Numerical experiments on the control of AMB with uncertain flexible dynamics

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ABSTRACT

In active magnetic bearing (AMB) rotor systems, the uncertainties of the plant model play the key role in robust control synthesis. In this research bending modes of AMB rotor are considered as uncertainties. The relative location of the mode shape in relation to the locations of sensors and actuators has significant effect. The main goal is to check how controller can deal with uncertain plant model. How accurate should we know bending modes including mode shapes and their frequencies? To check the issue rotor model of AMB is built in Matlab as a rigid body that does not take into account presence of bending modes. A robust controller is built and tuned using Glover McFarlane loop shaping method [1], [2] for this plant. Loop shaping guarantees good performance, while H_∞ normalized coprime factor loop-shaping guarantees both performance and stability. Matlab's ncfsyn function is applied. This controller is then tested with a flexible rotor model that comprises the known rigid modes and the number of lowest frequency bending modes in Simulink. Full rotor model with bending modes is shown in Fig.1. Numerical results are analyzed and presented.
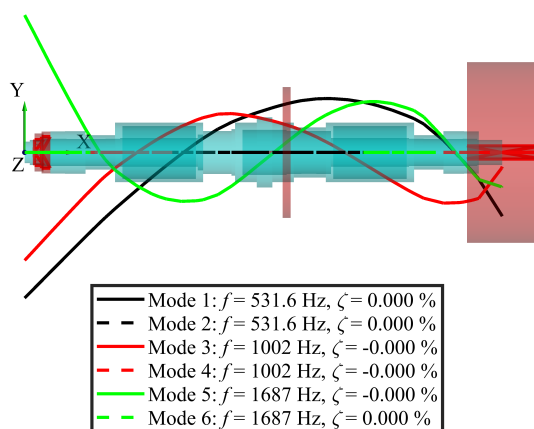
Mode 1: f = 531.6 Hz, ζ = 0.000 %
Mode 2: f = 531.6 Hz, ζ = 0.000 %
Mode 3: f = 1002 Hz, ζ = -0.000 %
Mode 4: f = 1002 Hz, ζ = -0.000 %
Mode 5: f = 1687 Hz, ζ = -0.000 %
Mode 6: f = 1687 Hz, ζ = 0.000 %

Figure 1. FEM rotor model with bending modes and their frequencies

Keywords: Active magnetic bearings, uncertain bending modes, control, loop shaping.

REFERENCES

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