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Prof. Ing. Zbyněk Škvor, CSc.
Vice-Dean for Science and Research,
Technická 2,
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CZECH REPUBLIC

30 July, 2013

Dear Prof. Ing. Škvor,

I have reviewed the Dissertation Thesis of **Ing. Jiří Cigler** and the results of that review are given here.

This thesis documents the investigation of Model Predictive Control (MPC) techniques for the practical control of energy flows within buildings. Given the large percentage of energy used in buildings (approximately 40%) and their correspondingly large contribution of CO_2 emissions, the work is of significant current interest. The emphasis here is on the development and real-world testing of practical MPC techniques for buildings. This area of research is gaining in both academic and practical importance and this PhD. thesis is relevant to this area.

The three major goals, and the contributions of the thesis in achieving these goals, are given below.

1. Evaluation of MPC energy savings potential on a real building. This has been successfully achieved and is documented in the 2011 Applied Energy paper included within the thesis. The MPC controller was successfully demonstrated on a pilot building at CTU in Prague and found to achieve energy savings between 15 and 28% compared to the baseline control system.

2. Development of a MPC formulation less sensitive to model mismatch and prediction errors. This question is addressed in the CLIMA 2013 paper included within the thesis. A modified cost function, using a smoothing function, is developed and tested in simulation.

3. Development of a computationally tractable PMV based MPC. There are benefits in using Predicted Mean Vote (PMV) as a cost function as it corresponds closely to the building occupants perception of comfort. The difficulties of implementing this in an MPC environment are presented in the

2012 Energy and Buildings paper included within the thesis. An approximate solution is used to give a practical solution to the problem.

The methods proposed in the thesis have been tested in simulation, and on full-scale building control systems. The practicality and appropriateness of the methods has been clearly demonstrated. Furthermore the author has demonstrated creativity in the development of the methods described.

The work presented in this thesis provides alternative approaches to the use of MPC for building control. These approaches can be used as the basis of further scientific work, including testing and further development on experimental building systems. As such, the work is a useful scientific contribution.

The author of the thesis proved to have an ability to perform research and achieve scientific results. I do recommend the thesis for presentation with the aim of receiving the Degree of Ph.D.

Yours sincerely,

Prof. Dr. Roy S. Smith ETH Zürich