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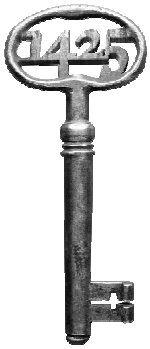

MPC, TABS and AHU in Hollandsch Huys

Model based Predictive Control with Thermally Activated Building Systems and Air Handling Unit

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Geotabs – Eindhoven meeting
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Overview

- TABS and AHU in MPC
- AHU-implementation in Hollandsch Huys MPC

TABS and AHU in MPC

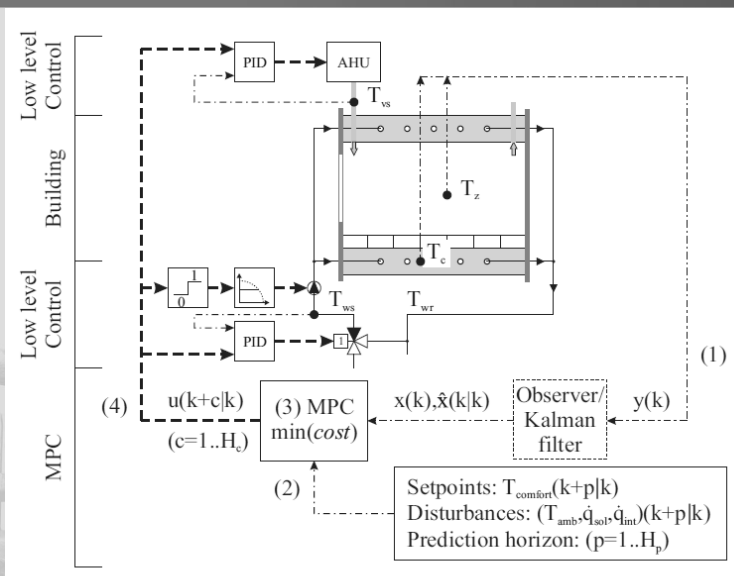
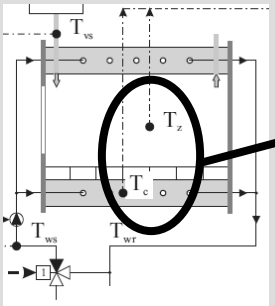


Figure 10.2: Overview of the MPC framework

MPC-TABS: initial state



- Crucial step: measuring the 'state' of the building zone <u>and</u> the TABS
  - High sensor accuracy required due to small ΔT's
  - Positioning of sensors?

subject to:

$$\boldsymbol{X}(0) = \boldsymbol{X}_0$$

MPC-TABS-AHU: model versus cost

Cost: physically derived, but not fitted to reality

$$\min_{T_{ws},T_{vs}} \sum_{k=0}^{H_p} \left[J_{ew,h}(k) + J_{ew,c}(k)\right] + \left[J_{ev,h}(k) + J_{ev,c}(k)\right] F_1 \ldots$$

$$\ldots + \left[\alpha_{du} J_{du}(k) + \alpha_{do} J_{do}(k)\right] (1 - F_1)\, F_2 \Delta t_c$$

TABS

AHU

Thermal discomfort

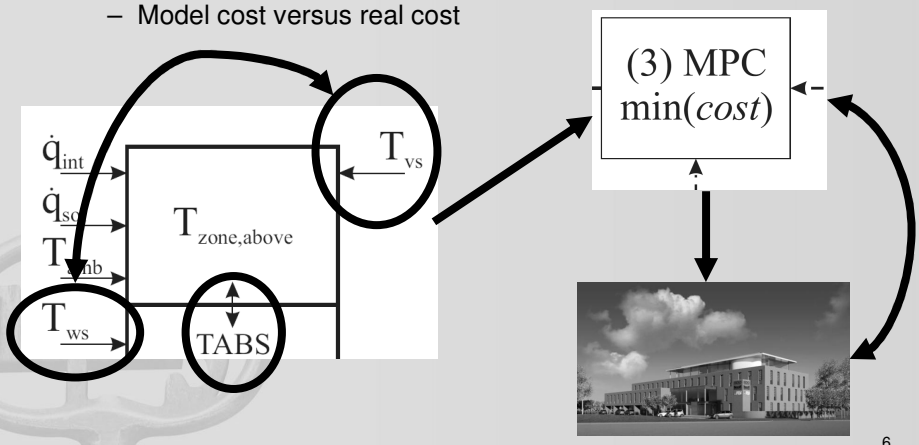
Model: parameter estimation to fit reality

subject to:

$$\boldsymbol{X}(k+1|k) = \mathsf{A}(k)\boldsymbol{X}(k) + \mathsf{B}(k)\boldsymbol{U}(k)$$

