OpenBIM Framework for a Collaborative Historic Preservation System

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ABSTRACT

The authors have developed a novel system framework for a historic preservation system utilising open standards and open source tools. The framework enables the integration of open standard 3D models and GIS in a virtual environment (VE). It also allows the storage and harvesting of data via an open source web-based central repository. The framework is designed for bi-directional interoperability when utilised for monument tracking, preservation, conservation, re-excavation, etc. To date, no such system framework exists for the development and management of historic monuments using open standards e57 for terrestrial laser scanning (TLS) data, the industry foundation classes (IFC) for 3D semantic rich models, and CityGML for integrating IFC and GIS in a VE. The web-based VE is accessed from the BimServer and envisaged for monitoring monument erosion, movement, and damage to monuments by human activity or nature, collaboration between different industry actors to share knowledge, experience, and expertise globally, etc.

KEYWORDS

BIM, CityGML, HBI, Historic Preservation, IFC, Laser Scanning, Open Source, Scan-to-BIM

INTRODUCTION

Re-establishing the location of and the preservation of heritage monuments after natural disasters and or war is a very time consuming and painstaking task. For example, imagine if the Valley of the Kings in Egypt was suddenly covered by sand, i.e. moving and altering monuments, and that traditional methods like the use of 2D drawings and topographical surveys were the only tools available to relocate and re-excavate all artefacts, buildings, monuments, etc. During the re-excavation of these objects, some may be harmed and some may never be found at all. Heritage monuments and buildings around the world suffer from erosion and other types of decay or weathering that may erase these heritage sites from existence. The research in this paper offers new opportunities for more efficient and effective methods to address the deficits inherent where traditional practices fall short, thereby radically changing how technology can be utilised to preserve heritage monuments and buildings.

In this paper, the author focused on a single monument at the Abu Simbel Temple in Egypt. A virtual semantic rich 3D model was created from the real monument utilising 3D imaging, i.e. reality data capture, utilising open standards and tools to demonstrate the applicable theoretical constructs of a historic preservation system framework. Also discussed is embedding information into the model and the storage of the model in a web-based repository for multi-actor collaboration.

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Furthermore, the benefits and implementation of a GIS and IFC VE is explained. The author is also investigating possible model validation techniques to verify necessary data in the model and the continued monitoring of the real monuments utilising the virtual model.

BACKGROUND

The author has designed an OpenBIM historic preservation system framework that allows historic preservationists to benefit from advanced technologies currently utilised by Architecture, Engineering, Construction, and Facilities Management (AEC/FM) disciplines. Historic preservation of heritage monuments and buildings is deeply rooted in the AEC/FM and has become a huge area of interest. Therefore, it makes sense that both can benefit from the same technologies.

OpenBIM refers to an open way of 3D information modelling and exchanging project information/data utilising open standards and schemas, e.g. the Industry Foundation Classes (IFC) when implementing Building Information Modelling (BIM), in the AEC/FM. The system framework herein encourages remote multi-actor collaboration on a global scale. Collaboration among actors is at the heart of the BIM process and should be able to be conducted by multiple actors from anywhere in the world. The framework demonstrated in this paper utilises the open standard IFC for seamless bi-directional BIM data interoperability between a BimServer database and virtual environment, i.e. a web-based centralised repository and the Common Data Environment (CDE). Also, a novel method for converting Terrestrial Laser Scanning (TLS) data into a semantic rich IFC BIM for a preservation system is revealed.

TLS reality data capture is a common survey methodology widely used in the AEC/FM and it is becoming a surveying tool of choice for many historic preservationists in surveying topography, monuments, and buildings. Scan-to-BIM methods are utilised to convert captured reality data into semantic rich data models, which is a key component to initiate the system framework in practice. Scan-to-BIM is a common term in use for the converting of reality data capture point clouds, i.e. in this case terrestrial laser scan data versus unmanned aerial vehicles (UVA) or ground-penetrating radar (GPR), into 3D semantic rich IFC BIMs. The next step in the framework employs an open source web-based BimServer for collaboration among actors using the IFC models. The BimServer is the central repository for all data exchange/sharing and offers an infrastructure on which a CDE can live.

The framework shown later in section four promotes the utilisation of CityGML for the CDE due to the fact that CityGML allows the integration of GIS and IFC BIMs (de Laat & Berlo, 2011). The BimServer and CityGML were chosen for the system framework because they are open source which means they are free to the public and can be freely modified for specific practical applications. Utilising CityGML that enables IFC and GIS integration facilitates bi-directional interoperability which can be utilised for many different virtual-to-real and real-to-virtual scenarios. Bi-directional interoperability allows the communicating of like or different schemas, languages or files through utilisation of common semantic data during information mapping, e.g. the IFC BIM can locally communicate, via the BimServer, with the CDE during model information validation and quality assurance methods, i.e. monitoring the real monument. It’s also important to mention now the requirement of utilising one BIM for multiple purposes omits replication and ensures possible real-time bi-directional processes. The single BIM is the model visualised in the CDE, whilst also it is the model stored on the BimServer. In theory, and system framework application, there is only one unique IFC BIM, i.e. virtual model, to represent each real object to reduce confusions commonly created by geometry and data replication in systems. Therefore, computational efficiency is optimized by reducing wasteful use of resources. These types of operational constraints encourage a leaner approach when implementing the system framework.
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