Theoretical and Experimental Study of Active Vibration Control of a Cylindrical Shell Using Piezoelectric Disks

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ABSTRACT

Active vibration control of a cylindrical shell using piezoelectric disks is studied both theoretically and experimentally in this paper. Hamilton's principle is used for deriving dynamic motion equations of the cylinder coupled with piezoelectric disks. The equations are discretised by Rayleigh-Ritz method. An adaptive feedforward controller based on steepest descent method is implemented on a PC to control the modal vibration. The proposed method solves the drawback of using PCs that is sending and receiving data in block form. It is shown that the proposed control system which consists of piezoelectric disks and an adaptive controller is effective in reducing vibration and radiated acoustic noise.

Keywords: Active vibration control; Feedforward control; Piezoelectric disk

1. INTRODUCTION

Nowadays, acoustic and vibration control are essential issues in many applications and industries. High levels of vibration and acoustic noise in human living environments may lead to many problems. It can cause hearing impairment, heart disease, increased stress level and occur precocious exhaustion [1]. Reducing the noise of household appliances, noise reduction of fancoils in libraries, hospitals and conference rooms, active noise and vibration control in car cabins for increased passenger comfort, decreasing noise in incubators and decreasing urban noise are examples of use of this technology in different applications and industries.

In many appliances, vibration of the structure produces acoustic noise due to interaction between the structure and acoustic fluid. This noise is called structural noise. In structural noise, the normal vibration of the structure moves the fluid in its vicinity and produces pressure field in the environment. Consequently, reducing the vibration of the structure will lead to reduction of noise in the environment [2].

Passive noise reduction methods consist of using acoustic absorbent or acoustic barriers such as elastomers, acoustic coatings or other material. Passive methods are inefficient for low frequency disturbances because they require massive and bulky design, limiting their use in many applications [3]. The idea of active control methods was illustrated in 1933 and implemented with emergence of high speed processors in the 1980s [4]. In this approach, an anti-noise signal is generated by a

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