INTEGRATED DAYLIGHTING AND ELECTRIC LIGHTING

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The embedded photometric device assessing work-plane illuminance based on sky monitoring.

The Integrated Daylighting and Electric Lighting research group works on advanced systems for optimal use of daylight in buildings with the aim to improve user comfort and health and reduce energy consumption. The group has set up a sophisticated daylighting laboratory with, among other, a scanning sky simulator and an automated heliodon, which allow reproducing with very high precision all daylight conditions that exist around the world. Several anidolic (non-imaging) daylight systems have been developed by the group. Furthermore, a bidirectional reflection and transmission goniophotometer based on digital imaging allows assessing the characteristics of complex fenestration systems. A photobiological laboratory completes the equipment and advanced monitoring devices are under development.

Published work relates to

- Circadian rhythms and impact of light in humans, visual comfort
- Daylighting computer design and analysis tools
- Integrated day- and electric lighting systems
- Bidirectional reflection and transmission goniophotometer
- Anidolic daylighting systems
- Experimental and ergonomic daylighting test modules
- High-resolution mapping of the sky and ground vault

2017 Activities

2017 was mostly dedicated to R&D in the framework of Module “Building Human Interaction” of the Swiss Competence Center for Energy Research “Future Energy Efficient Buildings and Districts”. In an effort to improve the accuracy of real-time on-board lighting simulation, an embedded device for high resolution mapping of the sky and ground vault has been developed and fine-tuned within a test module.

A new paper was furthermore published in Alzheimer Research based on studies on the effect of light on humans, performed at our lab by Mirjam Muench et al.

Research results in the field of day and electric lighting are fully integrated in smart building control systems (see separate topic).

Current Projects

SCCER FEEB&D Phase II, Task 1.2.2 Automated "Eyesight" Venetian Blinds
Funding: Commission for Technology and Innovation (CTI)
Duration: 2017- 2020

External Venetian Blinds (EVB) are prevalently used to manage daylight and solar radiation in dwellings and office buildings. Automation of the blinds can enhance occupants' visual comfort and achieve energy savings regarding electric lighting as well as cooling/heating load. In this task, an integrated 'open-loop' automated EVB system is developed by implementing a digital camera in the outer part of a window frame, pointing toward the sky vault. Issues of traditional 'close-loop' systems such as installing separate indoor sensors in the working space will be avoided by that way. Based on image processing and lighting computations, glare risks and luminance distribution (horizontally and vertically) in the room are evaluated in order to satisfy occupants' visual comfort. Both algorithms will be implemented in an ultra-fast microprocessor for real-time calculation in the system embedded in the window frame.

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*
- Lighting Environment in Buildings - Nonvisual Light Perception and Inter-Individual Differences, *Lenka Maierova, PhD Thesis* Czech Technical University in Prague, Faculty of Civil Engineering 2015, based on studies performed in the framework of a SCIEX Scholarship at our Lab from 2011-2013
- On advanced daylighting simulations and integrated performance assessment of complex fenestration systems for sunny climates, *Chantal Basurto, EPFL PhD Thesis #6425, 2014*
- The impact of light including non-image forming effects on visual comfort, *Apiparn Borisuit, EPFL PhD thesis #6007, 2013*
- Energetic, visual and non-visual aspects of office lighting, *Friedrich Linhart, EPFL PhD Thesis #4587, 2010*

Selected 2017 publications

- Scartezzini J.L. (editor & author) et al. SCIENCE/AAS Supplement "Changing Perspectives on Daylight: Science, Technology, and Culture", Daylight Academy, 2017
- Basurto C., Kämpf J. H., Scartezzini J.-L., Multi-criteria analysis for the integrated performance assessment of complex fenestration systems, in Building Research and Information, vol. 45, num. 8, p.926-942, 2017
- Wu Y., Kaempf J. H., Scartezzini J.-L., Characterization of a quasi-real-time lighting computing system based on HDR imaging, CISBAT 2017 International Conference, Lausanne, Switzerland, 6-8 September 2017, in Energy Procedia - CISBAT 2017 International Conference Future Buildings & Districts - Energy Efficiency from Nano to Urban Scale, p.649-654
- Muench M., Schmieder M., Bieler K., Goldbach R., Fuhrmann T., Zumstein N., Vonmoos P., Scartezzini J.-L., Wirz-Justice A., Cajochen C., Bright Light Delights: Effects of Daily Light Exposure on Emotions, Rest-activity Cycles, Sleep and Melatonin Secretion in Severely Demented Patients, in Current Alzheimer Research, vol. 14, num. 10, p.1063-1075, 2017

Patents

- Sky monitoring system, Deutsches Patent-und Markenamt, P17020-DE, Wu Yujie, Kämpf Jérôme Henri, Scartezzini, Jean-Louis