ASEN 5044 Statistical Estimation for Dynamical Systems
Spring 2020
Project Progress Report - Part 1

Out: Tuesday 4/7/2020 (posted on Canvas)

Due: Tuesday 4/14/2020, 5:00 pm: ***GROUP SUBMISSION*** **TO CANVAS!**

(only one group member needs to submit, but all group member names should be listed on page 1 of the document)

You are to submit solutions as a project group and will receive a group grade for this homework assignment. Show all your work and explain your reasoning. ***Note that this is a part of the final project, you will develop code needed for the final project – so read, think and plan ahead to organize, comment, modularize, and re-use your code! Good basic programming practices will save you a lot of time and effort!!***

This is a part of the final project, we expect a typed report, written professionally.

BASIC SYSTEM ANALYSIS: Select a system from the updated final project system descriptions list posted on Canvas. Report which system you selected – **you must stick with this choice for the final project assignment**. Then do the following to turn in with this Report:

a. Find the required CT Jacobians needed to obtain CT linearized model parameters. Show the key steps and variables needed to find the Jacobian matrices and state the sizes of the results. DO NOT use a symbolic solver or software to find the Jacobians (though you may use these to do a final check of answers).

b. Linearize your system about its specified equilibrium/nominal operating point (given in the description) and find the corresponding DT linearized model matrices (from the corresponding DT nonlinear model Jacobians) for a suitable sampling time (use $\Delta T = 10$ sec for the orbit determination problem, and $\Delta T = 0.1$ sec otherwise). **If possible**, discuss the observability, controllability, and stability properties of your time-invariant system approximation around the linearization point (if you have a time-varying result, then note this and skip the analysis).

c. Simulate the linearized DT dynamics and measurement models near the linearization point for your system, assuming a reasonable initial state perturbation from the linearization point (report the perturbation you chose) and assuming no process noise, measurement noise, or control input perturbations. Use the results to compare and validate your Jacobians and DT model against a full nonlinear simulation of the system dynamics and measurements using ode45 in Matlab (or a similar numerical integration routine), starting from the same initial conditions for the total state vector and again assuming no process noise, no measurement noise, and no additional control inputs (i.e. aside from those possibly needed for the nominal linearization condition). Provide suitable labeled plots to report and compare your resulting states and measurements from the linearized DT and full nonlinear DT model. (For the orbit determination problem: simulate at least one full orbit period; for the other systems, simulate at least 400 time steps).