Automation in Construction 20 (2011) 145–154

Contents lists available at ScienceDirect

Automation in Construction

journal homepage: www.elsevier.com/locate/autcon

Visualisation of impact of time on the internal lighting of a building

Farzad Khosrowshahi [a,*], Amir Alani [b]

[a] School of the Built Environment, University of Salford, UK
[b] School of Engineering Department of Civil Engineering, University of Greenwich, UK

ARTICLE INFO

Article history:
Accepted 16 July 2010
Available online 30 October 2010

Keywords:
Visualisation
Visual User Interface
VRML
Lighting system
Time related

ABSTRACT

With the increasing realisation of the importance of information and elicitation of knowledge, the need for improved methods of extraction and abstraction of information and knowledge has gained equal attention. To this end, visualisation methods have been viewed an effective way of abstracting information. Over the past three decades, these methods have undergone a rapid revolutionary progress, supported by sophisticated visualisation tools, analytical and simulation methodologies and techniques.

During this period, the visualisation of an object, such as a building, 'in time' – viewing it from different perspectives – has gained significant attention and developments have been underpinned by sophisticated software technology. However, visualisation of a building 'through time' – viewing it as it degrades through aging – has received limited attention. Indeed, the ability to visualise the behaviour of a building, through time, has the potential to yield significant advantages: at the design phase, the informed choice of different building materials enables the architect to meet the client's technical, aesthetic and economical objectives. Extending the same capabilities to the maintenance phase can result in the development of just-in-time schedules which can prevent wastages without compromising the service to the users of the building. With advances in the BIM technology and the promised paradigm shift in the manner stakeholders collaborate and interact, the ability to simulate and visualise the time-based behaviour of building elements can assist decisions relating to both design and scheduling.

In this paper, the overall model of the visual building design and maintenance is proposed and its practicality is demonstrated through its application to the building lighting system. The overall process is modelled and generalised and the lighting system is introduced as an example where the research work can be applied: the time-related behaviour of different light sources under the impact of intrinsic and environmental factors is modelled and expressed in a mathematical form which facilitates visualisation through the use of Visual User Interface.

1. Introduction

The increased attention towards whole-life evaluation has given rise to the growth of the shift from new-build development culture to maintenance-centric culture. This has been evident in several countries in Europe, such as Netherlands [27] and Norway [19]. Expectedly, this shift is paralleled with the sway of resources from construction developments to building maintenance. It is common knowledge that building elements degrade over time and unless there are corrections they can deteriorate to the point of no return. Typically, these corrections are carried out through remedial actions such as revitalising or replacing elements, whereby, a new lease of life is rendered to the particular element. Therefore, buildings rely on intervention, as there are only a few items which correct themselves through self-regulation, (e.g. overflow pipe outlets) [22,25]. Even most intelligent buildings can go as far as diagnosing and reporting the problems rather than taking corrective steps.

Basically, a building deteriorates due to interaction with its environment (including the users). Therefore, the prediction of elements' behaviour is filled with uncertainties associated with the environment of the building as well as the characteristics of the building elements. These uncertainties have given rise to a number of forms of maintenance programming. The techniques are broadly grouped into planned and unplanned maintenance (BS 3811, 1984). While the latter is primarily of corrective nature, the former is sub-grouped into corrective maintenance and preventative maintenance which itself is further sub-divided into scheduled and condition-based maintenance.

The alternative classification consists of predictive maintenance; preventive maintenance; corrective maintenance and maintenance on demand. While the Predictive maintenance places the emphasis on the comfort of users, the Preventive maintenance provides a more economical solution through detecting deficiencies by conducting

* Corresponding author.
E-mail addresses: f.khosrowshahi@salford.ac.uk (F. Khosrowshahi), M.Alani@greenwich.ac.uk (A. Alani).

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doi:10.1016/j.autcon.2010.09.012