Framework for shared visualization and real-time information flow to the construction site

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Abstract: The aim of this paper is to develop a framework for shared visualization between design office and construction office using augmented reality as a platform with a focus on the security of Building Information Model. The current paper is part of an ongoing study aimed at creating a real-time bi-directional information flow between the construction office and site and focuses on a shared visualisation context. A framework architecture for enabling shared visualisation with a stress on the security of Building Information Model is discussed. A prototype application based on the framework was deployed on an Android device in a controlled environment for testing. The application augmented Building Information objects dynamically to the real-world without any latency. Salient features of the prototype include dynamic loading of Building Information content during the runtime, data encapsulation based on user privileges, deployability on portable low-end computing devices etc. Using shared visualization would empower the construction engineers with real-time models updates with access to many near-optimal management solutions. This enables the engineers to narrow in on the best solution under given constraints

1. Introduction

The global construction industry accounted for approximately 11 % of the global GDP in 2011 and is predicted to increase to more than 13.2 % by 2020 (Roumeliotis, 2011). The major contribution to these sums comes from complex infrastructure projects with numerous interdependencies. Despite being large and complex, many of these projects are still managed with traditional construction management practices (creating a centralized baseline plan for decentralized construction execution and monitoring the same in a centralized manner). This results in cost overruns and schedule delays. Building on the advances in the computing and visualization domains, the construction industry is moving towards more agile project management practices to improve the performance and efficiency (Levitt, 2011; Whyte & Levitt, 2011). Our paper discusses a subsystem for such an agile project management practice by enabling shared visualization of the project model (designed and as-built) between different design teams and engineers at the construction site using virtual reality (VR) / augmented reality (AR) stressing on the security of the Building Information Model.

Applications of AR have helped in improving the performance of AEC domains in areas such as as-built and as-planned project status management, pre-empting work package schedule disputes, enhancing collaboration etc. (Behzadan, Dong, & Kamat, 2015; Kamat et al., 2011; Rankohi & Waugh, 2013). With advancements in mobile computing and the and availability of sensing and positioning systems in smaller devices, AR has shifted from bulky computers to smartphones and tablets (Bae, White, Golparvar-Fard, Pan, & Sun, 2015; Kodeboyina & Varghese, 2016).Construction researchers are using AR as a platform to visualize Building Information Data (Behzadan et al., 2015; Golparvar-Fard, Peña-Mora, & Savarese, 2009; Kopsida & Brilakis, 2016). Mobile based AR systems retrieve parts of Building Information Models stored in clouds for visualization rather than storing the model on the AR device. However, there are inherent risks in using central Building Information Modelling server pertaining to security of the model (Mahamadu, Mahdjoubi, & Booth, 2013). With infrastructure sector moving in the direction of digital transformation(Kemp et al., 2017) with