamics, determination and control simulation of a satellite. Write a report to document your design, use figures and tables to augment the narrative as much as possible (not to completely replace the narrative, just to complement it and make things more clear). In your report you must show that you have completed the following steps:

1. Code up the attitude dynamics and kinematics of the "true" motion. The initial conditions/perturbations must be such that the uncontrolled satellite tumbles. Gravity gradient perturbation is mandatory, the more you add on top of that, the better (Solar Radiation Pressure, Magnetic, drag, misaligned thrusters, etc.)
2. Choose a reference attitude of your liking (i.e. inertially fixed, Earth fixed, spinning, ...) and a controller to achieve your goal. (hint - initially feed the true states to the controller, **only initially, you will need to design the attitude determination as well!**)
3. Choose an actuator of your liking, the control command cannot feed the true dynamics directly, it must go through an actuator. Document you actuator model and which errors you include. You must include errors and they need to be randomizable. You need to include the statistics of these random errors in your report. The errors cannot be static, but there must be some time-dependent random fluctuation. While noise is ok.
4. Choose one or more attitude sensors of your liking. The navigation cannot receive the true data directly, it must go through a sensor. Document your sensors model and which errors you include. You must include errors and they need to be randomizable. You need to include the statistics of these random errors in your report. White noise is mandatory, if you have a gyro, a gyro bias is also mandatory. The more you add on top of that the better.
5. Implement a Multiplicative Extended Kalman Filter to estimate the attitude and the angular velocity.
6. Closed the loop by feeding the navigation estimate to the controller.
7. The atttitude determination and control functions must be called at a discrete, fixed time step, e.g., 10 Hz or 40 Hz.
8. Perform at least 100 Monte Carlo runs and document the results of this analysis.

If in doubt come ask, I might forget to mention some details here, I will talk about what needs to be done during class when we cover certain pertinent topics.