MPC-TABS-AHU: cost function

- Energy-cost: important when TABS and AHU cooperate
  - TABS cost versus AHU cost
  - Model cost versus real cost

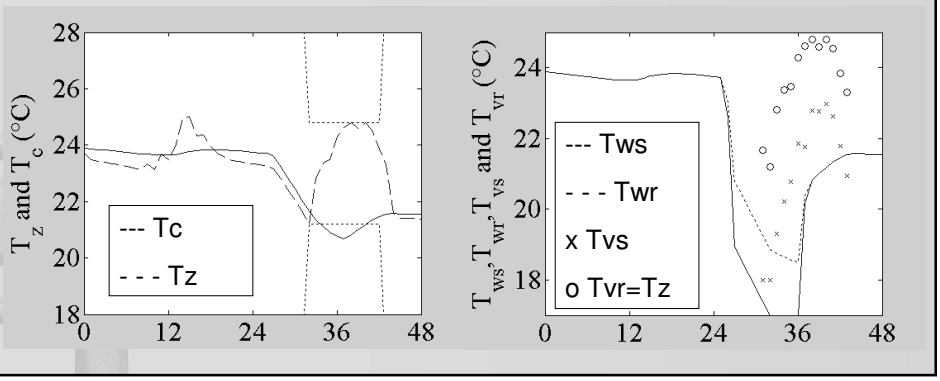


MPC-TABS-AHU: cost function

- TABS cost:
  - Heat transfer water-concrete
  - Production power and efficiency: COP(T), multistage, …
  - Circulation pumps
- AHU cost
  - Heating coil / cooling coil heat transfer (Moist Air!)
  - Production power and efficiency: heat recovery, bypass, recirculation, back-up configuration
  - Fans

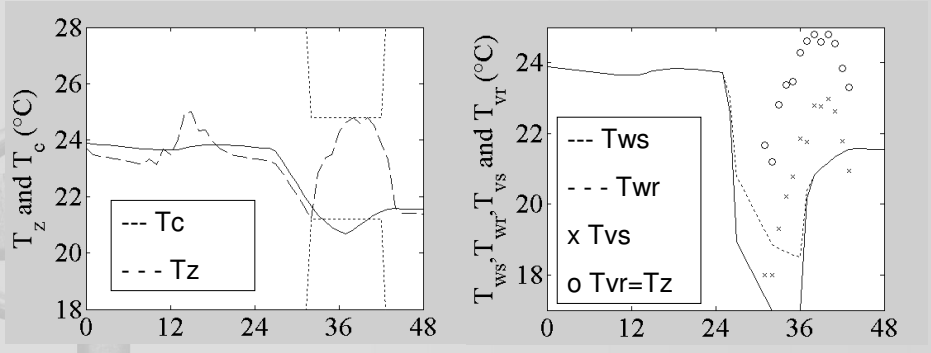
MPC-TABS-AHU: example

- MPC with 2nd order building zone model
- Sunday-Monday sequence
- $Q_{TABS,nom}$ = 42 W/m² ; $Q_{air,nom}$ = 10 W/m²



MPC-TABS-AHU: example

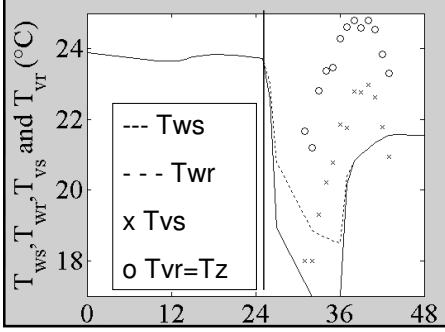
- Change: AHU-cost + 50%
- Solution does not change



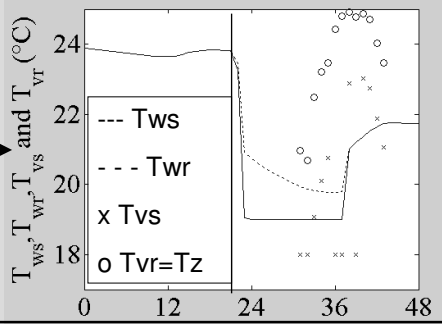
MPC-TABS-AHU: example

- Real $T_{ws,min}$ (TABS supply) = 19°C instead of 17°C
- as if available power is lower than expected by MPC
- Different solution! MPC will generate wrong control actions for TABS and AHU!

