Department of Engineering Cybernetics

TTK4215 Adaptive Control

Assignment 12: Adaptive Backstepping

Problem 4 on page 317 of *Adaptive Control Tutorial* by Ioannou and Fidan (note made available on Blackboard). Assume that $g_1(0) = 0$ and that g_1 twice continuously differentiable.

4. Consider the system

$$\begin{aligned}\dot{x}_1 &= x_2 + \theta_1^{*T} g_1(x_1),\\ \dot{x}_2 &= x_3,\\ \dot{x}_3 &= u + \theta_2^{*T} g_2(x_1, x_2, x_3),\end{aligned}$$

where g_1, g_2 are known nonlinear differentiable functions and u is the control input.

(a) Design a stabilizing control law assuming that θ_1^*, θ_2^* are known.

(b) Design an adaptive control law and show that it guarantees signal boundedness and convergence of the states to zero when θ_1^*, θ_2^* are unknown.

Hint for part b): See Section 2 of the paper: (made available on Blackboard)
M. Krstic, I. Kanellakopoulos and P.V. Kokotovic, "Adaptive nonlinear control without overparametrization," *Systems & Control Letters* 19 (1992) 177-185.