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SLIDING MODE CONTROL OF HYSTERETIC STRUCTURAL SYSTEMS

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Abstract. *Sliding mode control systems have been recognized to be robust in the presence of exogenous perturbations. For a sliding mode control design, a known upper bound of the perturbation is usually assumed. In this paper, we present an adaptive algorithm for the estimation of this upper bound, and consequently there is no need for the exact knowledge of this quantity. Moreover, we have applied the proposed controller for the perturbation rejection of seismically excited hysteretic structural systems. A key contribution presented in this work is that, although the hysteretic structural system considered is a nonlinear third-order model, the sliding mode control has been designed using a reduced second-order dynamic system. The performance and robustness of the controller are then analyzed by means of numerical simulations.*
Keywords: Sling mode control, Hysteresis, Base isolation

1. Introduction.

One of the most important features of sliding mode control is its ability to control a wide variety of nonlinear systems facing exogenous perturbations [1, 2]. In this context, sliding mode control has been applied to different control objectives such as, for instance, regulation, tracking, adaptive control, observer design, control of piezoelectric systems, navigation of submersible vehicles, etc. [1, 2, 3, 4]. A class of sliding mode control is the so-called *chattering* controller, where sliding motion just occurs at the origin [5, 6]. Traditionally, for sliding mode control design, the perturbation is assumed unknown but it is also set to be bounded above by a known value. It is important to remark that a sliding mode control design can be implemented using a conservative value on the upper bound of the seismic excitation. However, this conservative choice may lead to an unsuitable control effort. Therefore, and from an engineering point of view, a controller that can be auto-adjusted seems interesting. In this paper, and following the work in [7], we use an adaptive dynamic to estimate the switching gain, keeping the sliding mode control properties such as finite time convergence and asymptotic stability.

A key contribution presented in this work is that, although the hysteretic structural system considered is a nonlinear third-order model, the sliding mode control has been designed using a reduced second-order dynamic system. This model reduction is possible by considering some properties of the hysteretic structural systems. Finally, the performance and robustness of the controller are then analyzed by means of numerical simulations, where it can be seen that the proposed controller behaves satisfactorily and with a reasonable control effort.

The organization of this paper is as follows. The basic idea of sliding mode control for a second-order system is studied in Section 2. In Section 3, the modified sliding mode is