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Control of visual conditions for open-plan offices

Maximilien Leclercq [a,1], Etienne Arnal [b,2], Cédric Anthierens [c,*], Eric Bideaux [d,3]

[a] ISEN Toulon, Maison des Technologies, place Georges Pompidou, Toulon, France
[b] Sherpa Engineering, La Valette du Var, France
[c] Institut des Sciences du Mouvement UMR6233, Luminy, Marseille, France
[d] Laboratoire AMPERE, Institut National des Sciences Appliquées, Lyon, France

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ABSTRACT

This paper reports insights about energy savings in buildings dedicated to tertiary activity. The goal is to employ as much as possible natural light flows to minimize the artificial light source consumption. Although the solar energy is power-efficient to light and heat a room, this natural source remains complex to manage and can generate inconveniences related to occupants visual comfort. The authors propose a global solution to deal with visual comfort by controlling the daylight contribution to the indoor light atmosphere. This control structure is based on the use of an innovative sensor of light conditions and it was implemented within an experimental room equipped with classic Venetian blinds. This paper focuses on the control laws to apply in order to meet visual needs for current tasks performed in offices.

1. Introduction

The economical and ecological circumstances push the development of new solutions on in order to reduce the energy consumption in many domains including buildings [1]. The loss of energy in tertiary buildings is large and the present architectures of these buildings do not offer any sustainable and global solutions. Indeed the reduction of energy consumption usually involves heavy investments (update the heat systems and buildings coats...). Although these solutions are quite efficient, they do not match with French (and Worldwide) objectives, which state that the energy consumption must be divided by 4 by 2050. Moreover the renovation of tertiary buildings is a slow process and the few innovative devices to save energy in buildings are often designed to fit the new buildings rather than the old ones. So ecological issues are often in contradiction with economical issues, nevertheless new technologies in home automation tend to deal concomitantly with both for old and new buildings. Those new devices offer quite basic features but that highlights the great interest of exploiting the natural light flows to heat and light rooms almost for free. Note that new buildings are now designed to favor flow exchanges with external environment.

The management of natural flows involves preventing occupants from potential light inconveniences [2]. Indeed outdoor light, although the energy gains it supplies, can cause visual discomfort for occupants' everyday life. This is due to the perpetual variations of natural light conditions all day long but also during seasons. Based on this finding, the authors have focused their work first on the evaluation and the control of visual comfort of the occupants by relying on solar light [3] before considering potential energy savings. Once visual comfort specifications defined, the energy criteria can be controlled while maintaining a good comfort level. This way, the use and the management of the natural flows will help reduce energy consumption of the room without generating discomfort for occupants. CIE (International Commission on Illumination) states that natural light would provide occupants with 50% to 70% of light needs during work time in temperate areas [4].

This paper presents the different steps followed by the authors to tackle this global problematic. The second section is an overview about the different approaches to tackle the comfort of occupants within a room. Next the authors summarize previous works done to evaluate visual conditions within an open-plan office and the whole approach chosen to control those visual conditions. The fourth section describes several models to represent the behaviors of visual sensor, room, blinds and lights. The fifth part relates the control blinds and thus of the room with a light point of view. Finally the last section presents the control algorithm implemented and experimental results obtained in the case of two different

* Corresponding author. Tel.: +33 4 94 03 88 28.
E-mail addresses: maximilien.leclercq@isen.fr (M. Leclercq), e.arnal@sherpa-eng.com (E. Arnal), cedric.anthierens@supmeca.fr (C. Anthierens), eric.bideaux@insa-lyon.fr (E. Bideaux).
[1] Tel.: +33 4 94 03 89 50.
[2] Tel.: +33 4 94 08 09 88.
[3] Tel.: +33 4 72 43 89 78.

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