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A DECENTRALIZED PID CONTROLLER BASED ON OPTIMAL SHRINKAGE OF GERSHGORIN BANDS AND PID TUNING USING COLONIAL COMPETITIVE ALGORITHM

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Abstract. *In this paper a novel evolutionary global search strategy called Colonial Competitive Algorithm (CCA) is utilized to determine an optimal decoupling matrix and also to tune a decentralized PID controller for the multi-input multi-output evaporator plant. Recently, introduced CCA has proven its excellent capabilities, such as faster convergence and better global minimum achievement. First, parameters of the evaporator plant are identified based on prediction error model algorithm. The decoupling matrix for the identified plant transfer matrix is obtained through shrinking the Gershgorin bands by minimization of an appropriate cost function in frequency domain, to make the compensated plant diagonally dominant. Then a decentralized PID controller for the MIMO evaporator is designed based on CCA. The simulation results verify the superiority of the proposed method to the conventional approaches and also to the centralized MIMO PID controller designed with CCA, along with its less complexity.*
Keywords: Colonial competitive algorithm, Gershgorin band, Decentralized control

1. **Introduction.** Many industrial processes are usually modeled as multi-input multi-output (MIMO) plants. Designing appropriate control system for a MIMO plant is more cumbersome in comparison with a single-input single-output (SISO) plant due to the interactions between un-correspondent input and output channels. Designing controllers for MIMO plants has attracted a lot of research interests [1,13]. There are two general trends towards designing controllers for MIMO plants, i.e., designing a centralized MIMO controller, and development of a decentralized compensator. The latter approach has some advantages to the former one, especially for diagonal dominant systems. The decentralized controllers need fewer parameters to tune, while they are easier to implement and increase the loop failure tolerance of closed loop systems [6]. Some numerical search strategies are proposed in the literature, to design MIMO controllers by minimizing suitable cost functions [1,4,5]. Nevertheless, among the MIMO control techniques, decoupling control approach along with decentralized PID controllers have been deployed extensively due to their less complexity, high performance and easy implementation [2,3,6].

In this paper, a novel approach for MIMO controllers design is proposed and applied to a four-stage 3×3 industrial evaporator plant. The proposed method consists of designing a decoupling controller based on shrinkage of Gershgorin bands, and a decentralized PID controller optimally tuned based on Colonial Competitive Algorithm (CCA). For this purpose, first a decoupling matrix in series with the MIMO plant is determined so that the corresponding Gershgorin bands are shrunk to make the plant diagonally dominant. This