Nonlinear Dynamics and Systems Theory, **12** (3) (2012) 269–277

Partial Control Design for Nonlinear Control Systems

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Received: June 20, 2011; Revised: June 18, 2012

Abstract: This paper presents a general approach to design a partially stabilizing controller for nonlinear systems. In this approach, the nonlinear control system is divided into two subsystems, which are called the *first* and the *second* subsystems. This division is done based on the required stability properties of system's states. Furthermore, it is shown that partial control makes the possibility of converting the control problem into a simpler one by reducing the number of control input variables. The reduced input vector (the vector that includes components of input vector appearing in the *first* subsystem) is designed based on the new introduced control Lyapunov function called *partial control Lyapunov function* (PCLF) to asymptotically stabilize the first subsystem.

Keywords: *partial stability; partial control; partial control Lyapunov function (PCLF).*

Mathematics Subject Classification (2010): 34D20, 37N35, 70K99, 74H55, 93C10, 93D15.

1 Introduction

The problem of partial stability, that is stability with respect to a part of system's states, finds applications in many of engineering problems. In particular, partial stability arises in the study of inertial navigation systems, spacecraft stabilization via gimbaled gyroscopes or flywheels, electromagnetic, adaptive stabilization, guidance, etc. [1]– [14]. In the mentioned applications, although the plant may be unstable (in the standard concept), it might be *partially* asymptotically stable, i.e., some states may have convergent behavior. It is in contrast to many other engineering problems where Lyapunov stability (in its standard concept) is required [17]– [20]. For example, consider the equation of motion for the reaction wheel pendulum depicted in Figure 1 [15]:

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