DYNAMICAL SYSTEMS & CONTROL (DYSC)
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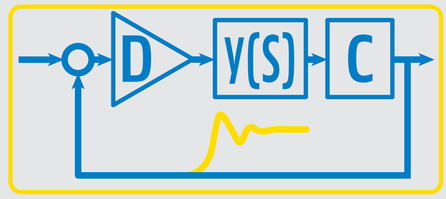


CAN WE MAKE OUR LAMPS SMARTER?

Distributed Model Predictive Control to reduce energy consumption

1. Problem Statement

- Electrical power demand ↗ ↔ Climate agreements
- Distribution demand

Office Buildings

Solutions:

A. Production ↗

B. Improve usage efficiency

2. Goal

- Artificial light complementary and subordinate to sun light
  - ☹ Variations in light intensity (e.g. clouds, flickering, etc.)
    > eye strain, discomfort, headache, etc.

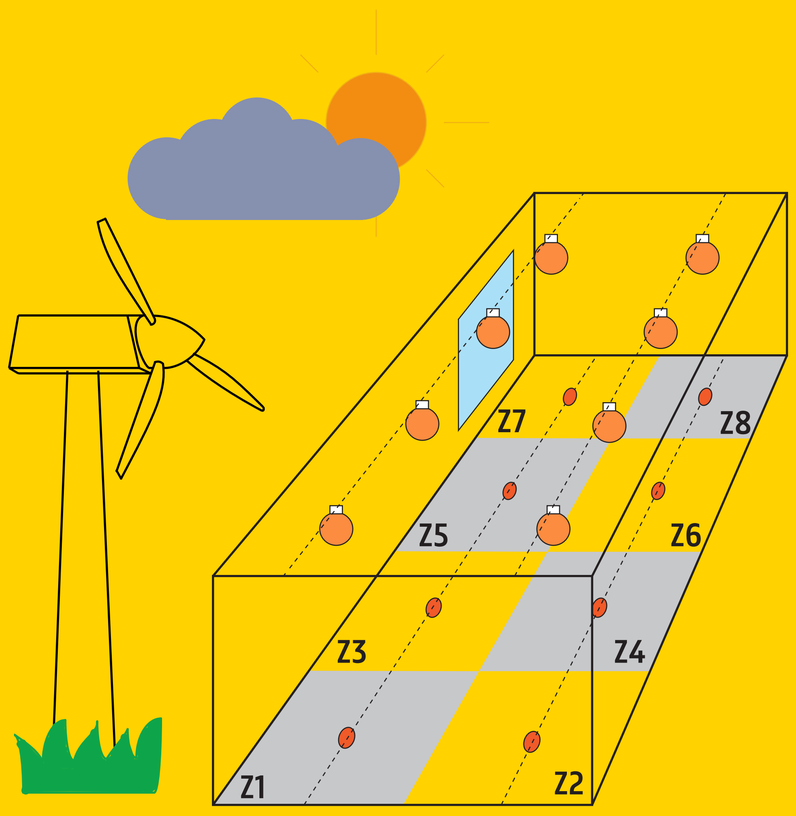
→ Solution: Model Predictive control (MPC)

- Complexity ~ (# lamps)^n (n>1)

→ Solution: Distributed control = only interested in neighbours

3. Testbed

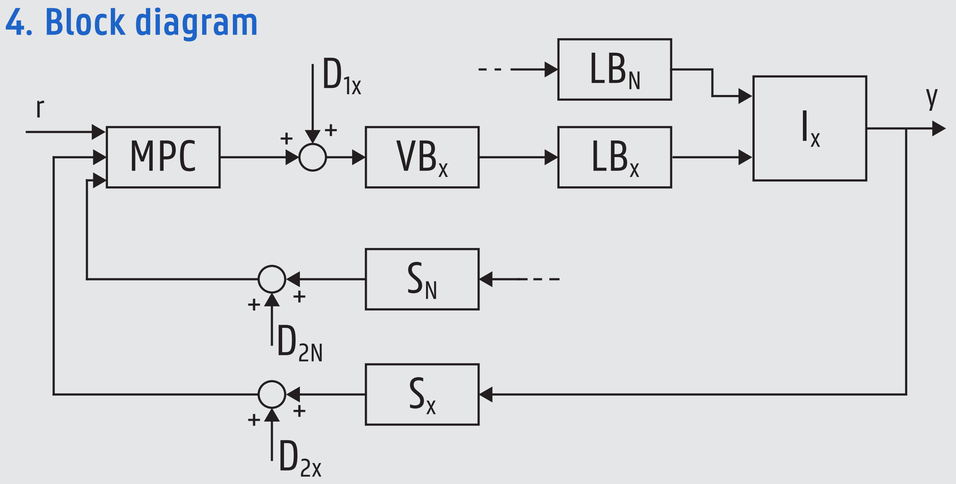
- Real-time controller: dSPACE DS 1104 R&D board
  > Simulink® block diagrams



dSPACE

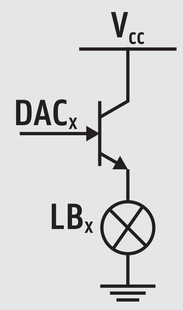
MATLAB® & SIMULINK®

4. Block diagram

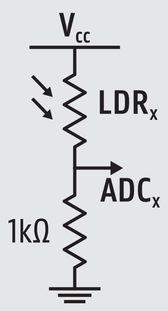


D	Disturbance	LB	Light bulb
N	Neighbour	S	Sensor
r	Reference	VB	Voltage buffer

Voltage Buffer

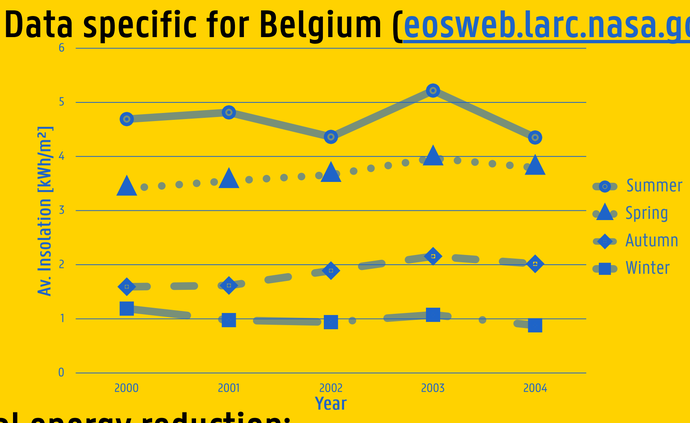


Sensor



5. Hypothesis

- Average insolation on a horizontal surface $\bar{E}$ [kWh/m²/day]
  > Data specific for Belgium (eosweb.larc.nasa.gov/sse/)



Maximal energy reduction:

reduction $\delta = \frac{4\bar{E}_{summer} - (\sum_{i \in seasons} \bar{E}_{summer} - \bar{E}_i)}{4\bar{E}_{summer}} = 60\%$

6. Analogy

Population dynamics	Urban Drainage system	Lighting system	Microgrids
Population	System	Lighting environment	Power dispatch
Strategy	Source reservoir	Lighting zones	Distributed generators
Population mass	Total inflow receptor res.	Total available voltage	Total demanded power
Agent	Flow unit	Voltage unit	Power unit
Proportion of agents	Proportion of flow	Proportion of voltage	Proportion of power
Strategic distribution	Flow distrib. in source res.	Voltage split among LB	Economic power dispatch
Payoff of strategy	Current volume	Tracking error	Marginal utility

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SMART LIGHTS