Multivariable control for power plant

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Abstract

- Purpose of the study
- Plant description
- Curent control
- Advanced control
- Conclusion / perspective

Purpose of the study

- Apply the method of EICAS to a thermic plant operating
- Motivations :
  - Weak performances of the current regulation (overshoots, solicitations of the drivers, risk of alarms…)
  - Developing the natural coupling process through a multivariable control

Plant description 1/3

- Commands :
  - Inlet valve, Os
  - Fuel output, Qc
- Outputs to control
  - Electric power, Pu
  - Steam pressure, Pv

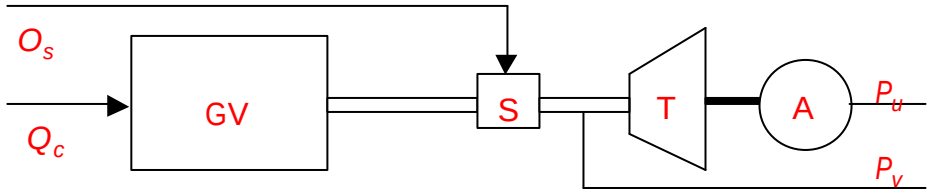
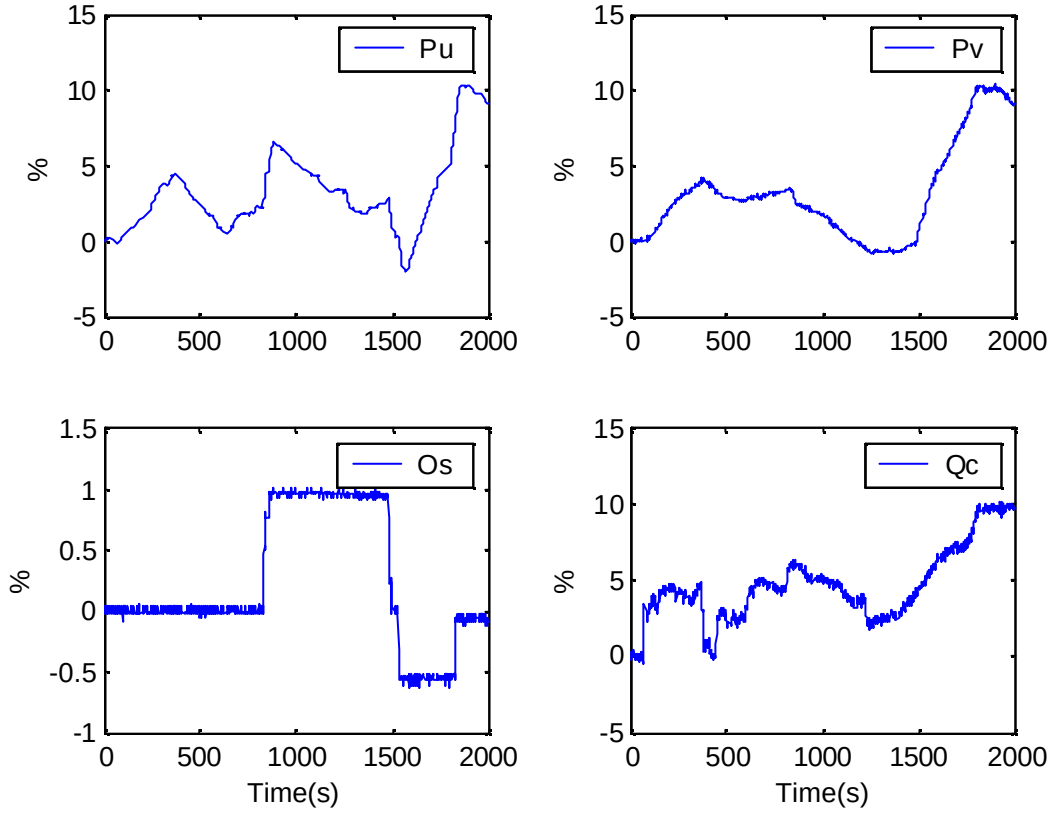


