05_03 An Example

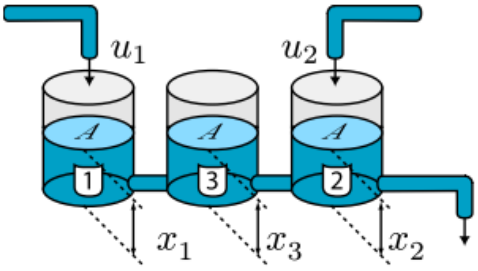
- There is a **drop down** after detection, the residual value goes down, it is because the **nature of the observer**, the observer will gradually compensate the effect of the fault

1. System Description

Benchmark description

$$\begin{cases} x_1(k+1) = x_1(k) + \frac{T_s}{A_1}(c_1 A_1^p \text{sign}(x_3(k) - x_1(k)) \times \\ \qquad \sqrt{2g|x_3(k) - x_1(k)|} + u_1(k)) \\ x_2(k+1) = x_2(k) + \frac{T_s}{A_2}(c_2 A_2^p \text{sign}(x_3(k) - x_2(k)) \times \\ \qquad \sqrt{2g|x_3(k) - x_2(k)|} - c_3 A_3^p \sqrt{2g x_2(k)} + u_2(k)) \\ x_3(k+1) = x_3(k) + \frac{T_s}{A_3}(c_1 A_1^p \text{sign}(x_1(k) - x_3(k)) \times \\ \qquad \sqrt{2g|x_1(k) - x_3(k)|} - c_2 A_2^p \text{sign}(x_3(k) - x_2(k)) \times \\ \qquad \sqrt{2g|x_3(k) - x_2(k)|}) \end{cases}$$

AMIRA DTS200



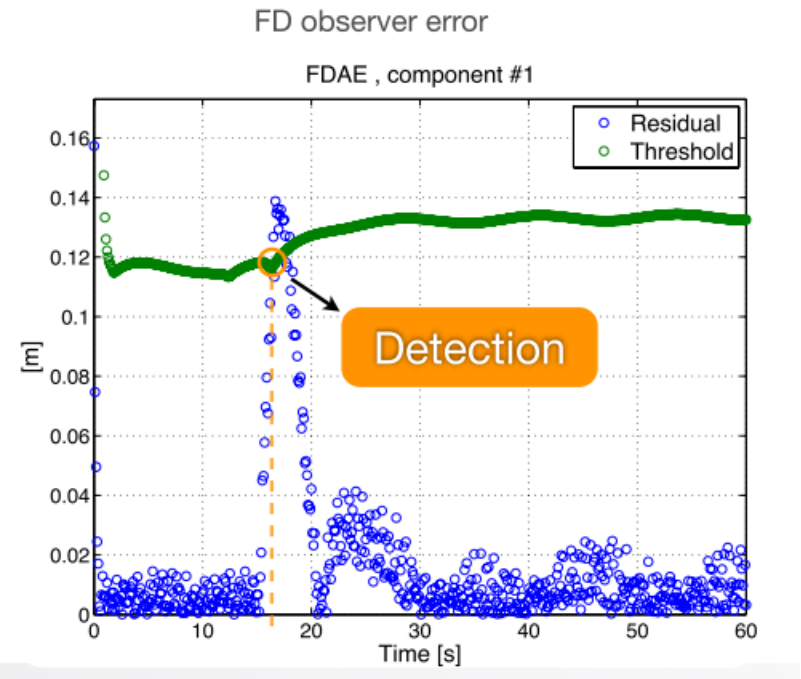
2. Fault Diagnosis (H_0 Case)

Benchmark Description

> Nominally all tanks have cross-section A=0.156 m2, all pipes have cross-section Ap=5 10-5 m2 and outflow coefficients are tuned to match the real 3-tanks system

> The actual parameters are off by 10%, 15% and 5%

> At t=15 s we model a leak in tank 3 with time constant b=1.05 and size



3. FDAE Case

Fault Description

> Pump n.1 shutdown

$$\phi^1 = \begin{bmatrix} \vartheta_1^1 g_1^1(k) \\ 0 \\ 0 \end{bmatrix} \qquad \vartheta_1^1 = a_1 \qquad g_1^1(k) = -\frac{T_s}{A_1} u_1(k)$$

