Preface

ADVANCED DIGITAL TOOLS AND ARCHITECTURAL HERITAGE

The ICT growth, the decreasing cost and the ease of utilize of digital tools have made available the most advanced technologies to a large number of users, thus favoring their practice and experimentation. In particular, digital technologies for architectural heritage surveying, modeling and representation have produced important methodological changes in those disciplines that concerns the study, analysis, protection and exploitation of historical buildings. Laser scanning, photogrammetry, and software of modeling and data analysis have focused the process of historical and critical knowledge on the use of complex 3D models.

Thanks to their characteristics of geo-referencing, interactivity and extended media and semiotic experiencing, 3D models favor new epistemological approaches to architectural disciplines. At the same time, digital visualization is a vector for heritage’s communication and exploitation.

The actuality of architecture moves to an immanent figurativity. From here comes the challenge for a scientific use of 3D digital surveying and modeling tools: they may be privileged instruments for the analysis, critical interpretation, and communication of the architectural perceivable data. They require a rigorous methodological approach in the transition from data to information, knowledge, and wisdom – the last one in this case intended as protection, enhancement, exploitation, and restoration –. 3D architectural heritage models favor the development of historical-critical analysis, realized in the three-dimensional digital space, such as metrological, proportional, constructive ones. In the 3D re-constructions of the architectural shape, from the raw data of point clouds, a special consideration should be given to the comprehension, interpretation, and definition of the design willingness of the author, with particular attention to the formal and geometrical principles, intended according to the historical and technological context of the building.

Another consideration concerns the role that the digital models are taking over time: No more only an “aesthetic” simulation of reality – i.e. a representative image of a visual perception – but they are becoming “complex model”: They are interactive models, manipulable, interrogable, and navigable. They allow new ways of visualization and new modalities to data and information access.

It is necessary a systematization of the results obtained in the architectural heritage field, because the digital technologies have changed and are still changing the ways to use of surveying, visualization, data archiving, analysis, and communication.

The main topics of the book are:
• Digital architectural heritage;
• Historic building laser scanner surveying;
• Digital photogrammetry and photo-modeling for architectural heritage;
• Architectural 3D modeling;
• Visualization of historical architecture;
• Virtual reconstruction of never built or transformed built heritage;
• Digital representation for historical critical analysis of historical buildings and cities;
• Information Systems for architectural heritage;
• Building Information Modeling for historical buildings;
• Communication, conservation and exploitation of architectural heritage.

Where Topics Fit in the Word Today

The study of cultural heritage has found place in many international conferences, and is the subject of several associations. The topics of his publication, considered in isolation, recur in numerous conferences and publications in the international arena. Therefore, according to digital heritage characteristics of inter-disciplinarity and/or trans-disciplinarity, the digital heritage has become the subject of dissimilar categories of researchers, for unlike purposes, with diverse levels of engagement. At the same time, they cohabit all together and work together on the same object.

However historic buildings presents different characteristics compared to other cultural heritage, because they are complex organisms, synthesis of spaces, surfaces, volumes, materials, functions, uses, constructive systems; besides they are the result of transformation and modification processes in their lifetime, witnesses of the events and cultures that have occurred during centuries.

Focus of the proposed publication is how digital technologies can favor architectural heritage knowledge, analysis, protection and exploitation.

So what is the situation described in this book?

After scholars of architecture have enriched swimming in the liquid “lump” of disciplines, digital heritage, and digital tools, they came back together and reflect on the situation. In this sense, the object of research – i.e. the architectural artifact – influences the research, its aims, and the way of technology application.

From the above derives the reasons of this book: It arises from the awareness of the results obtained in the field of architectural heritage surveying and representation. In particular, surveying, modeling, and visualization are intended in their broadest sense of methods and tools for understanding and knowledge, for design and restoration, for protection and enhancement. And they favor the expressive act for visual communication.

Target Audience

Computer sciences and digital technologies, associated with a higher diffusion of ICT, have produced important changes in the architectural representation and survey field: in particular digital 3D models have acquired an inescapable role in operational practice and as research instruments.

The affordances of digital heritage and of digital tools allow their use in different disciplines.
In this way, we have had a wide overlapping between the researches made by different kind of scholars, such as computer scientists, topographers, surveyors, archaeologists, architects, engineers. Necessarily the issues involve different disciplinary fields (such as information technology, computer graphics, surveying, etc.), however, in this case, the idea is to offer the specific contribution of expert scholars of historical architecture, which over the years have been involved in these technological topics.

Therefore the book presents the specific point of view, in order to make an original contribution. But remembering what was said before, the disciplinary angle of the book aims to two targets:

- To speak to scholars of architecture to present the experiences and take stock of the state of the art situation;
- To address to those that deal with technology, but not experts in architecture, to show them the architectural approach in using advanced technologies. Not only scientists but of all those are involved in the study or management of historical buildings, in educational or business activities related to architectural heritage.