Fig. 1. The plant

Plant description 2/3

•Modelisation : identification from real signals through a method of least square of innovation



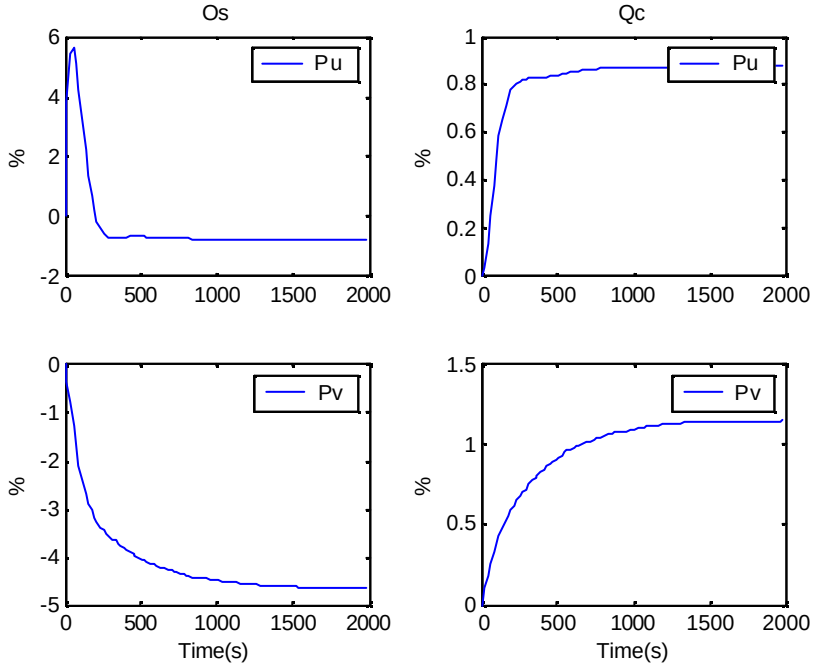
Plant description 3/3

- Continuous model order 3

$$\dot{x}(t) = \begin{bmatrix} -0.03134 & 0.1 & -0.08252 \\ -0.005968 & 0 & -0.001468 \\ -0.002405 & 0 & -0.002428 \end{bmatrix} x(t) + \begin{bmatrix} 0.268 & -0.0009587 \\ -0.01171 & 0.006941 \\ -0.01326 & 0.004912 \end{bmatrix} \begin{bmatrix} Os(t) \\ Qc(t) \end{bmatrix}$$

$$\begin{bmatrix} Pu(t) \\ Pv(t) \end{bmatrix} = \begin{bmatrix} 1 & 0 & 0 \\ 0 & 0 & 1 \end{bmatrix} x(t) + \begin{bmatrix} 0 & 0 \\ 0 & 0 \end{bmatrix} \begin{bmatrix} Os(t) \\ Qc(t) \end{bmatrix}$$

