Nonlinear Control

Homework 1: Modeling

In the picture below, a tank system is described in graph form. The liquid in the tank is to be maintained at some level by activating/deactivating a pump that can provide an inflow $\lambda$, while the liquid outflow $\mu$ is constant. A delay $\delta$ in the activation/deactivation of the pump is accounted for by introducing a clock $\tau$.

1.1 Write the automaton model $H = (Q, X, f, \text{Init}, \text{Dom}, E, G, R)$ of the tank system.

1.2 Set $y_{\text{min}} = 1$, $y_{\text{max}} = 2$, $\delta = 0.5$, $\mu = 1$, $\lambda = 3$ and determine a hybrid trajectory with finite hybrid time set of the automaton $H$ describing the tank system.

1.3 Set $y_{\text{min}} = 1$, $y_{\text{max}} = 2$, $\delta = 0.5$, $\mu = 1$, $\lambda = 3$ and analyze the properties of the automaton $H$. In particular,

1.3.1 verify if it is blocking/nonblocking, deterministic/nondeterministic, and whether it has unique infinite execution for each initial state;

1.3.2 prove that the automaton $H$ has no Zeno execution.

1.4 Determine if it is possible to set the parameters $y_{\text{min}}$, $y_{\text{max}}$, $\delta$, $\mu$, $\lambda$ so as to obtain

1.4.1 a blocking automaton

1.4.2 a nondeterministic automaton

1.4.3 a Zeno automaton