International Journal of Innovative Computing, Information and Control
Volume **3**, Number **6(B)**, December **2007**
 ISSN 1349-4198
pp. 1501–1510

SWING-UP CONTROL OF A CART-TYPE SINGLE INVERTED PENDULUM WITH PARASITIC DYNAMICS

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Received December 2006; revised April 2007

Abstract. *This paper describes an RTLinux-based swing-up control system design of a cart-type single inverted pendulum having a serial second pendulum as parasitic dynamics. The presenting RTLinux-based controller consists of two steps, Step 1: to swing up the first pendulum with controlling the motion of the cart and being robust to the parasitic part, Step 2: after the swing-up, to stabilize both angles of the pendulums and to control cart position. Real-time experiment is given to show the effectiveness of the control scheme.*
Keywords: Cart-type pendulum, Parasitic dynamics, Sliding mode control, Swing-up control, Stabilization, Real-time experiment

1. **Introduction.** Inverted pendulum systems are well known for evaluating the validation of various kinds of control theories for mechanical systems, because the system is a nonlinear and underactuated mechanical system [1] which it is hard to be controlled by a real-time controller. In general, an inverted pendulum system has several types, e.g., a single pendulum [2], a double pendulum [3,4,6,7], etc.. Since the inverted pendulum system is hard to be controlled by a standard linear controller, so many control methods have been proposed to control the inverted pendulum systems. such as feedback stabilization, energy based control [5], bang-bang control, sliding mode control [4], robust control [6], hybrid control, partial linearization. In spite of these existing methods, to control the inverted pendulum is still an interesting research topic. For example, the serial double inverted pendulum [3],[4] is strongly nonlinear and highly underactuated than a single inverted pendulum and the control of the serial double pendulum is a difficult problem. And a solution of this problem is applicable to other nonlinear and underactuated control problems [1].

For swing-up control of the serial double inverted pendulum, various methods are proposed, e.g., the method in [6] is a combination of a feedforward controller that swings up pendulums and a feedback controller that stabilizes the pendulum at the upright position. In [6], a control scheme which transfers the state of pendulum from an arbitrary equilibrium point to another arbitrary equilibrium point is proposed. However, those