Design of a smart mount for vibration isolation in precision equipment

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Introduction

In general, machine supports are designed for high stiffness, thus providing robust alignment of the machine and low compliance to direct disturbances. However, the support stiffness is sometimes sacrificed for very sensitive equipment. These machines are often placed on compliant mounts, e.g. pneumatic isolators, to reduce the effects of floor vibrations.

Objective

The objective of this research project is to develop a machine mount concept which provides high support stiffness as well as satisfactory isolation of floor vibrations by means of active vibration isolation control. Figure 1 shows a schematic drawing of a machine supported by a mount with an active vibration isolation system.

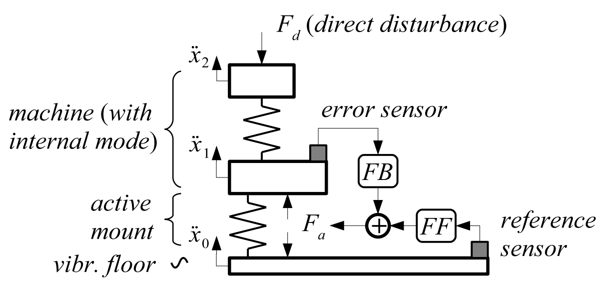

Figure 1 : Schematic drawing of a machine with an internal resonance mode, supported by an active mount. The machine is subjected to a direct disturbance force and floor vibrations.

Methods

Mechanical design The machine mounts are designed to be stiff in the actuated directions, which results in a low compliance to direct disturbances. Transverse and torsional stiffness are kept low, to prevent energy transfer through these 'parasitic' paths.

Control strategy The control system serves two purposes:

- integral acceleration feedback control (FB) is used to add artificial damping to the suspension modes and the dominant structural modes;
- adaptive feedforward control is then used to achieve further improvement of the vibration isolation performance by minimizing the squared acceleration error;

Results

The control strategy was implemented on a test setup with a single direction of motion, which closely resembles the schematic system shown in figure 1. A shaker was used to excite the 'floor'. Figure 2 shows the measured amplitude frequency response to the shaker force, for FB only and for FB combined with FF based on the shaker force.

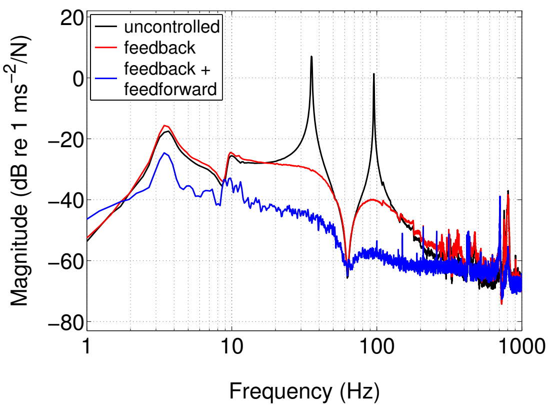

Figure 2 : Amplitude frequency responses of payload acceleration to shaker force

Discussion

The combination of feedforward and feedback control results in an improved floor vibration transmissibility while maintaining a stiff connection to the floor and thus low compliance to direct disturbances. Further research will focus on 3D mount design and improvement of the control system.

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