In this way, the potential use and intended audience are: professionals, academics and students working in the field of architectural heritage; scholars of surveying interested in architectural heritage; scholars of information technologies, computer graphics, digital modeling interested in architectural heritage; software houses; people interested in the management and enhancement of the architectural heritage.

**ORGANIZATION OF THE BOOK**

The book is organized into twenty-seven chapters, related to the book’s topics. Very often it’s difficult to assign a chapter to a single topic, because the complexity and articulation of subjects. A brief description of each chapter follows:

**Chapter 1 – “Color Acquisition, Management, Rendering and Assessment in 3D Reality-Based Models Construction”** presents smart procedures for color acquisition, management, rendering and assessment to produce high visual accuracy of architectural heritage 3D models from reality-based data.

**Chapter 2 – “The Surveying and Representation Process Applied to Architecture: Non Contact Methods for the Documentation of Cultural Heritage”** investigates the methodological changes occurred especially in the last decade concerning surveying and its representation, aiming at pointing out some conceptual issues involving measurement, interpretation and representation. The final objective is to propose an operative critical method to standardize and regulate the procedures of data collection, elaboration and representation of architectural artifacts.

**Chapter 3 – “On Visual Computing for Architectural Heritage”** addresses a critical discourse on the use of visual computing for historic architecture study. From the analysis of the experiences in similar scientific fields and of current researches in the architectural one, the paper highlights how visual computing has become an important approach in built heritage study and how it could favor new research lines.

**Chapter 4 – “Digital Photogrammetry and Structure from Motion for Architectural Heritage: Comparison and Integration Between Procedures”** focuses on multi-image monoscopic digital photogrammetry, illustrating several types of applications. At the same time it aims to underline and examine the central role of the operator.
Chapter 5 – “Comparative Study of Graphic Representation Methods on Architectural Heritage” offers an overview of architectural surveying systems and evaluates the differences between the latest state-of-the-art methods and the already well-established ones.

Chapter 6 – “Shape and Geometry in the Integrated Digital Survey” analyses the relationship between the phases of survey, acquisition and processing, and the definition of object’s shapes, according to the different characteristics of instruments and diverse modeling and surveying methods.

Chapter 7 – “Historic Building Information Modelling (HBIM)” presents the HBIM approach for modelling historic buildings which develops full Building Information Models (BIMs) from remotely sensed data. In particular it deals with the development of a library of parametric objects that can be used to model classical architectural elements: using concepts from procedural modelling, a new set of rules and algorithms have been developed to automatically combine HBIM library objects and generate different building arrangements by altering parameters.

Chapter 8 – “BIM and Interoperability for Architectural Heritage through ICT: The SEEMPubS Project” identifies a methodology based on Building Information Modelling (BIM) and interoperability to convert an existing building into a smart building. In particular it roots on an interdisciplinary approach where BIM and ICT aim to produce significant economic impacts in AEC industry.

Chapter 9 – “Semantic Representation of Accurate Surveys for the Cultural Heritage: BIM Applied on the Existing Domain” investigates a methodology able to express semantics and parametric interconnections among architectural heritage elements. In particular, using some software specifically written in order to manipulate geometries, information can be organized into proper hierarchical BIM frameworks, from the inferences of geometric and topological information.

Chapter 10 – “The SIArch-Univaq: An Architectural Information System for Cultural Heritage” presents the 3D architectural information system called SIArch-Univaq, based on the integration between 3D digital models and GIS. It is a knowledge-based instrument for the cataloging of architectural heritage, created to provide a powerful cognitive tool to all operators interested in studies and conservation of historical buildings.

Chapter 11 – “Integrated Multi-Scalar Approach for 3D Cultural Heritage Acquisitions” reviews the reliability of technologies based on the Structure from Motion approach for the 3D digitization of build heritage, and proposes a procedure to facilitate the work of surveyors called to restore digital representations at different scales.

Chapter 12 – “A Possible Method for 3D Photo-Scanning Speed Survey: The Case Study of the Bridge of Saint Angelo above Auso” presents a case study where an integrated surveying process based on digital photogrammetry is tested and validated.

Chapter 13 – “The Advantages of Using Laser Scanners in Surveying in Protected Sites: A Case Study in Historical Peninsula in Istanbul” focuses on an experience of laser scanning for urban surveying, where three-dimensional point clouds of silhouettes of streets and roads are transposed into surveying images.

Chapter 14 – “Digital Tools for Urban and Architectural Heritage” aims to present experiences that combine an analysis on territorial, urban and architectural scale with computerized techniques of representation, through a multi-scalar use of information systems for the analysis of Cultural Heritage, especially Urban and Architectural one.
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Chapter 15 – “Cities Over Space and Time: Historical GIS for Urban History” analyses the ability to manage both spatial and non-spatial data through relational GIS databases. By adding chronological data to engage with the issue of change over time, historical GIS lets scholars trace and visualize the development of a city as a process inflected by social and economic transformation, showing dynamics of spatial objects that cannot be represented with other tools.

