Robust Self-Tuning PID Controller for Nonlinear Systems

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In this paper, we propose a robust self-tuning PID controller suitable for nonlinear systems. The control system employs a preload relay (P_{Relay}) in series with a PID controller. The P_{Relay} ensures a high gain to yield a robust performance. However, it also incurs a chattering phenomenon. In this paper, instead of viewing the chattering as an undesirable yet inevitable feature, we use it as a naturally occurring signal for tuning and re-tuning the PID controller as the operating regime digresses. No other explicit input signal is required. Once the PID controller is tuned for a particular operating point, the relay may be disabled and chattering ceases correspondingly. However, it is invoked when there is a change in setpoint to another operating regime. In this way, the approach is also applicable to time-varying systems as the PID tuning can be continuous, based on the latest set of chattering characteristics. Simulation results for the level control of fluid in a spherical tank using the scheme are also presented.

Figure 1 shows the configuration of the proposed control scheme

![Fig. 1. Configuration of the proposed control scheme.](image1)

Figure 2 and 3 shows the simulation result on the level control of fluid in a spherical tank

![Fig. 2. Closed-loop performance based on proposed control system with \( K = 0 \).](image2)

![Fig. 3. Comparison of closed-loop performance (1) fixed gains PID controller, (2) proposed control system.](image3)