Modelling of piezoelectric sensors and actuators for noise and vibration control

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Introduction

Noise and vibration problems often originate from bending modes in structures. As an alternative to passive methods, such problems can be tackled using an active control system with piezoelectric materials as distributed sensors and actuators.

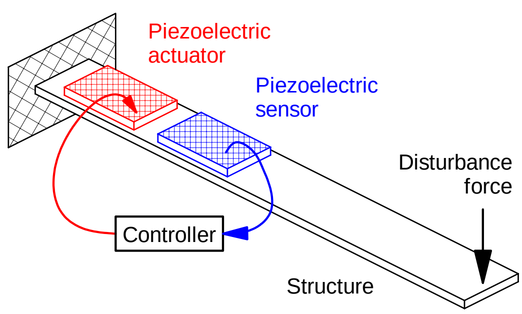

Figure 1 : Beam with piezoelectric sensor and actuator

Figure 1 shows an example: a feedback controller with a piezoelectric sensor and actuator aims to reduce the beam response due to a disturbance force.

Objective

In order to effectively reduce noise or vibration levels, the interaction between the structure and piezoelectric sensors and actuators bonded to the structure has to be known. Therefore numerical models are developed which account for the piezoelectric coupling.

Methods

Materials showing piezoelectric behaviour produce an electrical charge when subjected to a mechanical stress. Furthermore the opposite effect also occurs.

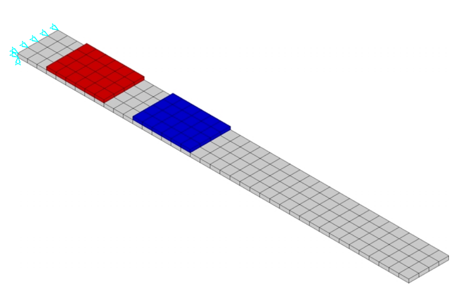

Figure 2 : FE model of a beam with piezoelectric sensor and actuator

The piezoelectric coupling between the structure and sensors and actuators is accounted for in the equations of motion. An analytical and a finite element (FE) model were developed for a beam with two piezoelectric patches (see Figure 2).

Results

Figure 3 shows the simulated response of the beam tip displacement and the sensor voltage as a result of a harmonic voltage applied to the actuator.

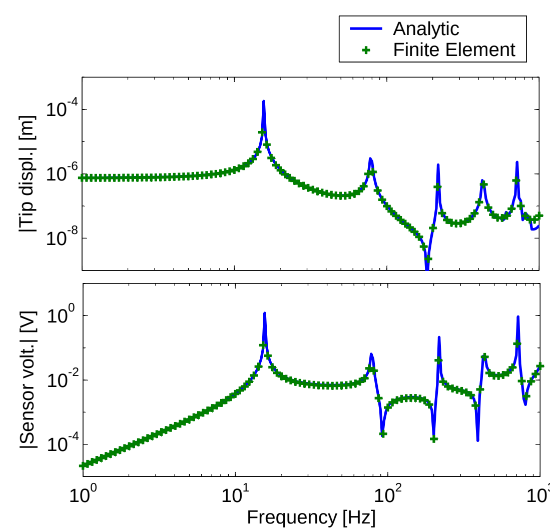

Figure 3 : Harmonic response of the tip displacement and sensor voltage to a unit actuator voltage

On the basis of the models a feedback controller can be designed for attenuation of the beam response to disturbance forces.

Future research

- Experimental validation of the models with piezoelectric coupling.
- Design and experimental implementation of several feedback strategies.
- Model reduction of FE models for application in real time controllers.

References

1. Fuller, C.R., Elliot, S.J., Nelson, P.A. (1996) Active Control of Vibration, Academic Press.