Water level regulation

The system is based on the water level regulation system of a tank studied in the thesis redacted by Sofiane Khaouni. Some liberty has been taken with regard to the model developed by Mr. Khaouni.

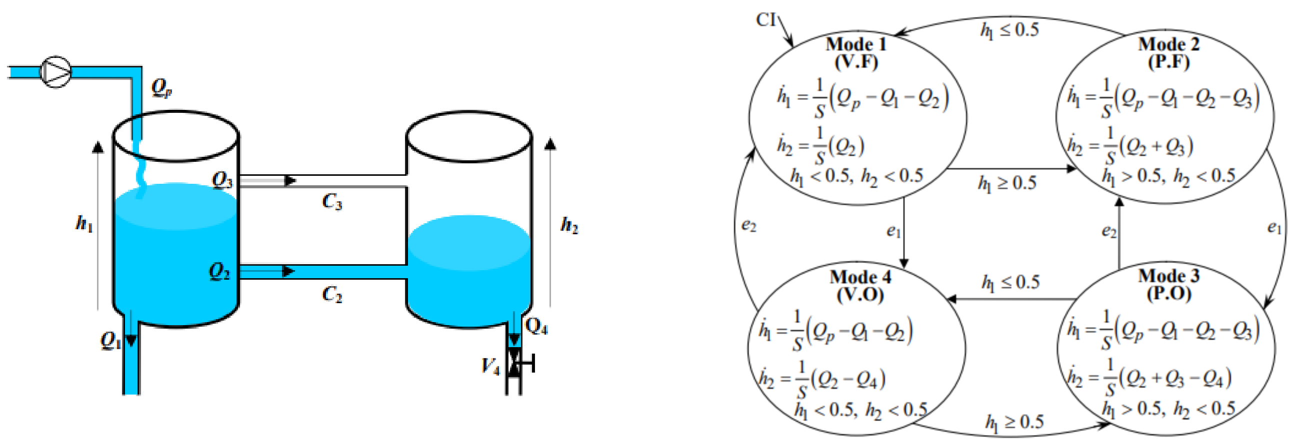

Figure 1: Schema of the system and its hybrid system modelisation (taken from Khaouni's thesis)

The objective of the pomp is to maintain the water level of second tank in a set range. The pomp will supply or not the first tank depending on the water level state and its speed in the second tank. After a while, the valve V4 is activated for a few minutes. The state of the models are mainly defined by the water level of the first tank and the state of the valve V4. Figure 1 shows the modeling the physical system, the states are defined in the following way:

- **State 1**:The water level in the first tank h_1 is between the height of the conduits C_3 and C_2. The valve V_4 is closed.
- **State 2**:The water level in the first tank h_1 is higher than the height of the conduit C_3. The valve V_4 is closed.
- **State 3**:Same situation as State 2 except the valve V_4 is open.
- **State 4**:Same situation as State 1 except the valve V_4 is open.

Thus the transitions between the State 1 and 2 and between 3 and 4 are done by comparing the water level in the first tank with the height of the conduit C_3. The transition between the State 1 and 4 and between State 2 and 3 are done during the opening of the Valve V_4. This transition will be modeled by a timed guard.

In the model, in order to command the pomp, knowing the water level speed is necessary. Matlab Stateflow does not allow the possibility to read the derivative value of continuous variables. Thus the idea was to consider the speed as another variable, solution of a differential equation which the derivative of the water level's one.

In order to establish the equations, we consider the flow is incompressible, stationary and perfect. Thanks to those hypothesis, the Torricelli formula can be used to establish the differential equations :

$$Q_1 = \alpha\sqrt{h_1}$$

$$Q_2 = \alpha \, sign(h_1 - h_2)\sqrt{h_1}$$
$$Q_3 = \alpha \, sign(h_1 - 0.5)\sqrt{h_1}$$
$$Q_4 = \alpha\sqrt{h_2}$$

We inject those relations in the relation between the water level and the flow rates to establish the differential equations.

Q_p represents the flow of the water supply. Depending on the evolution of the water level in the second tank, its value will either be null or constant.