Worksheet 6
Issued: Fri 9. 1. 25
Due: Thu 15. 1. 25

Assessed Assignments

H 6.1 · *Switched Optimal Control of Two Heated Tanks* *(30 points)*

For the final stage of the project, further elaborate your hybrid optimal control concept of the coupled heated tanks (Exercise 5.2c).

(a) Allow your hybrid automaton (HA) simulator to use a discrete reference signal $\mathbf{w}$ of length T, such that, after the nth switch ($n \in 0..T-1$), the reference vector $\mathbf{w}(n)$ is used. If needed, adjust the dynamic programming (DP) parameters (e.g., admissible states and inputs).

(b) Based on $\mathbf{w}(n) = \mathbf{x}_0(n+1)$ and $\mathbf{w}(n+1)$, identify the optimal finite horizon N^* to be used as a flexible switching instant between two stages of DP, each tracking the new reference temperature of its associated tank. [**Note:** Compute $N^* = \arg\min_N V(\mathbf{x}_0(n), 0, n) + V(\mathbf{x}_0(n+1), 0, n+1)$.]

(c) Simulate your extended HA with a manually or randomly generated reference signal $\mathbf{w}$.

Questions for Self-Study

Q 6.1 · *What is a hybrid system? How do we use them to model complex dynamics?*

Q 6.2 · *What are the building blocks of a hybrid automaton/program?*

Q 6.3 · *How can we control the modal dynamics of a hybrid automaton?*

Q 6.4 · *Which state-space formulation for closed-loop systems was discussed in the course?*

Q 6.5 · *How do we perform asymptotic regulation?*

Q 6.6 · *How can we check whether a closed-loop system asymptotically regulates itself?*

Q 6.7* · *How can we design optimal control laws for linear time-invariant (LTI) systems?*

Q 6.8 · *What does controllability for LTI systems mean? How do we check it?*

Q 6.9 · *How can optimality be inductively characterised?*

Q 6.10 · *How does DP work?*

Further questions based on the lecture material will be subject of the final oral exam.