Real Time Control of a Six-Degree-of-Freedom Vibration Isolation Setup

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Vibration isolation aims at reducing the transmission of vibration from one body or structure to another, to prevent undesirable phenomena such as sound radiation [2].A well-known method for vibration isolation is passive isolation, such as the use of supports which consist of springs and dampers. By designing the stiffness properties of the material, it is possible to provide a certain level of vibration isolation. However, vibrations in the lower frequencies are difficult to isolate [2].A more promising method for vibration isolation is hybrid isolation. In addition to passive isolation, an active vibration isolation control system is used with sensors and actuators, which compensates for vibrations in the lower frequencies.
For research and development, a six-degree-of-freedom vibration isolation prototype has been built at our laboratory (see Figure 1 on the left for a photo of the prototype). The setup consists of three mounts carrying a plate, which is being vibrated by a shaker, attached to it. The plate is connected to the mounts by six piezo-electric actuators (two actuators per mount). The three mounts itself are attached to a ground plate and every mount has two acceleration sensors on top of it. The goal of the setup is to suppress tonal disturbances at the ground plate, by minimizing the signals from the six acceleration sensors and by steering the six piezo-electric actuators, accordingly. The adaptive controller W we adopt is a finite impulse response model, which is updated on the basis of the least mean squares algorithm [1]. It is demonstrated that by using an accurate linear model of the secondary path S nearly perfect isolation control is achieved.

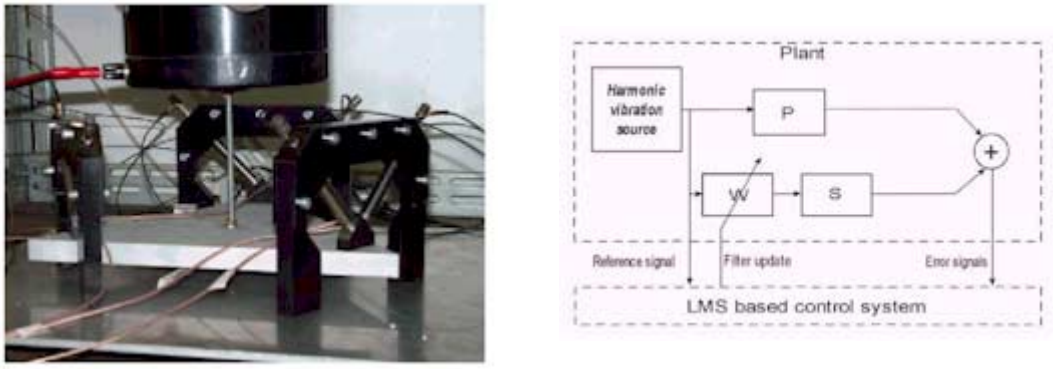

Figure 1:
Left: A photo of the six-degree-of-freedom vibration isolation setup.
Right: A block scheme of the experimental setup as depicted on the left. P represents the one input / six output primary path from the disturbance to the error sensors, S represents the six input/six output secondary path from the actuators to the error sensors and W represents the one input/six output adaptive controller.

References:

[1] S.Kuo and D.Morgan.Active Noise Control Systems John Wiley &Sons,Inc.,1996.
[2] C.Hansen and S.Snyder.Active Control of Noise and Vibration E &FN Spon,1997.