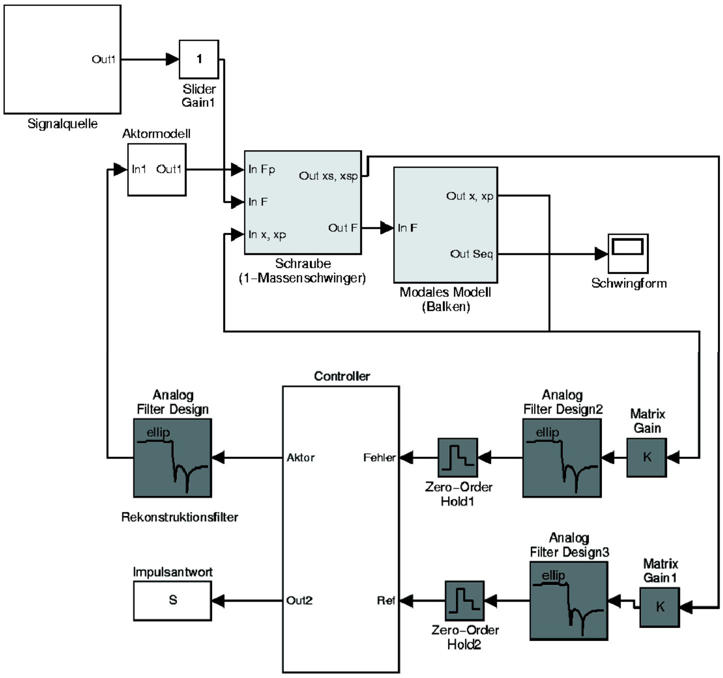
# Total Decoupling with an Adaptive Interface

CUSTOMERS

- Adaptive interface for neutralization of structural vibrations
- Controller running on dSPACE Prototyper
- RTI and ControlDesk for implementation and experiment

In the Department of Adaptronics at the Otto-von-Guericke University in Magdeburg, Germany, an adaptive interface is being developed to decouple two mechanical systems. This interface effectively cancels out vibrations propagating from one mechanical system to another. The model of the mechanical structure as well as an adaptive control algorithm is implemented within the MATLAB/ Simulink environment. For real-time simulation, the control algorithm, defined as Simulink blocks, runs on dSPACE Prototyper, comprising a multiprocessor system. The developed adaptive interface has been verified and proved to work fine. As a result, series production levels for various applications have been reached.

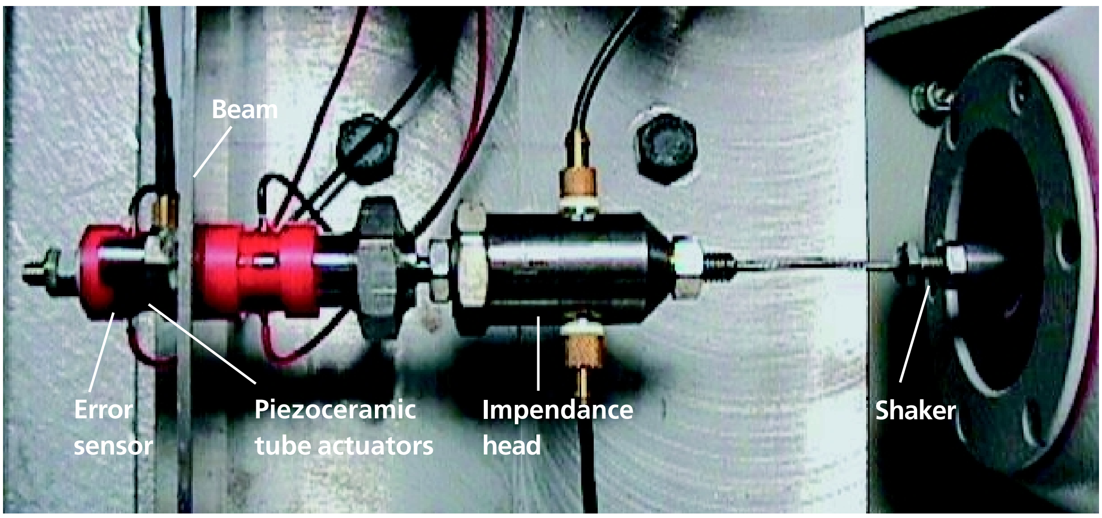



*Simulation of the adaptive system with Simulink.*

The adaptive interface is designed to eliminate vibrations moving from one mechanical system to another via a mechanical joint. The scope provided by the adaptive interface is fairly extensive. For example, if aircraft floors need to be mechanically isolated or sensitive electronic equipment in spacecraft needs to be protected, the adaptive interface cancels out the occurring vibrations and therefore massively reduces the impact via the mechanical connection.

