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Pole placement in non connected regions for descriptor models

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Abstract

This paper proposes a method to compute a static state feedback control law which achieves a non strict pole assignment on a continuous or a discrete descriptor system. The specification on the closed-loop poles is given in terms of $\mathcal{D}$-stability, i.e. in terms of a pole-clustering region $\mathcal{D}$. In this work, the clustering region is possibly non path-connected since it can result from the union of disjoint and non symmetric subregions. Such a choice, which is original when the design of linear descriptor systems is concerned, is made possible by a technique that enables a partial pole placement via aggregation. The distribution of the finite poles in various subregions can be chosen. Some key steps of the procedure are addressed through strict LMI (Linear Matrix Inequalities). This is an extension of a previous work from conventional to descriptor models. Therefore, not only stability is to be ensured but also, because of infinite poles, regularity and causality or impulse freeness (the whole of those properties being termed admissibility).

Keywords: Pole placement; LMI; Union of regions; Static state feedback; Descriptor models

1. Introduction

When designing a control law for a linear model, pole placement is a well-known strategy to help to reach some desired transient performances. Indeed, the shape of the transient response is strongly influenced, in terms of settling time and damping ratio, by the location of the poles in Laplace's plane. A *strict* pole placement is always achievable by a static state feedback control law provided that the model is controllable. Such a placement can be performed by a polynomial approach [2] or it can be obtained, in a state-space context, through a classical eigenstructure assignment [3]. For the discrete-time case, see for example [27,16]. The eigenstructure assignment approach is also available and efficient for the more general (but natural) linear descriptor systems [8] (see [12] and [17] to understand the interest in using descriptor forms and to see for which applications they can be useful). However, for descriptor models, there are finite and infinite poles, and special attention has to be paid to those infinite poles that can induce impulses in the continuous case or non causality in the discrete case [7] (corresponding to the full degree of the associated pencil) as well as to regularity, which means that the system is well-posed in the sense that there exists a unique solution to the state equation (see the books [7,20] and the numerous references therein).

The above-mentioned approaches lead to a *strict* placement. However, a slight migration of the poles may not induce a strong modification of the transient behaviour. Therefore, for conventional (non descriptor) models, significant

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