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Active Vibration Control of a Smart Beam by Using a Spatial Approach

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1. Introduction

The vibration control is an important and rapidly developing field for lightweight flexible aerospace structures. Those structures may be damaged or become ineffective under the undesired vibrational loads they constantly experience. Hence, they require effective control mechanism to attenuate the vibration levels in order to preserve the structural integrity. The usage of smart materials, as actuators and/or sensors, has become promising research and application area that gives the opportunity to accomplish the reduction of vibration of flexible structures and proves to be an effective active control mechanism.

For the last few decades there has been an extensive research about the piezoelectric materials because of the capability of being used both as actuators and sensors. The smart structure is a structure that can sense external disturbance and respond to that in real time to fulfil operational requirements. Smart structures consist of passive structure, highly distributed active devices called smart materials/elements and processor networks. The smart materials are primarily used as sensors and/or actuators and are either embedded or attached to an existing passive structure (Çalışkan, 2002). Today, the main and maybe the most widespread application area of piezoelectric materials is using them as collocated actuator and sensor pair for active vibration control purposes (Prasad, 1998).

Active vibration control of a smart structure starts with an accurate mathematical model of the structure. Modeling smart structures may require the modeling of both passive structure and the active parts. Crawley and de Luis (1989), by neglecting the mass of active elements, presented an analytical modeling technique to show that the piezoelectric actuators can be used to suppress some modes of vibration of a cantilevered beam. Similar approach was carried out on thin plates by Dimitridis et al (1991). Although neglecting the mass and stiffness properties of the smart materials compared to the passive structure is generally acceptable, the modeling of a smart structure mainly involves the force and moment descriptions generated by the smart materials. Sample modeling studies are proposed by