SMART BUILDINGS / SMART CITIES

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NEST SolAce Pilot unit

Smart control of building services (heating, cooling, ventilation, blinds, electric lighting) can simultaneously optimize energy use and indoor comfort (thermal, visual, air quality) through the use of advanced computer methodologies such as artificial neural networks, genetic algorithms, fuzzy logic, or advanced optimization algorithms. Our laboratory investigates control algorithms allowing at the same time:

- an optimal response to changing conditions (weather, building occupancy, lighting levels, thermal characteristics)
- a progressive adaptation to (possibly changing) building characteristics and to user preferences.

Research projects normally include two steps:

- development of innovative control algorithms and evaluation with computer simulation tools
- testing under real situations and evaluation of energy and comfort performances as well as acceptance by users.

Most smart controllers are evaluated in the LESO building, which represents a powerful tool for this group.

Published work relates to

- Self-adaptive integrated building control systems
- Blind and electric lighting control algorithms
- Advanced control of electrochromic glazing
- Genetic algorithms for adaptation to user preferences
- Fuzzy logic for implementing building physics expert knowledge into the control algorithms
- Artificial neural networks for adaptive models and control systems.

2018 Activities

HDR vision sensors developed in the framework of Ali Motamed's PhD thesis and further developed in collaboration with CSEM were integrated in a sun shading and electric lighting control platform in the NEST SolAce pilot unit at EMPA in Dübendorf. to measure photometric variables in a workspace: (i) the daylight glare probability experienced by the user and (ii) the workplane horizontal illuminance. Tests for multiple users were set up and contacts were established with industrial partners and research institutions for their further implementation and development.

Furthermore, work progressed on a system set to integrate the non-image-forming effect of light in venetian blind and electric lighting control.

Current Projects in Smart Buildings

SCCER FEEB&D Phase II, Task 1.2.1 - High Dynamic Range (HDR) Vision Sensing Technology
Funding: Commission for Technology and Innovation (CTI)
Duration: Phase II 2017-2018

The integration of advanced daylighting systems with high efficacy light sources (LEDs), energy efficient luminaries (based on non-imaging optics) and advanced controllers for HVAC and lighting systems should allow reaching energy self-sufficiency for lighting systems. In Phase I of this project, a high dynamic range (HDR) vision sensor was configured for use in a sun shading and electric lighting control platform, and its suitability for luminance measurements in a working environment as well as for glare risks assessment based on the Daylight Glare Probability was validated. In Phase II, sensing devices will be further refined and adapted to the needs of the lighting and shading industry. The controllers will undergo field testing in diverse testbeds.

NEST SolAce | REcomfort - Perception based Human Comfort and Multi-Functional Solar Facade
Funding: ETH Board
Duration: 2017-2020

Even in old-established branches like the heating, ventilating and air conditioning industry there are blank areas: one of these spots is the capture of solar energy and daylight by the building envelope. These topics are investigated by EPFL Researchers and their industrial partners in the SolAce | REcomfort unit: multifunctional facade technologies are implemented to achieve an Energy-Plus and Low Carbon combined working/living space.

Recent PhD theses in this domain

- Integrated Daylighting and Artificial Lighting Control based on High Dynamic Range Vision Sensors, *Ali Motamed, EPFL PhD Thesis #8277, 2017*
- Novel models towards predictive control of advanced building systems and occupant comfort in buildings, *Nikos Zarkadis, EPFL PhD Thesis #6440, 2015*
- Probabilistic Bottom-Up Modelling of Occupancy and Activities to Predict Electricity Demand in Residential Buildings, *Urs Wilke, EPFL PhD Thesis #5673, 2013*
- On the adaptation of building controls to the envelope and the occupants, *David Daum, EPFL PhD Thesis #4935, 2010*
- Towards a unified model of occupants' behaviour and comfort for building energy simulation, Frédéric Haldi, *EPFL PhD Thesis #4935, 2010*
- Bayesian optimisation of visual comfort, *David Lindeloef, EPFL PhD Thesis #3918, 2007*
- Simulating occupant presence and behaviour in buildings, *Jessen Page, EPFL PhD Thesis #3900, 2007*

Patents

- WO2017216623 (A2) Motamed A., Deschamps L., Scartezzini J.-l., Lighting control system, 2017

2018 Publications

- Motamed A., Deschamps L., Scartezzini J.-L., Novel miniaturized indoor glare sensor for human centric control of shading and lighting system, Licht 2018, 9-12 September 2018, Davos