

Mechanical Shortcut Localization for Active Vibration

Isolation Systems

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Abstract

High precision control systems with prominent applications in semiconductor lithography require an advanced vibration isolation. Such systems often comprise a spring-supported decoupling mass with an active damping using position sensors and actuators. Due to the increasing complexity of modern semiconductor machines, assembly faults, i.e. mechanical connections (shortcuts) become difficult to locate and can negatively impact the control system.

This contribution presents a model-free approach to locating shortcut positions using just transfer function measurements from the build-in sensors and actuators. The six degrees of freedom transfer function of the incorrectly assembled system is compared with a known reference system. These two are combined to set-up an optimization problem minimizing the error norm in order to get the direction of the shortcut. Extending this method, it is also possible to accurately locate the position, or to identify different types of shortcuts. The resulting optimization problem can be transformed into a simple eigenvalue problem which is solved efficiently.

The theory is shown to work well for a general 3D rigid body isolation system and the detection algorithm is tested with a simulation model and a known disturbance. Experiments with real systems have been performed and highlight that a mechanical shortcut can be located accurately. This leads to quality improvements and reduced repair efforts in high-precision semiconductor systems.

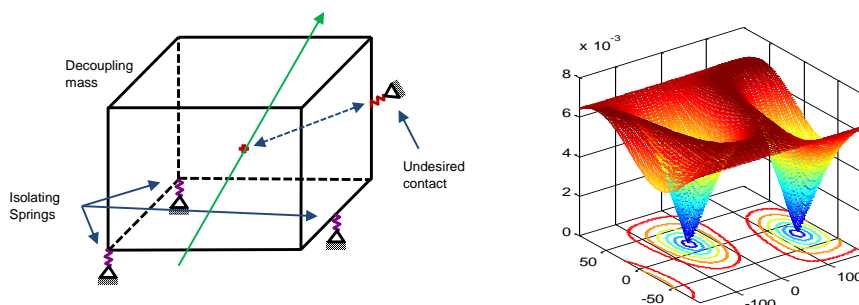


Figure 1: Vibration isolation system with an undesired mechanical shortcut and the localization obtained through an optimization algorithm.