Online optimization of the energy consumption in buildings

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Abstract: We consider the dynamic optimization of the energy consumption in a building. The goal is to find optimal policies that minimizes the energy costs subject to temperature constraints and disturbances. The case studied here consists in a single room comprised of a floor heating device, a radiator and a ventilation system with adjustable flow. We consider bounds in the floor temperature, the room temperature (air) and in the CO_2 levels. The floor heat capacity is assumed to be large enough so that we can store a considerable amount of energy in it, hence, giving us an extra degree of freedom for optimization.

The main complicating factor for this problem is the time varying nature of the disturbances, namely, the outdoor temperature and the energy price. We assumed that predictions of the temperature and price variation are available, but are not necessarily correct. Therefore, a moving horizon dynamic optimization scheme was proposed to compensate this variations and guarantee optimal operation. It has been shown that in a scenario where the energy price is time-varying, the economical benefit of the proposed scheme is substantial if we compare it to a simple temperature tracking controller.

Finally, simple solutions based on feedback control and offline analysis were proposed. This was carried out by extending the self-optimizing control idea (Skogestad (2000)) to dynamic optimization problems, where near optimal control inputs are generated without the need for re-optimization when disturbances occur. The simulation examples showed that negligible loss of optimality can be obtained for relatively small disturbances. It is worth to point out that the ideas discussed here could be applied to any other problem where the energy can be stored and the energy price is subject to changes.

REFERENCES

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