Ph.D. in Information Technology: Thesis Defense

July 18th, 2019

Room Seminari – 10.00 am

Soroush RASTEGARPOUR – XXXI Cycle

"Model Predictive Control Approaches for Energy Efficiency in Buildings with Heat Pump and Storage Systems"

Advisor: Prof. **Luca Ferrarini**

Abstract:

Air-to-water heat pump is one of the most common and energy efficient way for a building heating system, particularly floor-heating plants. One way to further improve its effectiveness is to control the heat pump exploiting the load dependency of its coefficient of performance, and exploit it in the control decision in a predictive manner, anticipating its effect on the building temperature. This dissertation studies the impact of using different types of energy storages integrated with a heat pump for energy efficiency in radiant-floor buildings. In particular, on one hand, the performance of the building energy resources management system is improved through the application of model predictive control to better anticipate the effects of disturbances and real-time pricing together with following the modular structure of the system under control. To this end, the load side and heating system are decoupled through a 3-element mixing valve, which enforces a fixed water flow rate in the building pipelines. Hence, the building temperature control is executed by a linear model predictive control, which in turn is able to exchange the building information with the heating system controller. On the contrary, there is a variable action of the mixing valve, which enforces a variable circulated water flow rate within the tank. In this case, the optimization problem is more complex than in literature due to the variable circulation water flow rate within the tank layers, which gives rise to a nonlinear model. Therefore, nonlinear model predictive control is used to deal with many physical constraints and nonlinear problems. Alternatively, linear time-varying MPC is also used, based on successive linearizations around a reference trajectory. The other goal of the dissertation is to analyze the advantages and disadvantages of those MPC techniques for temperature control in radiant-floor buildings. Moreover, a robustness analysis has been conducted, showing the impact of the heat pump efficiency on the control performance.

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