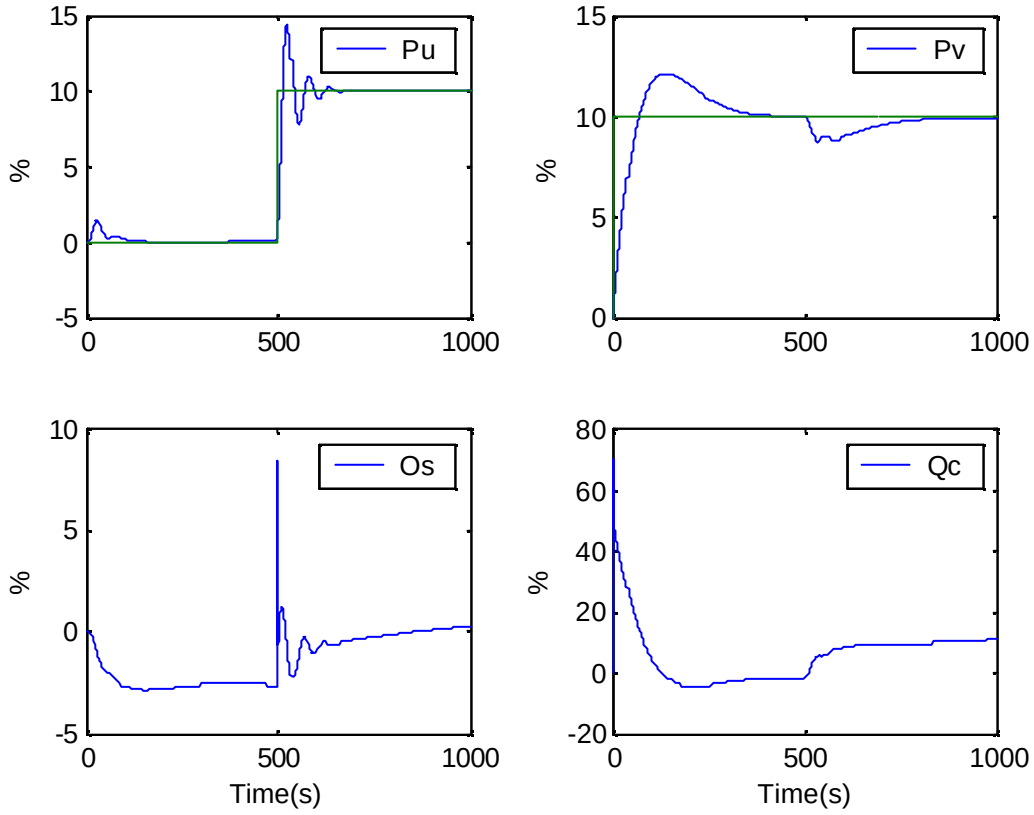
- Indexed responses



Current control

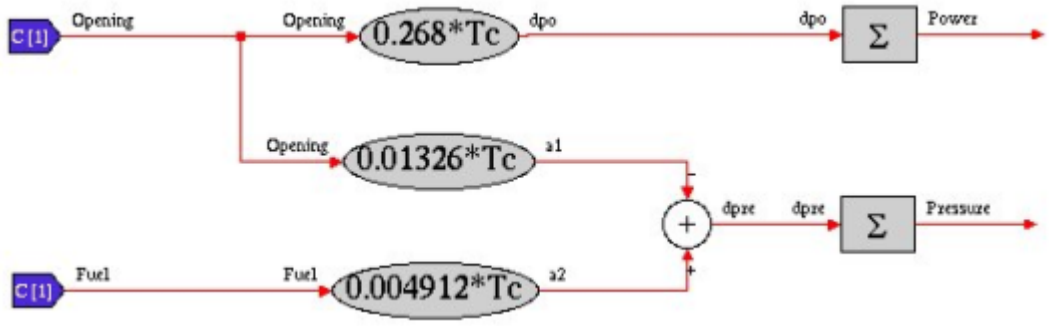
- Structure : PID without feedforward $PID = K_p + \frac{K_i}{s} + \frac{K_d s}{\frac{1}{N} s + 1}$
- Simulation
- Performances

Pu Control	
Excesses/Overshoot	44 %
Response time	12 s
Pv Control	
Excesses/Overshoot	20 %
Response time	51 s
Solicitation of the drivers	
Os	1.19 e^4
Qc	6.041 e^5



