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M. Luzi, M. Vaccarini, M. Lemma

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A tuning methodology of Model Predictive Control design for energy efficient building thermal control

M. Luzi[a,*], M. Vaccarini[a], M. Lemma[a]

[a] *Università Politecnica delle Marche, Department of Civil and Building Engineering and Architecture, via Brecce Bianche, 60131, Ancona, Italy*

Abstract

The Model Predictive Control (MPC) approach is based on the prediction of indoor and outdoor thermal loads in order to counter the deviation of the indoor temperature from the occupants' preference in advance. The minimization of temperature alteration allows for efficient energy use and improvement of indoor thermal environment. Unlike the classical reactive control, MPC is able to act in advance and to explicitly handle constraints on building variables when selecting the best scenario. This peculiarity makes MPC particularly suitable for the optimal energy management of buildings but, despite the increasing research activity in the field, the commercial technologies are lagging behind. Among the reasons are the lack of a well established design approach easily applicable to the buildings domain and the lack of a design optimization. In this paper a tuning methodology of MPC design for energy efficient building thermal control is presented. The tuning is performed on the controller parameters, and aims at identifying the best parameter set in terms of energy saving and temperature deviation from the chosen setpoint. To demonstrate the effectiveness of the methodology, a simulation based analysis using a model estimated on a real case study is presented. The methodology shows that by improving the control parameters it is possible to reduce energy consumption and improve thermal comfort for the final user.

Keywords: Model Predictive Control, Performance analysis, Parameter tuning, Thermal control, Intelligent buildings, Control design

1. Introduction

1.1. Problem statement

In the developed countries the construction sector is responsible for a large share of global energy consumption, more than for the industry and transport sector and mainly regarding non-renewable energy sources [1–3]. Limiting building energy consumption means reducing the energy involved in the production, use, and maintenance phase of the building. With regard to the use phase, the energy consumption mostly comes from heating and cooling rather than illumination or other services [3]. The most effective strategy to limit energy consumption during the use phase is that of control. The objective of control is to monitor the local temperature so that once the

*Corresponding author

Email addresses: massimilianoluzi16@gmail.com (M. Luzi), m.vaccarini@univpm.it (M. Vaccarini), m.lemma@univpm.it (M. Lemma)