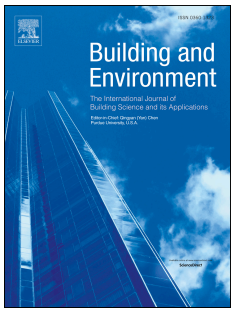
Accepted Manuscript



A review of open loop control strategies for shades, blinds and integrated lighting by use of real-time daylight prediction methods

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PII: S0360-1323(18)30147-1

DOI: 10.1016/j.buildenv.2018.03.018

Reference: BAE 5352

To appear in: *Building and Environment*

Received Date: 14 December 2017

Revised Date: 12 March 2018

Accepted Date: 14 March 2018

Please cite this article as: Jain S, Garg V, A review of open loop control strategies for shades, blinds and integrated lighting by use of real-time daylight prediction methods, *Building and Environment* (2018), doi: 10.1016/j.buildenv.2018.03.018.

A review of open loop control strategies for shades, blinds and integrated lighting by use of real-time daylight prediction methods

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Abstract

Automated shading and integrated lighting control systems are being used in buildings for electrical energy savings and improve occupant's comfort. These systems facilitate effective utilization of useful daylight in interior spaces that benefit an occupant's health, well-being, and productivity by preventing glare and overheating while maintaining the adequate illuminance levels. The pragmatic procedure to implement open loop shading and integrated lighting control comprises three parts: (i) a reliable estimation of sky conditions on real-time basis, (ii) determining indoor daylight metrics using outdoor conditions, and (iii) incorporating the metrics in the blind and integrated lighting control techniques. This paper presents a review of experimental studies done on open-loop window shade and integrated lighting control strategies. The aim of this paper is to analyse the performance and feasibility of various daylight prediction methods and their application in controlling blinds and integrated lighting system. The review mainly focuses on simulation assisted open loop control techniques that employ real-time daylight estimation methods. The review identifies the current challenges, recommends areas for improvement, and provides significant scope for future research. The paper concludes that modified and improved open loop system are more competent as an alternative compared to the conventional methods for automated blind and lighting control systems. Advanced open-loop control systems along with calibrated simulations have the capability to reduce post commissioning errors, allow easy monitoring of the system and predict daylight more extensively.

Keywords: day-lighting; open loop; blind control; lighting control; glare; real-time

1 Introduction

Daylighting in buildings is one of the indoor environmental factors that have a substantial impact on workers' health, productivity, performance, and circadian system [1,2]. However, excessive and uncontrolled daylight admission into a building can lead to visual discomfort, and higher cooling and heating demand due to which occupants prefer to close the window blinds and use artificial lighting instead of using natural daylight hours [3]. In case of manual blinds, they remain either fully open or closed; occupants rarely operate them, and when they do, it is usually to prevent visual discomfort while facing glare [4–6]. However, shades and lighting remain in the same state even when there is no discomfort. This scenario often leads to increase in building energy demand and the inability to access outdoor views. Integration of automated window blinds with artificial lighting controls can help modulate daylight, overcome glare and heating problems [7,8]. This mechanism can be significantly beneficial to occupant's comfort, health, and productivity; and reduces the cost of energy demands for cooling, heating and artificial lighting [9,10]. It has been reported in previous