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ON THE HADAMARD SYNERGIC STABILIZATION PROBLEM: THE STABILIZATION VIA A COMPOSITE STRATEGY OF CONNECTION-REGULATION AND FEEDBACK CONTROL: MATRIX INEQUALITY APPROACH

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Abstract. *In this paper, we investigate a new problem of Hadamard synergic closed loop design, i.e., the stabilization via a composite strategy of the state feedback control and the direct regulation of the part of connection coefficients of system state variables. Such a control is actually used very often in the daily life and many industrial areas but has not been clearly modeled or studied extensively. It extends the limitations of the traditional feedback control and may be of some potential applications in the emergency treatment such as isolation and obstruction control. With reference to the existing works, a bilinear matrix inequality (BMI) approach using iterative procedure and some less-conservative linear matrix inequality (LMI) approaches for such control are proposed.*

Keywords: Connection-regulation, Hadamard product, BMI, LMI, Hadamard synergic control

1. Introduction.

Almost all the existing control theories and applications are implemented by feedback controls, the feedback is, in a general sense, only one of the specific measures to implement the regulations of the connections of system states, and the capacity of feedback is limited [1-3], where the studies reveal the capacity of the feedback is not unlimited. Hence, some new control design techniques should be explored and developed to extend the capacity of feedback control.

Consider the following linear time-invariant system:

$$\dot{x}(t) = Ax(t) + Bu(t) \tag{1}$$

Here, $A = [a_{ij}]_{n\times n}$, $B = [b_i]^T$, $b_i \in R^m$; $i, j = 1, 2, \dots, n$. Let the feedback law be $u = Fx$, $F = [f_i]$, $f_i \in R^m$, $j = 1, 2, \dots, n$. Then the system matrix of the closed loop is of the form: $A = [a_{ij} + b_i^T f_i]_{n\times n}$.

Obviously, the element a_{ij} is the interconnection coefficient between *i-th* state and *j-th* state. The actual functions of the feedback are the compensations of a_{ij}, i.e., regulating the interconnection coefficients from a_{ij} to $a_{ij} + b_i^T f_i$ via the input information channel. Hence, the feedback control is just a special indirect regulation of interconnections of system states. If we replace the scalars a_{ij}, b_i, f_j by matrices A_{ij}, B_i, F_j with appropriate dimensions, then A_{ij} can be regarded as the interconnection coefficients between *i-th* subsystem and *j-th* subsystem. The observation is similar.

Recently, the interconnections among subsystems in large-scale systems are thought to be one of the most important root to produce complexity [20]. To enhance the effects of stabilization, [21] considers the strategy of coupling two decoupled subsystems via designing a suitable combined feedback, which is called the harmonic control. Control