LASSO-MPC: Model Predictive Control for Over-actuated Systems

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UKACC PhD Presentation Showcase

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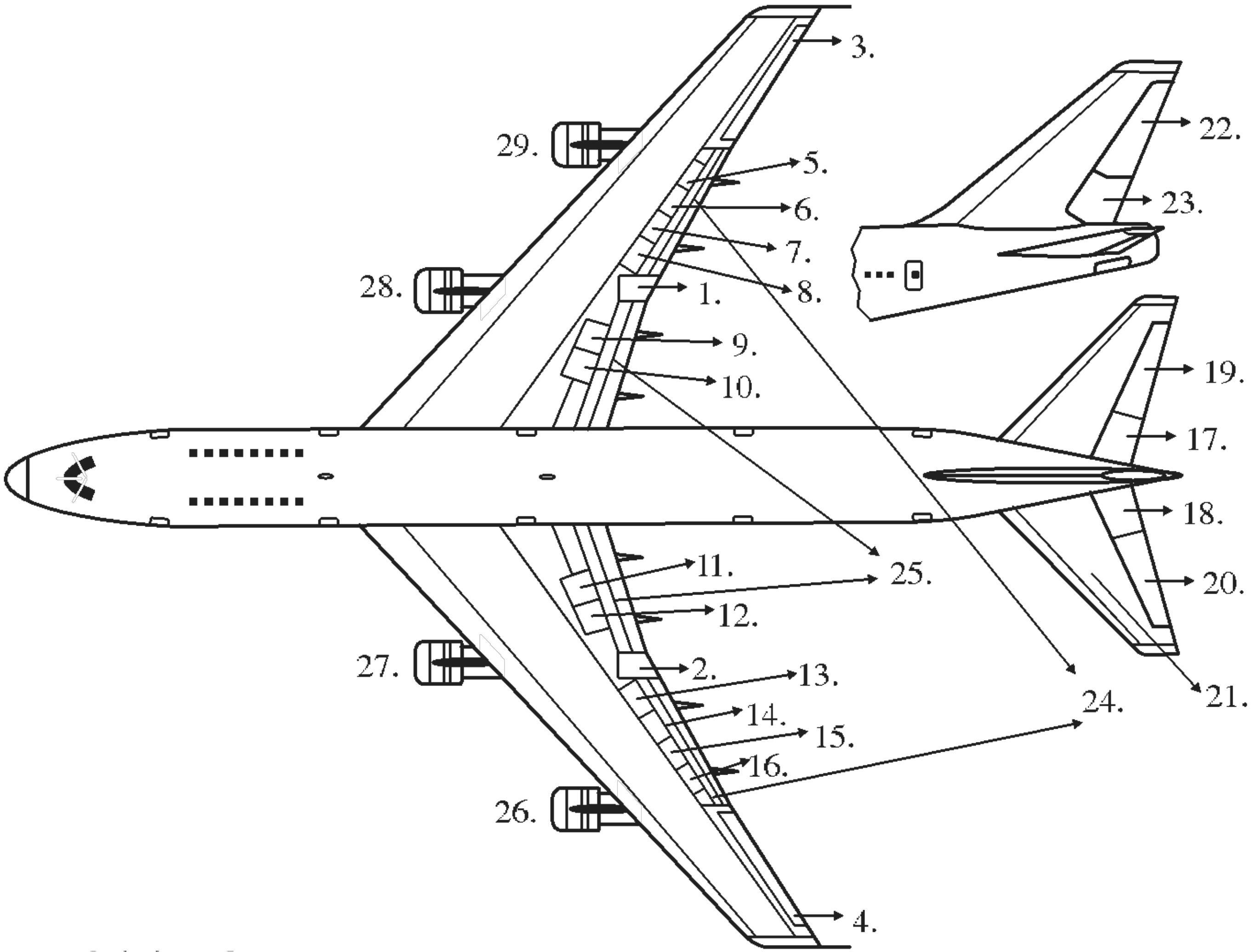
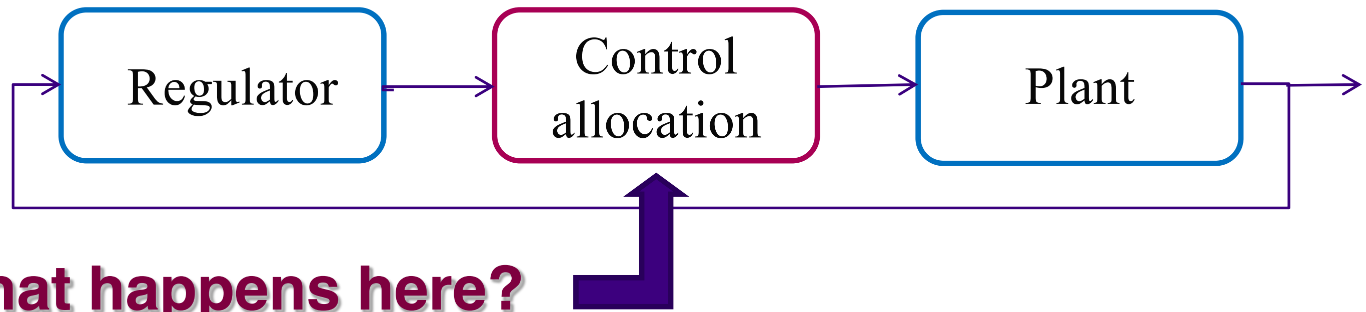
Over-actuated systems



Introduction

- **Potential of over-actuation**
  - *High performance (despite constraints)*
  - *Reliability - Fault tolerance*
- **Control design must exploit this potential !**
- **Common solution: control allocation block**



What happens here?

