Smart structures and active control of vibrations: 25 years of research at ULB

André J. Preumont*†[2,1]

[2]ULB Department of Mechanical Engineering and Robotics CP 165/42 Active Structures Laboratory (ULB) – Active Structures Laboratory avenue F.D.Roosevelt, 50 B-1050 Brussels Belgium, Belgium
[1]Université Libre de Bruxelles [Bruxelles] (ULB) – Avenue Franklin Roosevelt 50 - 1050 Bruxelles, Belgium

Abstract

Over the past 25 years, the Active Structures Laboratory of ULB has been pioneering active techniques for vibration control in various applications, mostly related to future space projects, precision engineering and bridges. The emphasis is placed on robustness and on the ability to develop a controller with a limited knowledge of the structure. The talk is divided into several parts:
The first part is devoted to the passive damping with piezoelectric transducers: This technology consists of transforming the vibrational energy into electrical energy which is dissipated in a passive network; it often involves active components (synthetic inductors, negative capacitors) and may be extended to applications requiring a negative damping.

The second part focuses of the vibration isolation and damping in large space structures: These applications highlight the importance of collocated control and illustrate how a clever passive design may sometimes compete successfully with an active one. An active member consisting of a linear piezoelectric actuator collocated with a force sensor is described (it works like as muscle). The Integral Force Feedback (IFF) controller exhibits very good robustness properties.

Next, the talk applies the IFF controller to the active tendon control of string and cable structures and discusses how the nonlinearities of the cable dynamics may be handled, in order to reduce the numerical effort in building complex models (this part may have some aspects of interest for modeling string instruments). Active vibration control is illustrated with the control of parametric vibration of a cable-stayed bridge.

Finally, the talk includes two additional parts (if time allows) which can be seen as nice examples of mechatronics: one on real-time sound radiation sensor (discrete sensor array and distributed sensor) and one on deformable mirrors actuated with an array of piezoelectric actuators used for adaptive optics.

References:

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*Speaker
†Corresponding author: apreumon@ulb.ac.be

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