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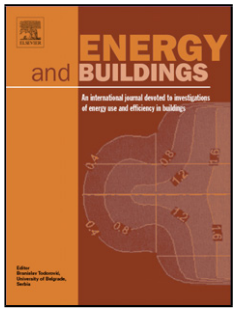

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An Experimental Survey of Feedback Control Methodologies for Advanced Lighting Systems

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Abstract

Lighting constitutes a significant portion of building energy consumption. Various lighting control strategies exist that reduce the energy consumption by decreasing dimming level of the fixtures and also ensure the color quality of the achieved light. These strategies differ in their input parameters, control objectives, control algorithms, cost of installation, complexity of commissioning, availability of hardware, etc. Each of these control schemes has a unique set of factors that affect their performance in terms of energy savings as well as the achieved light quality. This paper presents an experimental survey of four state-of-the-art lighting control strategies, the formulation of their associated problems as well as their solution approaches, the experimental results obtained from their implementation in a standard testbed, and the factors affecting their performances.

Keywords: Smart Lighting; Feedback Control; Polychromatic LED Sources; Spectral Optimization; Hierarchical Optimization; Daylight Harvesting; Daylong Experiment; Experimental Survey.

Nomenclature

Acronyms

CCT	Correlated Color Temperature
CRI	Color Rendering Index
DIC	Decentralized Integral Control
IBA	Illumination Balancing Algorithm
LDR	Light Dependent Resistor
LED	Light Emitting Diode
LTM	Light Transport Matrix
PWM	Pulse Width Modulation
SCR	Smart Conference Room

Variables

Δuv	Degree of departure from the black body curve
G	Light Transport Matrix
$T(\mathbf{u})$	CCT of the generated light
T_d	Desired CCT
u	Input intensities of the LED sources
y	Measurement from color sensors
y_d	Desired sensor measurement

1. Introduction

With rapid advancement in the sensing, actuation, and networking technologies, the new generation of advanced lighting systems can accomplish far more than mere illumination. While illumination is a crucial functionality in a building, other factors such as safety, power efficiency, and human comfort are also critical to management of modern commercial buildings.

In 2015, about 404 billion kilowatthours (kWh) of electricity were used for artificial lighting by the residential sector and the commercial sector in the United

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