Exercises on a hybrid system of an outdoor pool with a backup tank

Luca Geretti

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1 System

The system represents a primary tank (a pool) connected to a secondary tank (a backup) that saves water in case the water level increases too much due to rainy days, at the same time supplying water in sunny days. The underlying concept is to avoid wasting water due to overflow, but also to avoid depletion.

2 Objective

Complete the specification in order to model a realistic system where depleting and overflow of water are a possibility, which are avoided by the chosen control strategy.

3 Exercises

1. Model depletion of both tanks (i.e., water level cannot go below zero)
2. Model overflow of both tanks (i.e., water level cannot go over a given constant, say 2 meters for the pool), assuming the backup tank is the same as the pool
3. Modify the constants in the current system in a way that overflow occurs
4. Introduce an automaton that monitors the amount of wasted water due to overflow (hint: can be the integration of the instantaneous precipitation (summarized with the r variable) along the time spent in the overflow condition)
5. Modify the constants in all automata to cause both depletion and overflow (hint: work with the duration in the sunny and stormy locations), when the controller is disabled, i.e., the valve aperture a variable in the dynamics of the tanks automaton is instead a constant with a chosen fixed value between 0 and 1
6. Re-enable the controller and see for which of its parameters, if any, both depletion and overflow can be avoided
7. Try out a proportional controller in place of the hysteretic controller (hint: adapt the proportional controller shown in Lecture 7, while discussing dominance checking)

4 Deliverable

Produce source code for all of the exercises, using separate scopes or functions, in order to be able to run everything sequentially, producing the appropriate png figures that prove the results. Write down a report with details on the results obtained and on any issues encountered.