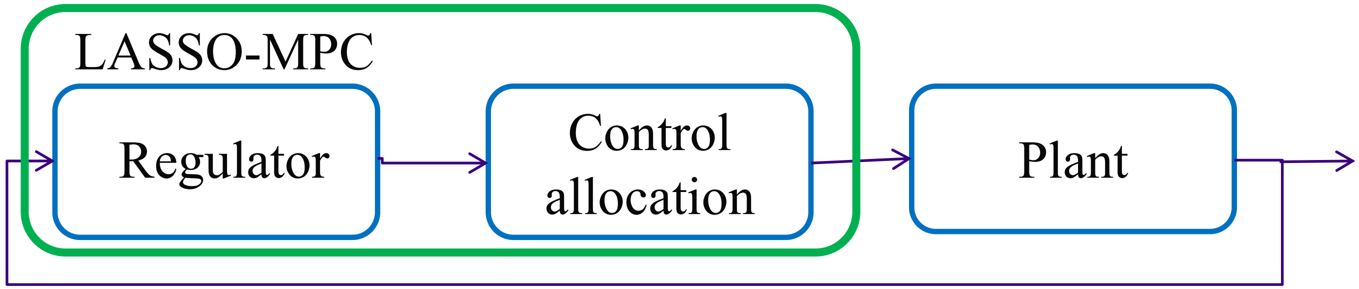
Closed-loop stability? Performance?

LASSO-MPC

- **L1-regularisation in MPC**

$$V_N(x, \underline{u}) = F(x_N) + \sum_{j=0}^{N-1} x_j^T Q x_j + u_j^T R u_j + \lambda \left\| S u_j \right\|_1$$

- **1-norm penalty gives "sparse" control signals**
  - *Some inputs are zero for most of the time*

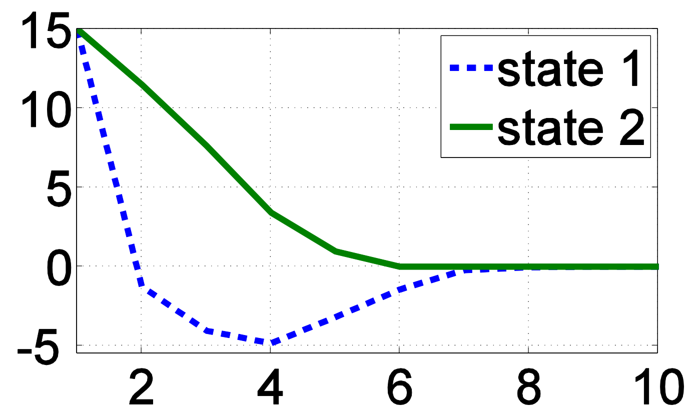


LTI example

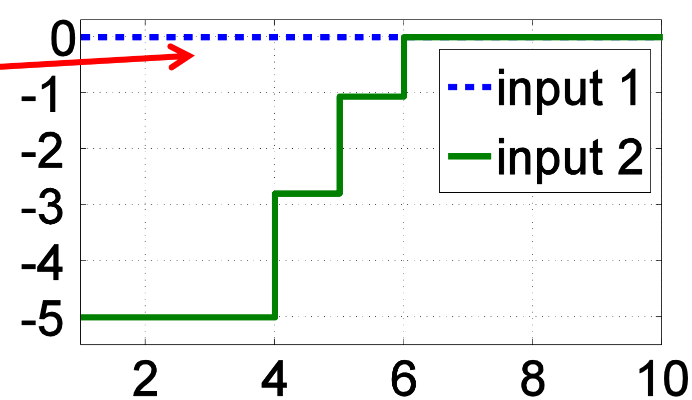
$$A = \begin{bmatrix} 0.15 & 0.1 \\ 0 & 1.1 \end{bmatrix} \qquad B = \begin{bmatrix} 1 & 1 \\ 0 & 1 \end{bmatrix}$$

$$Q = \begin{bmatrix} 20 & 0 \\ 0 & 60 \end{bmatrix} \quad R = \begin{bmatrix} 0.1 & 0 \\ 0 & 0.1 \end{bmatrix}$$

$$|x_j| \leq 20, \qquad |u_j| \leq 5,$$



Input 1 is never used



Sharp control allocation for a finite λ (300)

Conclusions

- **LASSO-MPC: regulation plus control allocation**
  - *For over-actuated systems or expensive control*
- **Research status**
  - *Stabilising formulation: ad-hoc Terminal cost and Terminal constraint*
    - **Quasi-infinite horizon, maximal DOA**
  - *Offline tuning for extra actuators*
    - **Improve pre-existing controllers**
- **Future directions**
  - *Setpoint tracking*
  - *Robustness*