Dynamics of Continuous, Discrete and Impulsive Systems
Series **B:** *Applications & Algorithms* **12 (2005)** 13-28

LAGRANGE STABILITY ANALYSIS AND SYNTHESIS FOR UNCERTAIN PENDULUM-LIKE SYSTEMS

Xinbin Li and Lin Huang

Center for Systems and Control,
Dept. of Mechanics and Engineering Science, Peking University, Beijing, 100871

Abstract. This paper is concerned with the Lagrange stability analysis and synthesis problems for a class of uncertain nonlinear systems with infinite equilibria set, called pendulum-like systems. The time-varying norm-bounded parameter uncertainty enters all the matrices of pendulum-like systems. A notion of robust Lagrange stabilization is introduced. On analysis problem, a LMI-based analysis result is derived. The synthesis problem is to design a observe-based feedback controller that robustly Lagrange stabilize the uncertain pendulum-like system.

Keywords. Pendulum-like systems, parameter uncertainty, robust Lagrange stability, robust Lagrange stabilization, Linear matrix inequality

AMS (MOS) subject classification: 34K20, 34K35, 34H05, 93D09.

1 Introduction

Stability problems for nonlinear system have been extensively studied in the past several decades years, where much attention has been focus on the systems with single equilibrium point. In fact, engineers often have to deal with nonlinear systems with multiple equilibrium points.

pendulum-like systems, initially introduced by F.Tricomi[11], represent a class of nonlinear systems whose nonlinear functions are periodic and consequently the systems have infinite equilibria sets. Such systems are widely applied in various fields of mechanics and engineering, for example, systems of phase synchronization[2,5]. The stability analysis and synthesis for such systems are rather different from those for systems with single equilibrium point. The classical absolute stability theory was constructed for investigation of global stability of systems with single equilibrium point and the standard Lyapunov functions which are exploited in control theory are aimed at such systems. In this way new types of stability problems appeared and the necessity arises to develop the classical theory in such a way that it should be possible to use it for the basic global property investigation of systems with multiple equilibrium points.

For pendulum-like systems, the basic global property is the Lagrange stability. Usually, if Lagrange stability is established for a system, its gradient-like behavior(i.e.global asymptotic stability) may be easily proved with the