Chapter 39
A Reality Integrated BIM for Architectural Heritage Conservation

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ABSTRACT

Building Information Modeling (BIM) has attracted wide interest in the field of documentation and conservation of Architectural Heritage (AH). Existing approaches focus on converting laser scanned point clouds to BIM objects, but laser scanning is usually limited to planar elements which are not the typical state of AH where free-form and double-curvature surfaces are common. We propose a method that combines low-cost automatic photogrammetric data acquisition techniques with parametric BIM objects founded on Architectural Treatises and a syntax allowing the transition from the archetype to the type. Point clouds with metric accuracy comparable to that from laser scanning allows accurate as-built model semantically integrated with the ideal model from parametric library. The deviation between as-built model and ideal model is evaluated to determine if feature extraction from point clouds is essential to improve the accuracy of as-built BIM.

INTRODUCTION

In the Architectural Heritage (AH) the traditional analysis, conservation, preservation, management, rehabilitation, exploitation and communication process is complex, driven from multidimensional data and approaches, fragmented, high-cost and still limited to major Monuments.

These activities are based on a continuous collaboration between architects, historians, engineers, researchers, managers and specialists, who work together on a complex process that includes the entire

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lifecycle: knowledge, use, communication and management. This implies the need for a platform to promote a real collaborative work between all parties involved, and an increasing degree of automation.

This situation leads to having only one database and one Information System for all of the different phases of the lifecycle. Overall, the model deals with global knowledge about AH, which could be shared and made available at any time, in any place, to any user: researchers, professional operators, students, and city-users.

Unfortunately these requirements and this methodological model are far from reality: we see a total lack of accessibility to the entire corpus of information that should be shared by the specialists and the breakdown of the process into discontinuous isolated parts.

The main reason of this deficit lies not only in the large amount of heterogeneous data (3D models, images, photos, drawings, written documents, etc.) required by the process, which prevents the immediate usability and an easy transfer of information, but also in the complexity and partiality of the systems developed to provide an answer to these problems.

A first key step to overcome these lacks and deficiencies is to recognize, as a central moment of the entire building lifecycle, the conservation and maintenance stages, whose design plans are substantially the active parts of the process, in which shape, appearance, functionality and efficiency of the building are determined, being therefore the most important features of interventions.

A further improvement towards a better AH process management is to exploit the Building Information Modeling (BIM) intrinsic capabilities well bounded by William J. Mitchell "BIM databases ... is opening up new ways to think about designing and producing buildings and - as we are beginning to see - new formal and functional possibilities." (Mitchell, 2009).

The use of BIM software in the AH lifecycle field, as reported by recent researches (Apollonio, Gaiani & Sun, 2012; Dore & Murphy, 2014; Oreni et al., 2014; Barazzetti et al., 2015), has many advantages such as semantic object-oriented modeling which allows for the classification of heritage objects, automatic lists of objects and material and automated conservation documents. However BIM techniques present in the AH field some limitations which prevented an effective use until today. It is easy to notice that one of the current limitations of BIM in the AH field is the lack of parametric library objects within BIM software that could be used for historical buildings or heritage sites. In addition, BIM as a tool of new design generally are not capable of modeling non-ideal state such as deviation, damage and deterioration, which are of prime concern when documenting AH and, more in general, the integration of low-level captured geometry with 3D parametric BIM objects is so hard. Also the activation of direct manufacturing processes for all objects BIM in the AH field is practically impossible.

We think, however, that a more accurate analysis of failing factors is needed today in order to go further in the use of BIM in the AH and to embed the BIM in the AH lifecycle process. We propose an in-depth approach based on the following issues:

- BIM methodology and AH
- Problems related to the 3D capture techniques focusing on image-based modeling
- Knowledge-based modeling in BIM platforms
- Structuring acquired information for BIM processes.