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ITERATIVE DECENTRALIZED PID TUNING BASED ON GAIN AND PHASE MARGINS FOR TITO SYSTEMS

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Abstract. *A simple PID controller tuning method is proposed which can achieve user-specified gain and phase margins exactly without any assumption on the structure of the process such as the limitation of FOPDT or SOPDT and approximation to the nonlinearity of the definition of gain and phase margins. The tuning procedure is realized via a fuzzy closed-loop system and applied to iterative decentralized controller design for TITO systems whose SISO equivalent processes are generally of complicated types such as high order systems with zeros and even RHP zeros. Some examples have been employed to illustrate the effectiveness and practicability of the proposed tuning method.*
Keywords: Decentralized control, Fuzzy loop optimization, Gain and phase margins, Iteration, PID controller, TITO systems

1. **Introduction.** In process control, more than 95% of the control loops are of PID type [1]. This should be mainly attributed to its relatively simple structure, which can be easily understood and implemented. However, the PID controller design is relatively difficult in multi-input multi-output (MIMO) systems and there exists no generally accepted design approach until now. Compared with single-input single-output (SISO) counterparts, MIMO systems are more difficult to control due to the existence of interactions between input and output variables. Adjusting controller parameters of one loop affects the performance of the others, sometimes to the extent of destabilizing the entire system. To ensure stability, many industrial decentralized controllers are tuned loosely, which causes inefficient operation and higher energy costs. Although considerable effort has been dedicated to this problem and many design techniques have been proposed over the years, such as sequential loop closing methods [2, 3], independent design methods [4, 5] and detuning methods [6, 7], decentralized control system design and implementation is still a challenging topic. The interaction reduction is the main issue concerned with decentralized control design. When interactions between different loops are considered as modeling errors which are difficult to describe analytically, the gain and phase margins approach is obviously an effective candidate for such a problem. Hence, our motivation is to exploit this kind of approach to MIMO system design. First, a simple PID controller tuning method is presented. This method can simultaneously achieve exact gain and phase margins without any assumption on process structure and approximation to definition nonlinearity. The kernel of the method is a fuzzy closed-loop system. The controlled