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An object-based 3D walk-through model for interior construction progress monitoring

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ABSTRACT

The complicated nature of interior construction works makes the detailed progress monitoring challenging. Current interior construction progress monitoring methods involve submission of periodic reports and are constrained by their reliance on manually intensive processes and limited support for recording visual information. Recent advances in image-based visualization techniques enable reporting construction progress using interactive and visual approaches. However, analyzing significant amounts of as-built construction photographs requires sophisticated techniques. To overcome limitations of existing approaches, this research focuses on visualization and computer vision techniques to monitor detailed interior construction progress using an object-based approach. As-planned 3D models from Building Information Modeling (BIM) and as-built photographs are visualized and compared in a walk-through model. Within such an environment, the as-built interior construction objects are decomposed to automatically generate the status of construction progress. This object-based approach introduces an advanced model that enables the user to have a realistic understanding of the interior construction progress.

1. Introduction

In order to ensure effective monitoring and control of construction projects, owners and project stakeholders often require detailed construction reports from general contractors and subcontractors [1]. Traditionally, general contractors collect paper-based daily progress reports from subcontractors. In recent years, web-based technologies have also been used to automate paper-based processes (Fig. 1). In order to quantify the progress of work completed from the reports, the actual work performed and as-built data are compared to the planned schedule through data tables or bar charts. Such reports can provide critical information in monitoring and control of construction progress and costs, or in decision making. However, compared with exterior construction, interior construction consists of a large amount of construction elements (*e.g.* electrical, HVAC, plumbing, fire protection, and security behind walls or above ceilings) and various schedules associated with performance by many subcontractors. Such complicated nature of interior construction makes detailed monitoring and control of interior construction progress challenging.

Existing approaches for reporting interior construction progress have visual limitations, especially in representing the complexities of interior construction components. They do not adequately support project managers and subcontractors in providing visual comparison and spatial contexts between as-planned model and as-built conditions [2]. In particular, the complicated nature of schedule discrepancy of interior works makes it difficult for project managers to identify and predict accurate subcontractors' progress and productivity [3] without any visual support. Thus, for effective monitoring of interior construction works, it is important to provide additional processes to better understand the link between the subcontractors' activities and schedule with spatial contexts from 2D drawing or 3D model.

The complicated nature of interior construction works requires that the interior construction activities associated with different building components should be split at an early stage of the project and continuously monitored with the proposed schedule. These product models of building components are often required to be updated for detailed interior construction progress monitoring. However, existing approaches used by subcontractors for monitoring interior progress involves ad-hoc methods and complicated processes for maintaining continuous data collection. Project managers analyze paper-based progress reports and convert numbers into a data format that could be readily utilized by a project management application. The analysis of huge amounts of collected as-built data and the subsequent manual evaluation for construction progress monitoring and control is time-consuming [4] and prone to error.

Due to the practical problems related with complicated nature, limited visual understanding and the manually intensive process of reporting interior construction progress, many schedule delays and cost overruns in monitoring interior construction are caused [3]. To minimize such potential conflicts in interior construction, a key

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