Using adaptive integral gain for overshoot reduction in PID control systems

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ABSTRACT
This paper examines intrinsic characteristics of the integral control of a PID controller, and points out one that can cause excessive overshoot when the reference signal changes abruptly. Reasons for not totally relying on the derivative control to suppress overshoot are discussed, and then augmentation of an adaptive integral gain to an existing PID controller is proposed. The associated smooth adaptive law for the gain is presented, with the correspondingly allowable upper and lower bounds that guarantee input-to-state stability for the system of interest. Effectiveness, simplicity, and desirable properties of the proposed adaptive integral gain are clearly shown in two design examples. Numerical simulations show that maximum overshoot can be reduced by approximately 50%, without upsetting rise time.