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ACTIVE DECOUPLING FOR DOUBLE-LOOP DELAYED SYSTEMS WITH ADRC TECHNIQUES

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Abstract. *An active decoupling method for double-loop delayed systems with Active Disturbance Rejection Control (ADRC) techniques is presented. The proposed ADRC consists of the tracking differentiator (TD), the extended state observer (ESO) and the nonlinear state error feedback (NLSEF). In this approach, the double-loop system with time delay is treated as two correlated control loops according to the best variable pairs selection, the interactions of two control loops are estimated by the extended state observers, and the nonlinear state error feedback compensates the interactions. Those two filters were designed to reduce the interactions of each loop, so that a good decoupling control performance is obtained. The theoretical results are illustrated via simulation studies.*

Keywords: Double-loop control system, Active disturbance rejection controller, Decoupling, Delayed process with two inputs and two outputs

1. **Introduction.** Delayed processes with multiple inputs and multiple outputs (MIMO) have widely occurred in industry control field. More and more research attention has recently been paid to control systems with time-delays (see, for example, Basin et al. [1], Wang and Zhao [2], Hassan and Boukas [3] and the references therein). However, most control methods for processes with single variable can not be used in control systems with multiple variables due to the interactions between output channels of processes with multiple variables [4], and most control methods for processes with multiple variables can not be used in practice due to time-delays [5, 6, 7]. Double-loop control system, with a long record of satisfactory performance in chemical and power industry, is the simplest structure to accomplish a given two input-two output control task [9, 10].

In double-loop control system, Proportional-integral-derivative (PID) control schemes are still mainly used due to their simple structures. Many methods of tuning double-loop PID controller exist in the literature (see, for example [11, 12, 13, 14]. Most of these methods, however, have the main disadvantage of being rather computationally intensive and/or requiring a full plant model, thus making them difficult to tune on-line. ADRC is a nonlinear controller [15], it consists of the tracking differentiator, the extended state observer and the nonlinear state error feedback. The ADRC control scheme treats the two-inputs-two-outputs processes with time delay as higher-order systems without time-delays [17], the interaction of two control loops, uncertainness, and disturbance is estimated by the extended state observer [16] and compensated during each sampling period.