# Adaptive Smooth Second-Order Sliding Mode Repetitive Control Method and Its Application to a Hydraulic System

**C. Jia**[1] **and R. W. Longman**[2]

**Abstract:** Currently, the adaptive smooth second-order sliding mode control method has been the subject of considerable research in the field of sliding mode control. This is mainly due to the following advantages: (1) One can specify that the sliding mode function and its derivative reach a pre-specified region in finite time; (2) The chattering phenomenon can be nearly eliminated; (3) It is not necessary to specify bounds on the disturbance; and (4) Because of the adaptation the control gains do not need to be conservative.

However, for systems subject to persistant disturb, the second-order sliding mode control method can only guarantee that the sliding mode remains within a region, and the control gains will increase with time. This can limit the applicability of the method in practice. Disturbances can be classified into periodic and aperiodic. For periodic disturbances there are various control methods proposed in the literature. In particular, repetitive control method can be very effective. Hence, a method that combines the advantages of adaptive smooth second-order sliding mode control and the advantages of repetitive control offers substantially improved performance.

This paper creates such a method, and studies the performance when both periodic and apriodic disturbances are present. Because both above advanges is utilized, with both periodic and aperiodic disturbances present, the proposed method forces the sliding mode into a pre-specified region in finite time, and if only periodic disturbance exists, the proposed method forces the sliding mode to converge to zero. Thus the tracking performance is improvement, and this is accomplished without needing to know a bound on the disturbance, and while the control action maintains its smoothness property. The control gains need not always increase, and can even decrease when only periodic disturbances are present. A rigorous theoretical proof is presented based on a Lyapunov approach.

The performance of the proposed method is evaluated on an hydraulic system via simulations.

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[1] School of Electrical and Electronic Engineering
Tianjin University of Technology
391 Binshuixi Road, Xiqing District, 300384 Tianjin, China
*jacky20042004@126.com*

[2] Department of Mechanical Engineering
Columbia University MC4703
New York, NY 10027 USA
*RWL4@columbia.edu*