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Evaluation of image-based modeling and laser scanning accuracy for emerging automated performance monitoring techniques

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ABSTRACT

Accurate and rapid assessment of the as-built status on any construction site provides the opportunity to understand the current performance of a project easily and quickly. Rapid project assessment further identifies discrepancies between the as-built and as-planned progress, and facilitates decision making on the necessary remedial actions. Currently, manual visual observations and surveying are the most dominant data capturing techniques but they are time-consuming, error-prone, and infrequent, making quick and reliable decision-making difficult. Therefore, research on new approaches that allow automatic recognition of as-built performance and visualization of construction progress is essential. This paper presents and compares two methods for obtaining point cloud models for detection and visualization of as-built status for construction projects: (1) A new method of automated image-based reconstruction and modeling of the as-built project status using unordered daily construction photo collections through analysis of Structure from Motion (SfM); (2) 3D laser scanning and analysis of the as-built dense point cloud models. These approaches provide robust means for recognition of progress, productivity, and quality on a construction site. In this paper, an overview of the newly developed automated image-based reconstruction approach and exclusive features which distinct it from other image-based or conventional photogrammetric techniques is presented. Subsequently the terrestrial laser scanning approach carried out for reconstruction and comparison of as-built scenes is presented. Finally the accuracy and usability of both of these techniques for metric reconstruction, automated production of point cloud models, 3D CAD shape modeling, and as-built visualizations is evaluated and compared on eight different case studies. It is shown that for precise defect detection or alignment tasks, image-based point cloud models may not be as accurate and dense as laser scanners' point cloud models. Nonetheless image-based point cloud models provide an opportunity to extract as-built semantic information (i.e., progress, productivity, quality and safety) through the content of the images, are easy to use, and do not need add burden on the project management teams by requiring expertise for data collection or analysis. Finally image-based reconstruction automatically provides photo alignment with point cloud models and enables image-based renderings which can remarkably impact automated performance monitoring and as-built visualizations.

1. Introduction

Accurate and rapid assessment of progress, productivity, and quality control/quality assurance (QC/QA) is critical to successful project management. These assessments provide an opportunity to understand the current as-built status of a project efficiently, identify discrepancies between as-built and as-planned progress, and aid in deciding on remedial actions. Despite the importance of site assessment, within the Architectural, Engineering, Construction, and Facility Management (AEC/FM) industry, this process has not yet been completely automated, nor has accuracy measurement benchmark been firmly established. Current manual practice for collecting data on as-built status of a project is still time-consuming and labor intensive [1]. For example, on a 200,000 S.F. construction project with 11 bid-packages, on average 20–25 daily construction reports are filled out and collected on a daily basis. Processing of such data is a difficult task due to its labor-intensive nature

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