Use of Weather and Occupancy Forecasts for Optimal Building Climate Control – Part II: Demonstration (OptiControl-II)

Project Summary

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Recent work by the applicants and other researchers suggests that predictive control presents a promising option to enhance the energy efficiency and comfort of buildings, and to reduce their peak power demand at modest additional cost. However, most evidence provided so far was based only on computer simulations. Here we propose rigorous testing and assessment of predictive building control technologies, in particular of Model Predictive Control, based on almost two years of monitoring and full-scale experimentation with a representative, currently well functioning, fully occupied office building.

The proposed project presents a follow-up to the forerunner project "Use of Weather and Occupancy Forecasts for Optimal Building Climate Control (OptiControl)" that dealt with the development of tools, methods and novel algorithms for improved building control, and in particular with predictive control involving weather forecasts. The new project's objectives are: (i) Modeling and preparation of the target building; (ii) Practical demonstration of the feasibility of the novel control algorithms; (iii) Performance assessment of the novel control algorithms in terms of total energy usage, energy costs, occupant comfort, reliability in operation, and peak power demand in practical operation; (iv) Analysis of acceptance by occupants, facility manager and building owner; (v) Benefit/cost analyses for building owners.

The overall approach taken is based on an iterative process that combines computer based modeling, model validation, and simulations with carefully designed measuring campaigns and feedback from users. User comfort will be evaluated based on measured and simulated room temperatures, illuminance levels and CO2 concentrations. User satisfaction and acceptance will be assessed by questionnaires, interviews, and the analysis of complaints before, during, and after the various field experiments. The benefit/cost analysis will be based on year-round simulations for energy and monetary cost, an analysis of the needed extra implementation and operation costs as compared to standard control solutions, and the results from the user satisfaction surveys.

The work will be divided into the following packages: coordination and communication; preparation of the target building; modeling, simulation and control; design, execution and analysis of the field experiments; synthesis and reporting.

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At beginning of the project a professional communication concept will be elaborated. This will ensure that the project gets appropriate visibility while the interests of all stakeholders are respected. The communication concept includes informing the building occupants about the experiments. The project's results will be disseminated by publication in scientific journals and the press, talks and presentations, a project web site, and an on-site event targeted at professionals from the building, energy and educational sectors.

Project risks relate to possible problems with the preparation of the building, the performance of the predictive control algorithms, and user acceptance. The latter will depend to an unknown degree on the acceptance of the optimized blind control that is an important element of the new control algorithms. Extensive preparatory work from the forerunner project and the availability of a proven, experienced project team contribute to minimizing the likelihood of these risks eventuating. The project brings together specialists on modeling, simulation and control engineering (ETH Zurich) with building modelers and planners (Gruner), as well as research and development engineers and marketing specialists from the global market leader in the field of building automation and control (Siemens).