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EIGENVECTOR APPROACH FOR REDUCED-ORDER OPTIMAL CONTROL PROBLEMS OF WEAKLY COUPLED SYSTEMS

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Abstract. In this paper we show how to decompose the weakly coupled algebraic Riccati equation and the corresponding linear-quadratic optimal control problem at steady state in terms of reduced-order subproblems by using the eigenvector approach. The eigenvector approach should be used for decomposition of weakly coupled control systems in the cases when the weak coupling parameter is not sufficiently small. In such cases the decomposition methods based on series expansions, fixed point iterations and Newton iterations, either fail to produce solutions of the corresponding algebraic equations or display very slow convergence. In addition, the eigenvector approach provides new tools and novel insight into the nature of the decomposition problem and finds all required solutions without solving the corresponding subsystem Riccati equations.

Keywords. Optimal Control, Weakly coupled systems, Decomposition, Eigenvector Method, Nonsymmetric Riccati equation.

AMS (MOS) subject classification: 93C70, 65H10, 65H17, 47J25.

1 Introduction

The research of this paper is motivated by the existence of a transformation for decomposition of the weakly coupled algebraic Riccati equation and the corresponding linear-quadratic optimal control and filtering problems [17] and [6]. This transformation is valid for any value of a weak coupling parameter ϵ. The algebraic equations comprising the transformation in [17] have the structure of general nonsquare Riccati equations, which for *sufficiently small* values of a weak coupling parameter ϵ can be solved by performing iterations on systems of linear algebraic equations (e.g., fixed point iterations and Newton iterations). However, all iteration algorithms depend highly on the initial guesses and, when the weak coupling parameter ϵ is *not sufficiently small*, there is no guarantee that the above methods will find the solutions, hence they will not provide the desired decomposition. Even more, the upper bound of the small weak coupling parameter ϵ for which the corresponding algebraic equations can be solved by any of the above iterative methods is highly problem dependent.

In this paper, we present the eigenvector method for solving the corresponding algebraic equations of weakly coupled linear systems that produces