REGULARIZABILITY OF LINEAR DESCRIPTOR SYSTEMS VIA OUTPUT PLUS PARTIAL STATE DERIVATIVE FEEDBACK

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ABSTRACT

Regularizability of a linear descriptor system via output plus partial state derivative feedback is studied. Necessary and sufficient conditions are obtained, which are only dependent upon the open-loop coefficient matrices. It is also shown that under these necessary and sufficient conditions, “almost all” output plus partial state derivative feedback controllers can regularize a regularizable linear descriptor system. The proposed conditions generalize many existing results. The presented example demonstrates the proposed results.

KeyWords: Linear descriptor systems, output plus partial state derivative feedback, regularizability.

I. INTRODUCTION

Regularity is an important property for descriptor linear systems. It guarantees the existence and the uniqueness of the solution of a descriptor linear system [1]. Quite a few reported results for descriptor linear systems have assumed open-loop regularity, see, for example, [2-4] and the bibliographies therein. However, this assumption is unnecessarily strong since it limits the analysis of a number of practical physical systems ([3,5]). Due to this practical reason, the problem of regularizing descriptor systems using various feedbacks has attracted much attention (see [6-21]).

Regularization of descriptor linear systems has been studied by many authors. References [5] and [8] treated the state feedback case and presented various necessary and sufficient conditions for the problem, while [7] and [9] concentrated on the proportional plus state derivative feedback case. In [10] and [11], regularization of descriptor linear systems via proportional output feedback was considered, and again necessary and sufficient conditions were given. In 1999, Chu and Ho [12], considered regularization of a descriptor linear system using proportional plus derivative output feedback and established necessary and sufficient conditions.

Besides giving necessary and sufficient conditions for the regularization problem, many researchers have also developed numerical algorithms for finding the regularizing feedback controllers which guarantee certain desired characteristics of the closed-loop systems (see [6,12-21]). One type of such problems is to design a feedback controller for a descriptor linear system such that the closed-loop system is regular and has index at most one (see [6,12-15,20]). For this type of problems, reference [6] considered the state feedback case, while [14,15] and [20] concentrated on the output feedback case. In references [12] and [14], the more general proportional plus derivative output feedback controllers were adopted. Different from [14], reference [12] considered the problem of designing a feedback controller for a descriptor linear system such that the closed-loop system is regular, has index at most one, and moreover, possesses a desired dynamical order. Extension of this work to the case of output plus partial state derivative feedback control was presented in [13]. Besides the above, the problem of designing a feedback controller for a descriptor linear system such that the closed-loop system is regular and impulse-free ([18,19] and [21]), or regular and strongly controllable and strongly observable ([15] and [20]), have also been investigated. Reference [21] focuses on the existence of a decentralized output