Advance control 1/4

- Simplified model

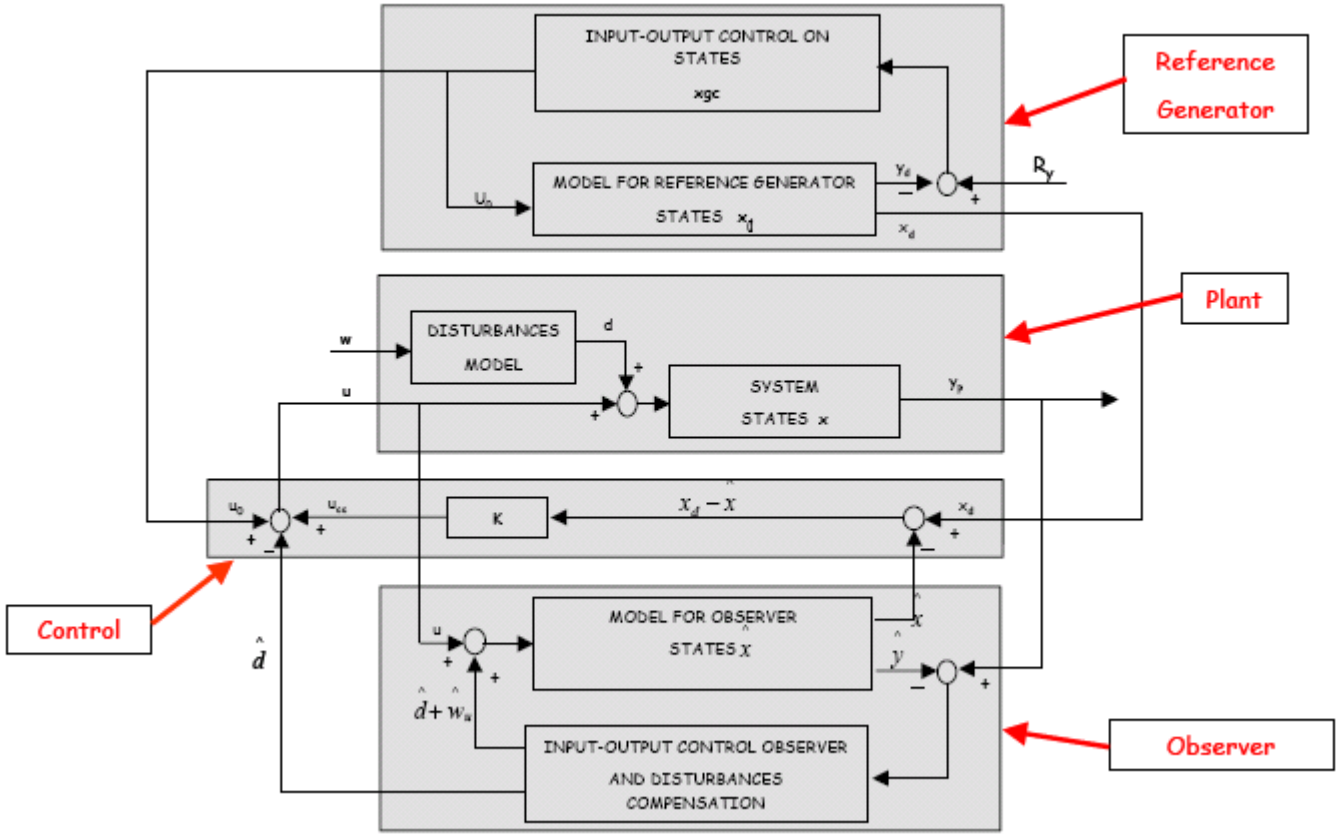


$$X(i+1)=\begin{bmatrix}1 & 0\\ 0 & 1\end{bmatrix}X(i)+\begin{bmatrix}0.0268 & 0\\ -0.001326 & 0.0004912\end{bmatrix}u(i)$$