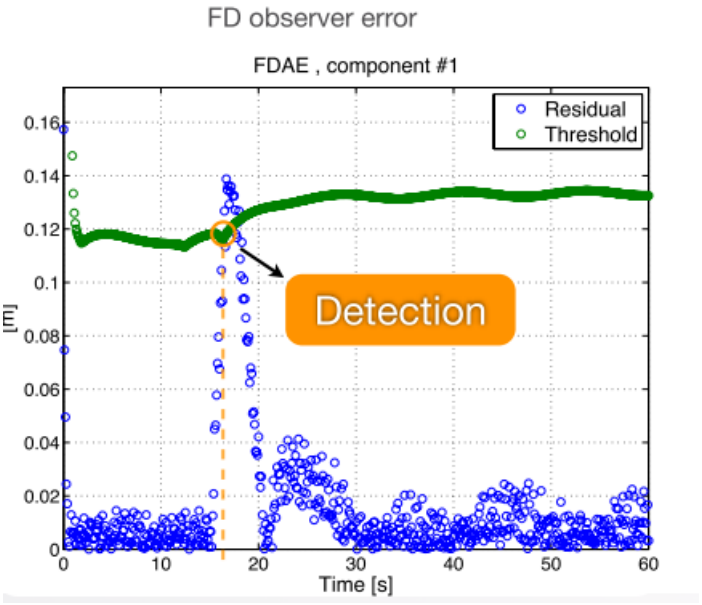
> Leakage in tank 1

$$\phi^2 = \begin{bmatrix} \vartheta_1^2 g_1^2(k) \\ 0 \\ 0 \end{bmatrix} \qquad \vartheta_1^2 = \pi(\rho_1)^2 \qquad g_1^2(k) = -\frac{T_s}{A_1}\sqrt{2g x_1(k)}$$

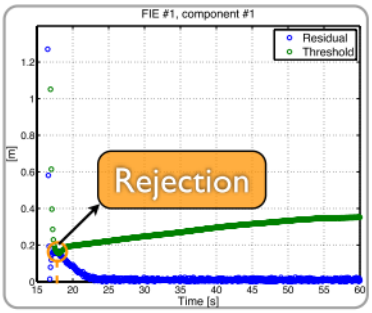
> Pump n.2 shutdown

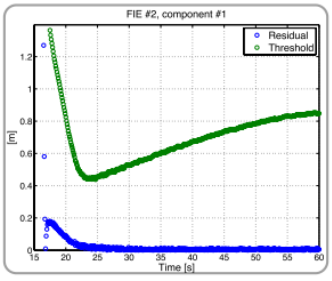
$$\phi^3 = \begin{bmatrix} 0 \\ \vartheta_2^3 g_2^3(k) \\ 0 \end{bmatrix} \qquad \vartheta_2^3 = a_2 \qquad g_2^3(k) = -\frac{T_s}{A_2} u_2(k)$$

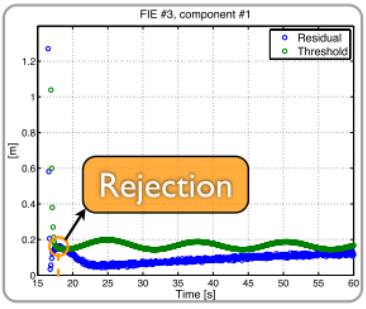
Detection



Isolation

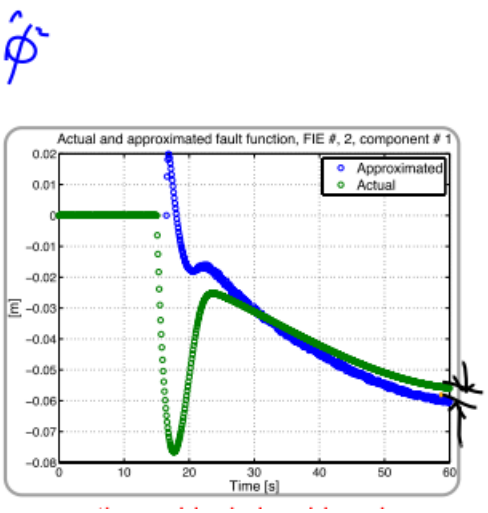


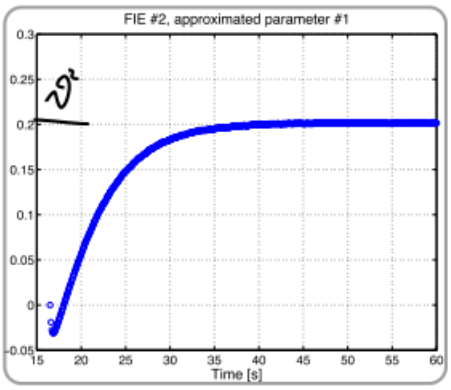




- Fault 1 may have chance to mix with fault 2, because they have similar effect on the state

Approximation and Estimation





- The residual also driven by other parts, not only the error, so there may be some final error in the end