Optimization of PID controller based on maximization of the proportional gain under constraints on robustness and sensitivity to measurement noise

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References:
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Abstract:
This technical note presents a new, simple and effective, four-parameters proportional-integral-derivative (PID) optimization method. The set of adjustable parameters is defined by the proportional gain \( k \), integral gain \( ki \), damping ratio of the controller zeros (DRCZ), and desired value of the sensitivity to measurement noise \( Mn \). Given \( Mn \) and desired value of the maximum sensitivity \( Ms \), for both maximization of \( k \) and maximization of \( ki \), only three nonlinear algebraic equations need to be solved for a few values of DRCZ. Contrary to the method based on maximization of \( ki \), in the method based on maximization of \( k \) the improvement of performance is obtained by decreasing DRCZ from 1 to the value corresponding to the minimum of the integrated absolute error (IAE). Moreover, this is achieved without deteriorating robustness to the model uncertainties, for a large class of stable processes. Compared to the recently proposed PID optimization methods, for the same \( Ms \) and \( Mn \), lower values of IAE and \( M_p \) are obtained by using the method presented here.

Keywords:
optimal tuning, proportional–integral–derivative (PID) control, Measurement noise, robustness