Classical Autonomous Systems – Autumn 2021

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Exercise Session 7

1. Consider the simplified 1 DOF model of a satellite described by

$$\begin{cases} \ddot{\theta} = u \\ y = \theta \end{cases} . \tag{1}$$

After rewriting the above model under a state-space form, design and tune a continuous-time observer using the Matlab command `place`.

2. Implement your observer to estimate the state of system (1) in Simulink (make a *clean* program with subsystems, separate observer and plant, and add noise on measurements after you have checked that your observer is working, retune if necessary).

3. There is actually a bias on the input induced by an unknown imbalance in the steering system, ie instead of control input u in system (1), we now have $u + u_0$ where u_0 is an unknown constant bias on the actuator. After rewriting the above model under a state-space form that includes the imbalance as a state component, analyze the observability property of the new system.

4. Implement a new observer (in continuous-time) to estimate unknown imbalance u_0.

5. Replace your observer with a continuous-time Kalman Filter, which you will implement entirely yourself (with Riccati equation included).

6. Design, implement and test an output feedback controller combining a state-feedback controller and the observer you designed, in order to stabilize the system around the origin despite the unknown imbalance u_0.