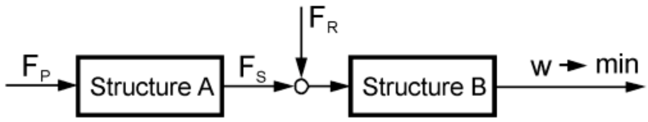
## Mechanical Setup

The basic principle is to apply forces at the linkage of the coupled structures. An adaptive interface based on piezoceramic stack actuators is applied, which can transmit static forces while isolating dynamic disturbances. For the experiment setup, the interface is mounted on a bi-clamped beam and driven by a digital controller in such a way that no dynamically disturbing forces will affect the beam. Therefore, the actuators counteract




*Experimental setup of the adaptive interface.*

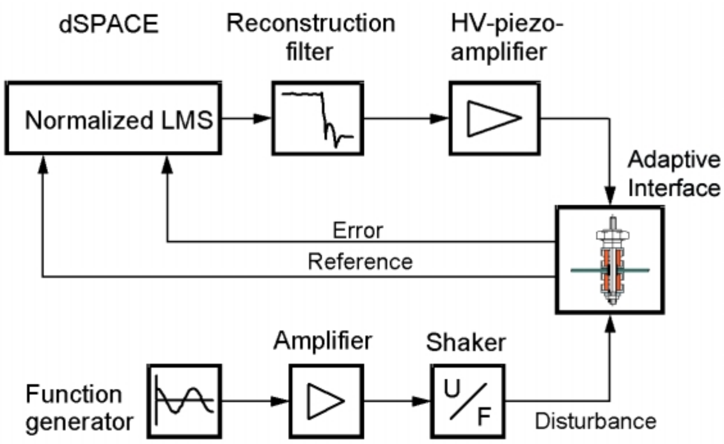
each other: one actuator is withdrawn while the other is extended.




*Principle of the decoupling of structural vibrations.*

### Development Process

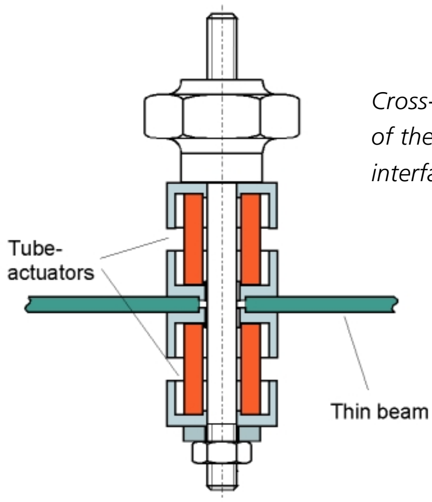
Initially, the entire development takes place within the MATLAB/Simulink environment. This means, a model of the interface's mechanical structure is programmed graphically. Actuators and sensors are then added to the model, along with an adaptive feedforward-controller (consisting of C-coded S-function blocks performing special tasks), to create an entirely software-based experiment. The required reference signal is taken from structure A, since this part vibrates even in perfectly decoupled structures. The error sensor is attached to structure B. In a next step, the adaptive interface within MATLAB/Simulink is replaced by real components with a mechanical setup as introduced above. This is where dSPACE Protoytper comes into play. The adaptive control algorithm, along with the digital processing (e.g., FIR filter with order 400 and coefficient adjustment by a gradient filtered-X-LMS algorithm), is implemented on the dSPACE real-time hardware featuring a sample time of 0.25 ms. The link to the dSPACE hardware is performed with dSPACE's Real-Time Interface (RTI), which contains all required blocks for addressing the hardware graphically. All Simulink blocks are coded automatically and loaded onto dSPACE Prototyper. To control and monitor the real-time experiment, dSPACE ControlDesk is used. During the experiment processing, the ability to cancel out vibrations in the frequency range from 30 Hz to 800 Hz is analyzed.




*Layout of the adaptive system.*

### Conclusion

The adaptive interface is a promising approach to eliminate vibration propagation from one mechanical system to another. The implemented control algorithm covers the entire frequency bandwidth and provides good reduction of the beam vibration. dSPACE Protoytper proved to be the perfect solution for performing real-time experiments without any implementation overhead. The adaptive control algorithm could be analyzed on the spot, and evaluation of a new design takes just a few seconds.




*Cross-section of the adaptive interface.*

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