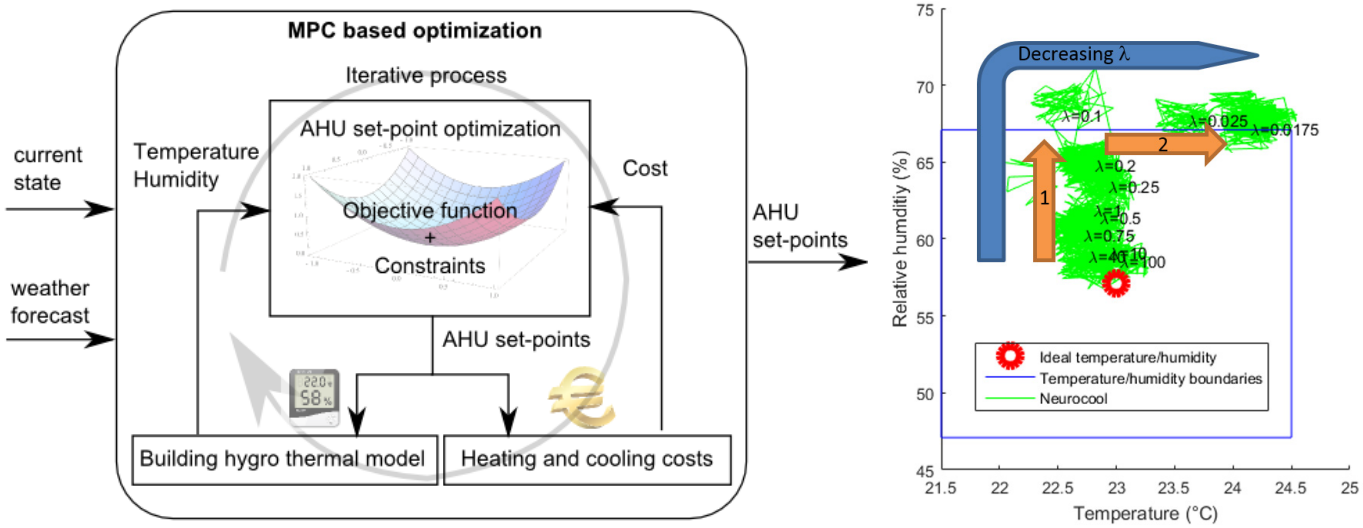
Heating Ventilation and Air Conditioning control

Model predictive control of air conditioning for high comfort at reduced cost

Swiss companies spend on average 30% of their electricity on ventilation and air conditioning. In order to reduce the associated expenses, various energy conservation measures are deployed. The effectiveness and hence payback time of such methods varies greatly. In that context replacing the tradition controller, by a novel model predictive controller (MPC) with anticipation capabilities, was identified as a very efficient solution. Indeed, no expensive hardware modification of the system is required and when applied to building heating control system, savings of up to 28% are obtained with such controllers. We successfully developed and validated a MPC based HVAC. For similar comfort levels, energy savings between 12% and 20% were obtained.

In order to optimize the energy expenditure of the HVAC unit while at the same time ensuring user comfort, we use an MPC approach as depicted below. Doing so allows to anticipate future events and drive the system accordingly. The heart of this algorithms is an objective function that is composed of two terms: energy cost and user comfort. The weight of these two terms can be controlled by a regularization parameter λ. The algorithm is able to find the optimal values of the pulsed air: temperature, humidity and flow rate, while taking into account constraints that are imposed by the technical systems and users.



CMPC based HVAC control overview (left) measured indoor temperature/humidity for various comfort (λ) settings (right).

After a successful validation in simulation, NeuroCool was deployed on three sites. The first site is a climatic chamber in HEIG-VD. There, various climatic conditions under different comfort levels (i.e. λ) were tested. It can be observed, in the figure above, that the comfort can be controlled as expected. For low values of λ, the measured temperature/humidity in the room reaches the admissible boundaries, whereas for high values of λ, a good comfort is obtained. In addition, first the dis-humidification is decreased, which is the most costly process then the cooling is decreased. The two remaining test sites are office spaces located in Neuchatel and Winterthur. There it was shown that energy savings between 12% and 20% could be obtained while ensuring user comfort.

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