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The Rayleigh Quotient of Matrix and Its Applications ⋆

Chaoyong Jin [a,*], Xiangwei Zhang [b]

[a] *College of Applied Mathematics, Guangdong University of Technology, Guangzhou 510090, China*
[b] *College of Electromechanical Engineering, Guangdong University of Technology, Guangzhou 510090, China*

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Abstract

In this paper, the concept of Rayleigh quotient for arbitrary matrix, based on that of real symmetric matrix, is introduced, the properties of which are discussed, and some useful results are obtained. Using it to study the decentralized stabilization of linear time-invariant large scale systems, a class of linear interconnected systems which can be stabilized by a decentralized state feedback control are obtained. An algorithm for the determination of such control is given, which is simple, practical and effective as compared with the corresponding results in the literature.

Keywords: Rayleigh quotient; Large scale systems; Decentralized stabilization; M-matrix.

1 Introduction and Problem Formulation

Let Σ be a dynamic linear time-invariant system defined by N interconnected subsystems $\Sigma_i, i = 1, 2, \cdots, N$, which are factored as

$$\Sigma_i : \begin{cases} \dot{x}_i(t) = A_i x_i(t) + B_i u_i(t) + \sum\limits_{j=1, j\neq i}^{N} A_{ij} x_j(t), \\ y_i(t) = C_i x_i(t), \qquad i = 1, 2, \cdots, N, \end{cases} \tag{1}$$

where $x_i \in R^{n_i}, u_i \in R^{m_i}, y_i \in R^{r_i}$ represent the state, input and output of the subsystem Σ_i respectively, and A_i, B_i, C_i and A_{ij} are constant matrices of appropriate dimensions. We denote $\sum_{i=1}^{N} n_i = n$, $\sum_{i=1}^{N} m_i = m$, $\sum_{i=1}^{N} r_i = r$, and assume that all pairs (A_i, B_i) are controllable and all pairs (A_i, C_i) are observable, our general goal is to stabilize the overall systems (1) by employing a decentralized state feedback control law

$$u_i(t) = K_i x_i(t), \quad i = 1, 2, \cdots, N \tag{2}$$

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*Corresponding author.
Email address: Cyjin10@163.com (Xiangwei Zhang).

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