Decoupling Control Based on Linear/Nonlinear Active Disturbance Rejection Switching for 3 Degrees of Freedom HMB

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Background

Compared with the conventional bearings, magnetic bearings possess many advantages such as no friction and abrasion, no lubrication and no sealing, high speed, high precision and long life, which have innovated the traditional supporting forms fundamentally. Hybrid magnetic bearings with permanent magnet biased flux are among the most recommended magnetic bearings for reducing cost and consumption. Hence, hybrid magnetic bearings have a broad prospect of application in high-speed machine tool spindle, nuclear energy, flywheel energy storage system, and so on.

Objectives

- Good performance of the 3 degrees of freedom 6-pole hybrid magnetic bearing (3-DOF 6-pole HMB) system while occurred the external disturbance.
- Outstanding decoupling performance between the variables in different directions.

Control System Simulation Test

The influence of the configuration and suspension forces mathematical models of the 3-DOF 6-pole HMB is shown in the figure.

Supposing that the rotor has a small displacement in the axial positive direction, $x$ and $y$ in the radial positive direction. Through the rotor’s force analysis of the 3-DOF 6-pole HMB, we can derive the 6-order state equations of the system.

Conclusion

- The effect of the configuration and suspension forces mathematical models of the 3-DOF 6-pole HMB is analyzed.
- Using the linear/nonlinear active disturbance rejection switching control (SADRC), the 3-DOF 6-pole HMB system is converted into a multivariable, decoupled and linear system.
- The simulating results show that the control system has achieved good performance, and the SADRC has a better capability to inhibit the disturbances from the input of the system.
- The experimental results show that the proposed controller has good static/dynamic stability and outstanding decoupling performance.