Active vibration suppression of a thin circular pipe

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This paper presents an active vibration control system designed to suppress small-amplitude vibrations of a thin circular pipe that serves as a model for a lightweight robotic arm. The system integrates control algorithms, intelligent materials, and supporting hardware and software technologies. The pipe, with a diameter of 40 mm, was clamped at a point of 1 metre from its free end. Rectangular piezoelectric patches (Macro Fiber Composites, MFCs) were employed as both sensors and actuators. Vibration excitation was introduced via an MFC actuator mounted on the pipe surface, and the response was recorded using the xPC Target environment. For the system considered, the ARX method of discrete-time model identification was applied to enable real-time active vibration control. On the basis of this model, a control algorithm employing the pole-placement method was developed and implemented on a physical test stand. Experimental results demonstrate that the proposed closed-loop system, with paired MFC piezoelectric elements working as actuators, is able to effectively suppress pipe vibrations.