Tws,min=17°C

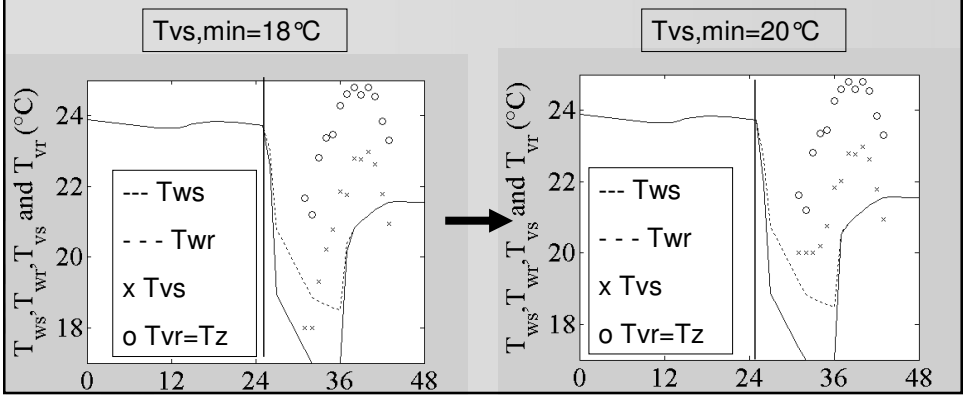


Tws,min=19°C



MPC-TABS-AHU: example

- Change in $T_{vs,min}$ (air supply) = 20°C instead of 18°C
- No real change in MPC control action due to low thermal power of air supply

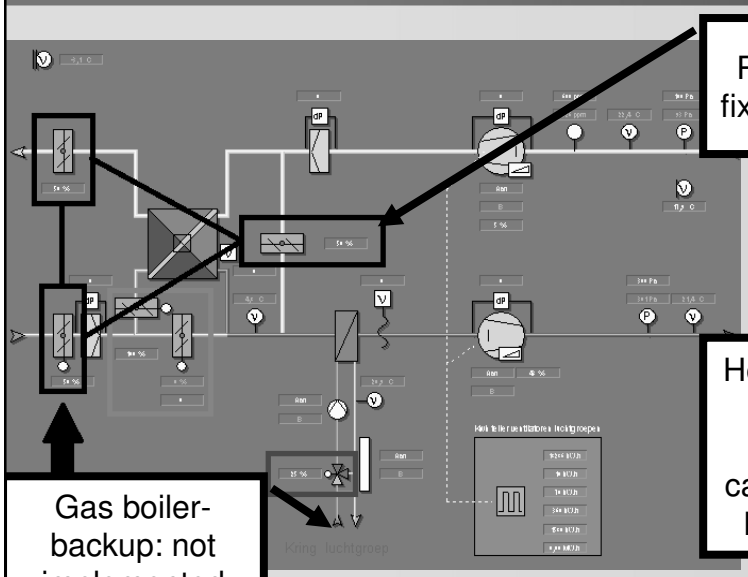


AHU in Hollandsch Huys MPC

- Now only modelled as a disturbance to the zone,
- but with an energy consumption that effects the heat pump production unit

  – $P_{heat\text{-}pump} = P_{TABS} + P_{AHU}$

AHU in Hollandsch Huys MPC



AHU in Hollandsch Huys MPC

- r1 = return air from office **(T_{office})**
- r2 = return air after return fan: **$T_{r2} = T_{r1} + 0.5$**
- r3 = return air after heat recovery: **$\eta_{heatrecovery}$**

- s1 = supply air from outside **($T_{ambient}$)**
- s2 = supply air after heat recovery: **$\eta_{heatrecovery}$**
- s3 = supply air after heat recovery bypass
- s4 = supply air after mixing point: **fixed recirculation (50-50)**
- s5 = supply air after coil:
  Moist air calculation, P_{max}=75kW (see specs;supply water 17-20)
  $P_{calculated} = P_{AHU}$
- s6 = supply air after supply fan to offices : **$T_{s6} = T_{s5} + 0.5$**