D4AR – A 4-DIMENSIONAL AUGMENTED REALITY - MODEL FOR AUTOMATION AND VISUALIZATION OF CONSTRUCTION PROGRESS MONITORING

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ABSTRACT: Early detection of schedule delay in field construction activities is vital to project management. It provides the opportunity to initiate remedial actions and increases the chance of controlling such overruns or minimizing their impacts. This entails project managers to design, implement, and maintain a systematic approach for progress monitoring to promptly identify, process and communicate discrepancies between actual and as-planned performances as early as possible. Despite importance, systematic implementation of progress monitoring is challenging: (1) Current progress monitoring is time-consuming as it needs extensive as-planned and as-built data collection; (2) The excessive amount of work required to be performed may cause human-errors and reduce the quality of manually collected data and since only an approximate visual inspection is usually performed, makes the collected data subjective; (3) Existing methods of progress monitoring are also non-systematic and may also create a time-lag between the time progress is reported and the time progress is actually accomplished; (4) Progress reports are visually complex, and do not reflect spatial aspects of construction; and (5) Current reporting methods increase the time required to describe and explain progress in coordination meetings and in turn could delay the decision making process. In summary, with current methods, it may be not be easy to understand the progress situation clearly and quickly.

To overcome such inefficiencies, this research focuses on exploring application of unsorted daily progress photograph logs - available on any construction site - as well as IFC-based 4D models for progress monitoring. Our approach is based on computing, from the images themselves, the photographer's locations and orientations, along with a sparse 3D geometric representation of the as-built scene using daily progress photographs and superimposition of the reconstructed scene over the as-planned 4D model. Within such an environment, progress photographs are registered in the virtual as-planned environment, allowing a large unstructured collection of daily construction images to be interactively explored. In addition, sparse reconstructed scenes superimposed over 4D models allow site images to be geo-registered with the as-planned components and consequently, a location-based image processing technique to be implemented and progress data to be extracted automatically. The result of progress comparison study between as-planned and as-built performances can subsequently be visualized in the D4AR - 4D Augmented Reality - environment using a traffic light metaphor.

In such an environment, project participants would be able to: 1) use the 4D as-planned model as a baseline for progress monitoring, compare it to daily construction photographs and study workspace logistics; 2) interactively and remotely explore registered construction photographs in a 3D environment; 3) analyze registered images and quantify as-built progress; 4) measure discrepancies between as-planned and as-built performances; and 5) visually represent progress discrepancies through

superimposition of 4D as-planned models over progress photographs, make control decisions and effectively communicate those with project participants. We present our preliminary results on two ongoing construction projects and discuss implementation, perceived benefits and future potential enhancement of this new technology in construction, in all fronts of automatic data collection, processing and communication.