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Prof. Ing. Zbyněk Škvor, CSc.
Vice-Dean for Science and Research,
Technická 2,
166 27 Prague 6,
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Dear Prof. Ing. Škvor,

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

The thesis addresses the problem of developing mathematical models of the dynamic responses of buildings for use in model predictive control (MPC) strategies to reduce energy consumption. The control of energy use within buildings is a topic of significant research interest and there are active projects in Europe, North America and Asia. The motivation behind this interest is also addressed in this thesis; buildings consume over one third of the total energy use, and contribute a similarly large percentage of CO_2 to the atmosphere. Furthermore, buildings are typically in service for many years, meaning that advances in energy efficient construction will not change the overall energy or pollution characteristics for a long time. Modifying the control of energy within buildings is the best opportunity for making immediate improvements in this area.

This thesis also points out that one of the major hurdles to the widespread adoption of advanced control techniques is the difficulty in obtaining suitable models for existing buildings. The more advanced control systems required for significant energy reduction require relatively sophisticated models. The theory and tools underlying the development of these models is lacking. This is the focus of this thesis and it is an area of immediate scientific and engineering importance.

The main objective of this work is to develop methods for the experimental modelling of buildings for energy control. The author has listed several related objectives (surveying current methods and analysing the difficulties, benefits and potential of these methods) which constitute a sound scientific approach to the problem. All modelling methods will yield a variety of potential models and it is important for the user to be able to select the most appropriate model. A related objective is the development of relevant selection criteria to guide the user in selecting the best model. The objectives stated are clear and appropriate for the problem. The author has met these objectives and published the results in peer-reviewed articles.

The research behind this thesis has used both simulation studies and experimental data as the basis for improving building model development methods. Using simulation studies alone would lead to a lack of realism in the resulting models. Using experimental studies alone would leave the work open to the risk of developing methods that were in fact appropriate only for a very limited type of building. By combining both the author is able to refine the practical methods on experimental data, and also gain insight into their generality by studying well chosen simulation case studies. This approach is a good one for this class of problems as opportunities for extensive building experiments are severely limited.

The main results of this thesis are the following:

1. The evaluation and demonstration of the appropriate modelling method for different classes of building;
2. The development of a method for incorporating prior information about the building into statistical modelling methods;
3. The development of methods for combining existing physical building modelling domains (Trnsys and EnergyPlus) with statistical subspace identification methods (N4SID) for the production of building models suitable for advanced control methods; and
5. The demonstration of the these modelling methods on both experimental buildings and advanced simulation testbeds.

The development of control-relevant building models is a broad field. This thesis provides several concrete methods which can be applied to engineering problems. The results will also form the basis of further development in this important field. This thesis is a suitable platform for the continuation of the field.

The author has published his thesis work in five peer-reviewed journal articles and seven conference papers. In addition, he is a coauthor on an additional three journal papers and six conference papers in related areas. This level of scientific output is more than is common during doctoral studies and speaks to the significance and creativity of the work.

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