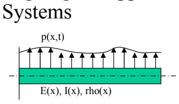
Collocated/Non-Collocated Control

Lecture 6

Motivation

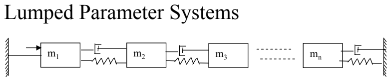
Control of (Flexible) Structures

- Usually, models for (flexible) structures can be obtained in two ways:
  - Lagrangian Approach for distributed Parameters Systems



$$\frac{\partial}{\partial x^2}\left(EI\frac{\partial^2 y}{\partial x^2}\right)+\rho\frac{\partial^2 y}{\partial x^2}=p$$

    - In this case, the system has to be discretized (FEM)
  - Lumped Parameter Systems

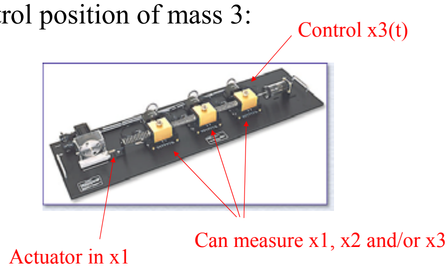


Placement of Sensors and Actuators

- Where to place sensors and actuators ?
  - Infinite possibilities (depends on your discretization)
- Two Options:
  - Collocated Control ⇒ sensor and actuator are placed in the same position (control what we measure)
  - Non-collocated Control ⇒ sensor and actuator are placed in different positions

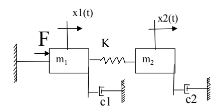
Examples

- Rectilinear Plant: Suppose we would like to control position of mass 3:



Examples – cont.

- Take the following simplified Model



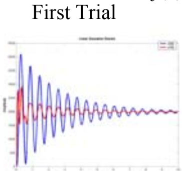
  – Wants to control position of m2 using actuator at m1 and sensors either at x1 or x2.

Examples – cont.

- Implement a PD, let's say, based on the damped control of the previous lab using x1 as feedback ⇒ Collocated Control

$$G_c(s) = K_p + K_d s$$

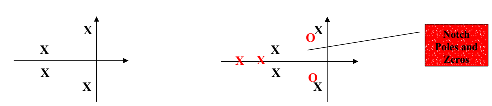
First Trial



Improved resp. for x1

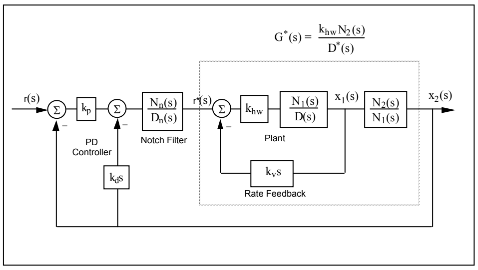
Solutions

- For systems with high-frequency vibration modes, i.e, plant exhibits pair of complex conjugate poles near the imaginary axis ⇒ Use of a Notch Filter (or pole-zero cancellation filter)



- For the coupling problem ⇒ use minor loop feedback (example: rate feedback)

Solutions – cont.

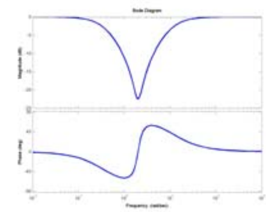


Notch-Filter

- Cancel poles that are close to the imag. axis by placing a zero at the same position. Example:
  - Plant ⇒ $G_p(s) = \frac{1}{(s^2 + 0.8s + 4)}$

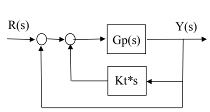
Notch-Filter

$$G_F(s) = \frac{(s^2 + 0.8s + 4)}{(s + 0.384)(s + 10.42)}$$



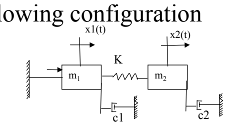
Rate feedback

- So far, we have used series controller in the forward path (PID, Lead,-Lag, etc..)
- Advantages in placing the controller in a minor feedback loop ⇒ used for positional servo systems (tachometer);
- Behaves as a PD controller;



Today's Experiment

- Use the following configuration



  - Start with the PD controller designed for a 1DOF and iteratively determine the best PD controller for both masses using a collocated-type controller
  - You can use Matlab simultaneously with the implementation for best results.
  - Use LabVIEW Software
  - Values of the PD are given on the Hand-out!!

Today's Experiment – cont.

- For your lab report, you will also design a noncollocated PD controller + Notch Filter, using the LabVIEW parameters
- Follow all steps on the lab manual, but disregard implementation.
- Optional ⇒ Implementation of your PD noncollocated design
  - If you want to implement it, let me know, so you can come back later
  - You will have to recalculate your PD ⇒ implementation of the noncollocated ⇒use ECP.