$$Y(i)=\begin{bmatrix}1 & 0\\ 0 & 1\end{bmatrix}X(i)$$

Advance control 2/4

•Description : Package 2.A



Advance control 3/4

•Description : Package 2.A

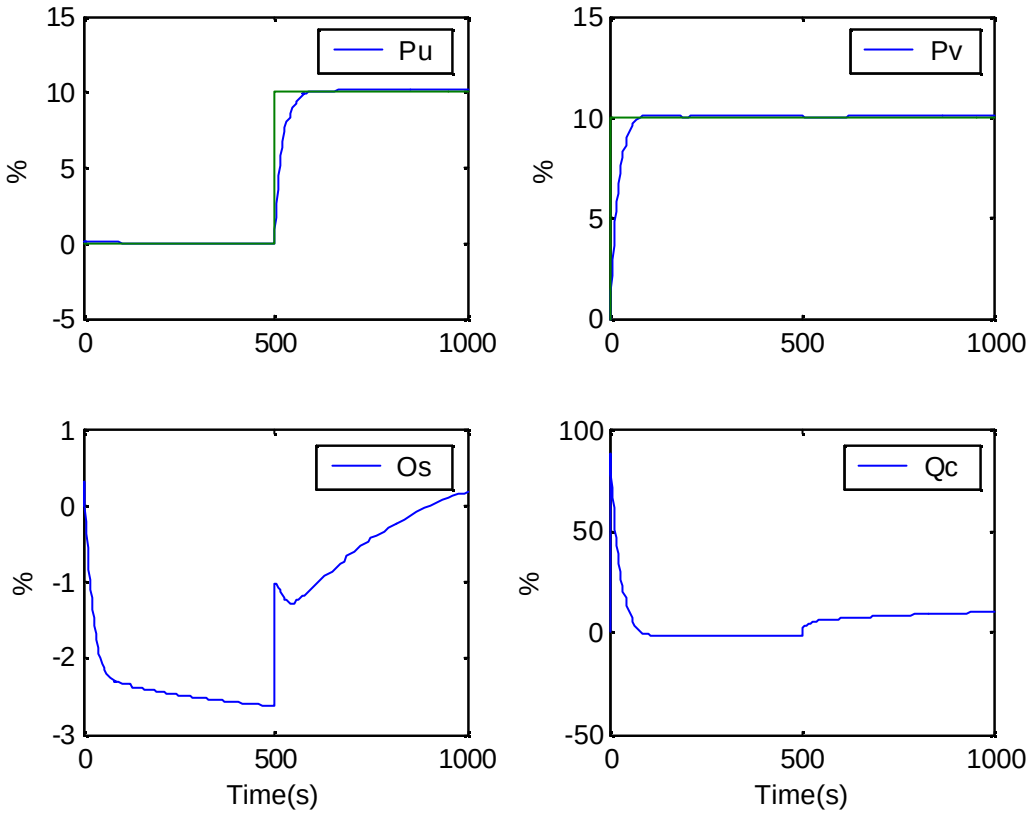
Reference generator poles
0.98 ; 0.98 ; 0.99 ; 0.99
Observer poles
0.9 ; 0.9 ; 0.9 ; 0.9 ; 0.9
Control poles
0.9 ; 0.9
Weight for identification – Observor error
1 ; 0
Weight for optimisation – Observor error
1 ; 0
Weight for optimisation – Control error
1 ; 0
Model
$X(i+1)=\begin{bmatrix}1 & 0\\ 0 & 1\end{bmatrix}X(i)+\begin{bmatrix}0.0268 & 0\\ -0.001326 & 0.0004912\end{bmatrix}[U(i)+D(i)+W(i)]$ $Y(i)=\begin{bmatrix}1 & 0\\ 0 & 1\end{bmatrix}X(i)$

Advance control 4/4

- Simulation

- Performances

Pu Control	
Excesses/Overshoot	0 %
Response time	39 s
Pv Control	
Excesses/Overshoot	0 %
Response time	39 s
Solicitation of the drivers	
Os	4.85 e^2
Qc	6.16 e^4



Conclusion / perspectives

- Reached purposes :
  - Reduction of the solicitation of the drivers
  - Reduced Excesses
  - Similar behaviour when following the instructions of the sizes to control
- Perspectives :
  - Integration of the non linearities
  - More complex use patterns
  - Integration of a smooth commutation device