Improving the vibration isolation performance of hard mounts for precision equipment

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Introduction

Disturbances are becoming increasingly important in high-precision machinery, in which the required accuracy level is reaching (sub-) nanometer levels. Commonly, sensitive machines (or components) are supported by soft mounts – e.g. pneumatic isolators – to reduce the transmission of base vibrations to the supported machine. Inherent to their low stiffness, such soft mounts offer only poor machine positioning under the influence of direct disturbances, e.g. internal stage motions or contact forces. These vibration isolation systems may not perform satisfactorily in the presence of both significant direct disturbances and base vibrations.

Design strategy

This research projects aims at designing a vibration isolation system which offers high support stiffness as well as reduced transmissibility of base vibrations. It is based on a mechanically stiff mounts (so-called hard mounts) and an active control system which should provide the required vibration isolation. The control strategy combines feedback control to add artificial damping and adaptive feedforward control to reduce the base vibration transmissibility.

Performance and limitations

Some experimental results on a highly simplified, one-directional laboratory setup are presented, which illustrate the effectiveness of the presented control strategy. Performance limitations that were observed during the experiments are the presence of low-frequency noise, time and computational delays in the control loop and the computational complexity of the adaptive feedforward control algorithm.

Future research

Future work will focus on the extension to a more complex setup having multiple sensors and actuators as well as improvement of the control system. In this multi-channel setup, the mechanical design of the hard mounts will be of key importance as well.