Chapter 16 – “Communication Technology & Digital Culture: The Conservation and Enhancement of the Architectural Heritage” presents an experience for the development of new integrated communication systems, technology and digital culture, applied to cultural and architectural heritage. Tangible, intangible and digital heritage are integrated to design a Museum of collective memory.

Chapter 17 – “Digital Reconstruction of Demolished Architectural Masterpieces, 3D Modeling and Animation: The Case Study of Turin Horse-Racing by Mollino” reviews methods and techniques of digital reconstruction of disappeared architectural masterpieces. Through the overview of theoretical positions are explored heuristic values and communicative potentials of three-dimensional reconstruction, and prerogatives of animation in the interaction with three-dimensional data.

Chapter 18 – “Female Architecture. Unbuilt Digital Archive” aims to analyze the thought and work of some women-architect – who, between 1926 and 1962, have designed and/or built buildings of fine architectural quality – through drawing and modeling, intended as a critical means of inquiry. At the same time the study proposes a visual inedited and exhaustive repertory of some unrealized projects.

Chapter 19 – “The Image of Historic Urban Landscapes: Representation Codes” presents a strategic process, based on local character assessment, through a place-visualizing toolkit, developed from documentation and color representation to design coding. That is a workflow for visualization of landscape’ values and multimedia surveying pipeline, implementing processes, methods, and tools for the narration of tangible values and intangible assets.

Chapter 20 – “A New Cloud Library for Integrated Surveys: The Ancient Via Flaminia and the Nextone Project” addresses an innovative way to improve the landscape visualization and enhancement, through cutting edge technologies of survey, integrated management of data and innovative communication systems. As results, the chapter shows a catalogue of buildings survey, their semantic/ontological organization in a Cloud library (2D/3D) and several outputs collected in exhibitions.

Chapter 21 – “A Virtual Journey Through 2D and 3D Elaborations Recorded with Range-Based and Image-Based Method: The Experience of Vitelleschi Palace in Tarquinia” presents a virtual journey into the vast repertory of images and representations realized as a result of the surveying operations, made by laser scanner technology, digital photogrammetric techniques and multi-image processing.

Chapter 22 – “Understanding and Conserving Fortified and Difficult to Access Architectures through Digital Survey: A Case History in Southern Sicily” proposes a multidisciplinary approach to study an ancient tower, through the integrated use of: the current technologies of surveying able to provide a metrically-accurate three-dimensional model; the reading of the technological, typological and material elements that constitutes the constructive system of the building (masonry, ribs, ring-like vault); the geometric analysis addressed at the virtual reconstruction of the original shape.

Chapter 23 – “3D Reconstruction for the Interpretation of Partly Lost or Never Accomplished Architectural Heritage” reflects on the use of virtual reconstruction and visualization of non- or no longer-existent buildings. The paper illustrates the current situation taking into account the state of the art, the different suggestions in solving such kind of problem, and through up to date examples suggests a possible unified method and some lines of research.

Chapter 25 – “Integrated Methodologies for the Study and Documentation of the Architectural and Archaeological Heritage: The Treasury of Petra in Jordan” studies the integration of laser scanning data with more traditional and direct analysis performed through watercolor drawings from life.

Chapter 26 – “The Landscape Cultural Construction: A Recognition of the Roman Tradition” presents an experience of using a GIS for the understanding of tradition, following the current concepts of ecological and cultural sustainability. In particular it allows to analyze the interdependent relation between urban settlements and environment.

Chapter 27 – “Digital and Mechatronic Technologies Applied to the Survey of Brownfields” proposes the use of mobile robot technology for the investigation of a paper mills, providing information on the damage of structures, degradation of plaster and in general on the state of the materials forming the different parts of the brownfield. A procedure is described to combine the traditional survey with a robot one.

CONCLUSION

Aim of the book is to bring the attention of the international community on the issues relating the application of most advanced digital technologies and tools to architectural heritage. The state of the art and the results achieved in the key areas are described. Even if from the methodological point of view the discipline of architecture is well defined, however applied research opens up numerous issues and potentialities.

To talk and collaborate with, and to learn from other fields, it is necessary that scholars of architecture are aware the research lines and achievements.

Moreover they should define their ontologies and a thesaurus for knowledge sharing: A real semantic treasure that is useful to internal reflection and external comparison. Hence, at the end of each chapter, there are keywords definitions.

We hope that this book will be read – and “criticized” – by scholars of architecture but also by academics of other research fields, such as archaeology, surveying, Humanities, computer graphics and by those that deal with cultural heritage. Because we wish it will be a reference for discussion and a starting point for new researches.

Stefano Brusaporci
University of L'Aquila, Italy