algorithms

MDPI

Supplementary Material

for the paper

Quadratic Model-Based Dynamically Updated PID Control of CSTR System with Varying parameters

from the authors

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Here, an important control scenario is pinpointed. Namely, the DUPID controller is tested in a scenario considering a poorly tuned integral term in the PID controller and a ramp change in the set-point. The simulation result shown in Figure 1, reveals that the 1D DUPID controller adapted the PID control value properly, enabling the plant output to track the set-point with satisfactory error. For brevity, the simulation results for 2D DUPID are not discussed here, but it is expected that it will perform comparably to the 1D DUPID. To show that the improvement is genuine, we simulated the plant for 10 different uniformly distributed values of the integral term K_i drawn from the interval [0.01,1].

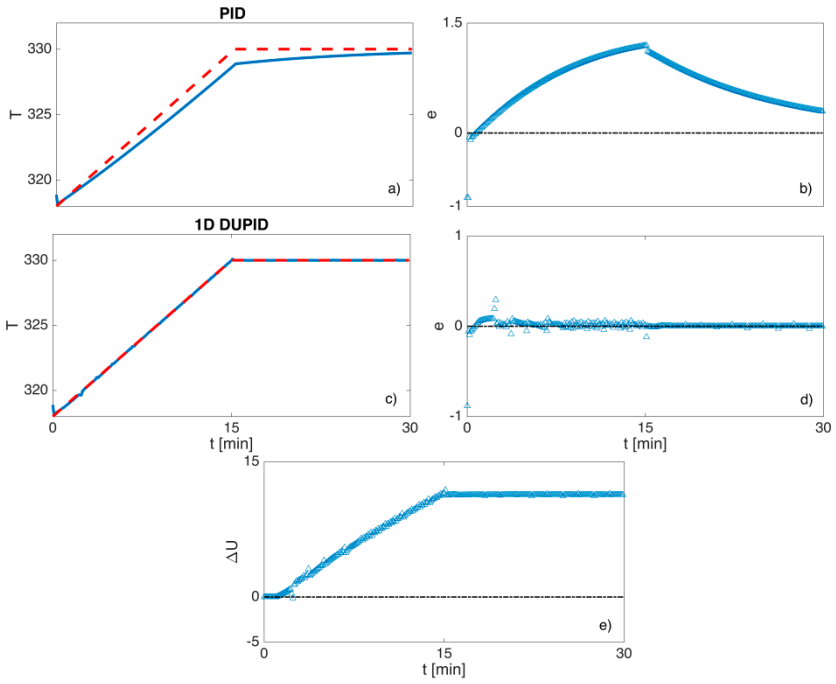

Figure S1. The plant response under PID and 1D DUPID control for $K_i = 0.4919$. In the figures a) and b) the plant response and the control error are given respectively, in the case of the PID control. In the figures c), d) and e) the plant response, the control error and the incremental value are given respectively in the case of the 1D DUPID control.

Table S1. It contains the average IAE values obtained by the 1D DUPID and PID controllers for ten realizations of the $K_i \in [0.01,1]$ value. In the last column the relative difference (RD) between the average IAE values is given.

Avg. IAE value		
1D	PID	RD
0.0243	0.6973	0.9652

The rest of the PID parameters and all of the DUPID parameters were assumed to be the same as in the main paper. The plant parameters are assumed to be stationary and a ramp change is introduced in the set-point (SP) for a certain period of plant operation. The set-point is defined as given with Equation (1):

$$SP = \begin{cases} 0.08i + 318;\ 1 \le i \le 150 \\ 330; 151 \le i \le i_{max} \end{cases}. \quad (1)$$

In Figure 1, the plant response for one of the ten realizations of K_i is given. The value of the K_i is assumed to be 0.4919. In figures a), c), and b), d), the plant output and the control error under PID and 1D DUPID control are given respectively. In figure e), the evolution of the incremental value is given. From the figures a) and c) is clearly visible that, unlike the PID controller which can't accomplish precise set-point tracking, the plant output under 1D DUPID control tracks the set-point with significantly smaller error. We observed similar results for all the realizations of K_i. The results were quantified by the average values of the obtained IAE metric values for both controllers (Table 1). The relative difference of the average IAE values revealed that the 1D DUPID controller achieved improvement of the PID control performance with mistuned integral term, of around 96%. Overall, the result strongly indicates that the DUPID controller can improve the control performance of a mistuned PID controller.