

NEW APPROACH TO SOLVE ALGEBRAIC CONSTRAINTS IN LINEAR SYSTEMS USING LINEAR DYNAMICAL CONTROLLERS

MANUEL JIMÉNEZ-LIZÁRRAGA¹ AND JOSE B. CRUZ JR.²

¹Faculty of Physical and Mathematical Sciences
Autonomous University of Nuevo León
San Nicolás de los Garza Nuevo León, México
manalejimenez@yahoo.com

²Department of Electrical and Computer Engineering
The Ohio State University
Columbus, OH 43210, USA
jbcruz@ieee.org

Received June 2009; revised October 2009

ABSTRACT. *This paper addresses the problem of rapidly driving a linear system's state near a manifold. These manifold or linear algebraic constraints represent desired surfaces in the state space whose neighborhood the system is required to move to. For practical reasons, only linear type controls are allowed and neither discontinuous nor any other type of nonlinear controls are permitted. To solve this, we propose to reformulate the original problem by extending the state space to include additional dynamics that will be a part of the controller. The extra dynamics are partly specified by the same algebraic constraints the system is required to satisfy. The design involves a two-part control which makes use of a linear dynamic, as well as static feedback control. The feedback gains are chosen so that the extended system is stable. Furthermore, they are adjusted so that the rate of the decay of the controller states will go to zero "faster" than the rate of the original states. For a scalar case, we present a complete characterization on how to select the eigenvalues allocations to achieve the requirement. Examples are presented to illustrate the suggested approach, including the problem of attitude control for the linearized model of a spacecraft with flexible rods. A brief simulation study is presented comparing the method under consideration with a previous one from the literature.*

Keywords: Linear systems, Manifold constraints, Dynamic feedback control, Spacecraft attitude control

1. Introduction.

1.1. **Antecedents and motivation.** Among many types of control problems that arise in linear systems (see [1,2]), the requirement for a linear system to satisfy some manifold or algebraic state constraints corresponds to many important applications in engineering. This is why it has attracted great attention from researchers working on linear control dynamics [3-5]. In many applications, having this kind of restriction is equivalent to saying that the system is required to move along certain manifolds of the state space, which may be needed to satisfy some physical constraints on the state variables, or just by the design of the control task. The importance of studying this type of problems cannot be overlooked, as they are widely found in different systems. For example, it is well known (see [6]), that in mechanical systems, very often we are concerned with the equations of constrained mechanical motion. If the constraints are violated at any point of time t , serious consequences may ensue, for example, physical components may be damaged or saturation may cause a loss of closed-loop stability [1,7-9]. In estimation problems, we