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Titel des Beitrags: Funnel control for systems with relative degree two

Abstract: Tracking of reference signals $y_{\text{ref}}(\cdot)$ by the output $y(\cdot)$ of linear (as well as a considerably large class of nonlinear) single-input, single-output systems is considered. The system is assumed to have strict relative degree two with (weakly) stable zero dynamics. The control objective is tracking of the error $e = y - y_{\text{ref}}$ and its derivative $\dot{e}$ within two prespecified performance funnels, respectively. This is achieved by the so-called funnel controller $u(t) = -k_0(t)2e(t) - k_1(t)\dot{e}(t)$, where the simple proportional error feedback has gain functions $k_0$ and $k_1$ designed in such a way to preclude contact of $e$ and $\dot{e}$ with the funnel boundaries, respectively. The funnel controller also ensures boundedness of all signals. We also show that the same funnel controller (i) is applicable to relative degree one systems, (ii) allows for input constraints provided a feasibility condition (formulated in terms of the system data, the saturation bounds, the funnel data, bounds on the reference signal, and the initial state) holds, (iii) is robust in terms of the gap metric: if a system is sufficiently close to a system with relative degree two, stable zero dynamics, and positive high-frequency gain, but does not necessarily have
these properties, then for small initial values the funnel controller also achieves the control objective. Finally, we illustrate the theoretical results by experimental results: the funnel controller is applied to a rotatory mechanical system for position control.