Politecnico di Milano

AUTOMATION AND CONTROL ENGINEERING

Study and Control of the Mechanichal System: Rotary Flexible Joint

Course

Automation and Control Laboratory

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Problem Description

This report will describe the model of the system, our solution and some attempts to describe and control the system.

The system is composed by a motor's module that provide torque to a turret, above the turret there's a beam which is attached at one of the two edges through a screw to the turret. The beam will follow the movement of the base due to two springs attached between the turret and the beam.

The system has several interfaces that could be connected to an acquisition system (DAC/ADC + Amplifier) to acquire measurements and provide input signal, the interfaces are:

- Actuators:

  Power Supply input of the motor's module (changing the voltage);

- Sensors:

  Incremental Encoder for the position of the turret with respect to to the motor's module;

  Incremental Encoder for the relative position of the arm with respect to the turret.

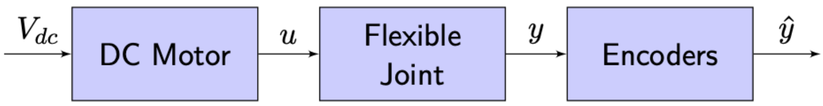
The acquisition system composed by ADC/DAC + Amplifier is already configured, it doesn't require our attention, for this reason it will not treat in this report.

The main task is to control a low damped system with variable parameters, this goal is divided in sub-tasks to be achieved:

1. position control of the top base, with a frequency based approach;
2. position control of the arm tip, with a frequency based or a state space approach;
3. position control of the arm tip with uncertainty in the spring stiffness and arm moment of inertia, with a state space approach or other advanced control techniques.

Model Identification

The system is composed by a coupling of a DC electric motor, schematically the system is:



The physical equations of The DC Motor follow the static motor dynamic (neglecting the $L_a \cdot pI_a$ component), in fact that the resonance frequency is pretty higher with respect to the maximum frequency that the system can acquire. So the equations are:

$$\begin{cases} V_a = R_a I_a + E \\ E = k_m \Omega \\ \tau = k_t I_a \end{cases} \tag{2.1}$$

After several mathematician steps and considering the gearbox effect:

$$\tau = \frac{\eta_m \eta_g K_t K_g (V - K_g K_m \dot{\theta})}{R_m}$$

To model the inertia and the friction of the gearbox instead we consider their equivalent effect using the coefficient J_{eq} and B_{eq}. The turret

Position Control of the Base

Position Control of The Tip

Position Control of the Tip with Uncertanties

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