Jin, Weiwei; **Qu, Zhihua**; **Serra, Reinier**

Nonlinear simulation of a string system under boundary robust control. (English)

Zbl 1084.93013
Int. J. Nonlinear Sci. Numer. Simul. 2, No. 4, 343-351 (2001).

In this very important and useful paper, vibration control of a nonlinear flexible system is considered. The dynamic equations governing the motion of the system have the following form:

$$M_0[\ddot{p}_0(t)+\ddot{y}_b]=f_0(t)T(0,t)y_x(0,t)-b_0(p_0,t)\dot{p}_0(t),$$
$$M_1[\ddot{p}_1(t)+\ddot{y}_b]=f_1(t)+T(1,t)u_x(1,t)-b_1(p_1,t)\dot{p}_1(t) \quad \text{and}$$
$$m(x)\frac{\partial^2 Y(x,t)}{\partial t^2}=\frac{\partial}{\partial x}\left\{T(x,t)\frac{\partial Y(x,t)}{\partial x}\right\},$$

where $Y(x,t)=y(x,t)+y_b(t)$ represents displacement of the string with respect to the ground. It is assumed that the string tension is nonlinear and of the form $T(x,t)=T_0(x)+w(x)y_x^2(x,t)$, $T_0(x)>0$ for all $x\in[0,1]$. In the model, the forces $f_0(t)$ and $f_1(t)$ are boundary control variables to be designed. Given $f_0(t)$ and $f_1(t)$, a trajectory of the system can be solved under the initial conditions (initial positions of control mechanisms, and initial displacement and velocity of the string). Here, the problem of using boundary controls to suppress vibration is considered.

Main result: In order to damp out oscillation, a new robust control is designed to compensate for non-linear uncertainties in string dynamics and in the control mechanism. It is shown (the Lyapunov direct method is used) that the proposed control makes the closed-loop system exponentially stable. Finally, the effectiveness of the control is demonstrated through nonlinear simulation when the finite-difference approach is used.

Reviewer: Jan Lovíšek (Bratislava)

MSC:

93C20 Control/observation systems governed by partial differential equations
37N35 Dynamical systems in control
93C10 Nonlinear systems in control theory
93D21 Adaptive or robust stabilization
74H45 Vibrations in dynamical problems in solid mechanics
74K05 Strings

Keywords:
boundary robust vibration control; nonlinear string system; Lyapunov direct method; simulations; finite difference approach; boundary control; uncertainties; nonlinear string tension; nonlinear friction

Full Text: DOI