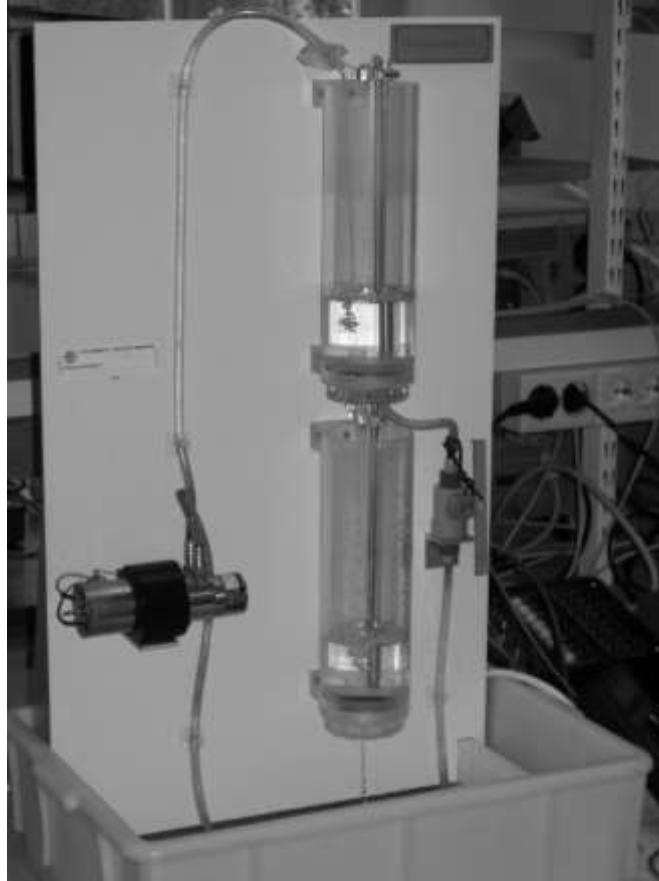


Two cascaded tanks

The process is a fluid level control system consisting of two cascaded tanks with free outlets fed by a pump. Water is transported by the pump to the upper tank. The process is depicted below.



The input signal to the process is the voltage applied to the pump and the two output signals consist of measurements of the water level of the tanks. Since the outlets are open, the result is a dynamics that varies nonlinearly with the water level. The process is controlled from a PC equipped with A/D and D/A converters.

The laboratory process is suitable for physical modeling. Application of Bernoulli's principle and conservation of mass results in:

$$\begin{pmatrix} \frac{dh_1}{dt} \\ \frac{dh_2}{dt} \end{pmatrix} = \begin{pmatrix} -\frac{a_1\sqrt{2g}}{A_1}\sqrt{h_1} + \frac{1}{A_1}ku(t) \\ -\frac{a_2\sqrt{2g}}{A_2}\sqrt{h_2} + \frac{a_1\sqrt{2g}}{A_2}\sqrt{h_1} \end{pmatrix} + \begin{pmatrix} w_1(t) \\ w_2(t) \end{pmatrix}$$
$$\begin{pmatrix} y_1(t) \\ y_2(t) \end{pmatrix} = \begin{pmatrix} 1 & 0 \\ 0 & 1 \end{pmatrix} \begin{pmatrix} h_1(t) \\ h_2(t) \end{pmatrix} + \begin{pmatrix} e_1(t) \\ e_2(t) \end{pmatrix}.$$

Here h_1 and h_2 denote the levels of the upper and the lower tank, respectively. $w_1(t)$ and $w_2(t)$ are system noises. The outputs are given by $y_1(t)$ and $y_2(t)$, corrupted by the measurement disturbances $e_1(t)$ and $e_2(t)$.

The areas of the tanks are A_1 and A_2 while the effluent areas are denoted a_1 and a_2 . The gravity is denoted by g , the voltage-to-input flow conversion constant, by k and the applied voltage to the pump, by $u(t)$.

Data was collected in open loop experiments using zero-order hold (ZoH) sampling. The input signal was first generated as a PRBS signal and then multiplied by a random number, uniformly distributed between 0 and 1.

Data of file tank1.dat used a sampling period of 5.0s and provide 2500 samples of input-output data for both the upper and lower tank. The input signal changes its value every 30 sampling periods. Data of file tank2.dat used a sampling period of 4.0s and provide 7500 samples. The input signal changes its value every 15 sampling periods. In both files, the first column is the input and the second and third columns are $y_1(t)$ and $y_2(t)$, respectively.