Foreword

A deep knowledge of the Cultural Heritage is needed before going into action to restore or rehabilitate. According to Docci and Maestri (1992), in the particular case of architecture, buildings present different characteristics when compared to other type of cultural heritage, as they are complex organisms, synthesis of spaces, surfaces, volumes, materials, functions, uses, and constructive systems.

Besides, historic buildings are the outcome of transformations and pathologic processes in their lifetime, being thus witnesses of the events and cultures that have occurred during centuries, but also victims of natural and artificial agents.

From 1900 on, terrestrial applications of aerial photogrammetry have been developed. Early in Spain, the scientific Jose María Torroja together with the Military Cartographers and Engineers improved the existing stereophotogrammetric techniques, which were born for industrial and military purposes or land surveying.

Lately, digital technologies for architectural heritage surveying, modeling and representation produced important methodological changes in those disciplines concerning the study, analysis, protection and exploitation of historical buildings.

Currently computer sciences and digital technologies, associated with a higher diffusion of ICT, have produced important changes in architectural representation and survey field.

On the one hand, technologies of laser scanning and photogrammetry, together with the advanced software of modeling and data analysis, have focused on the process of historical and critical knowledge on the use of complex 3D models. On the other hand, non-invasive techniques as thermography and X-ray sensors are helpful research tools that provide other kind of datasets related to hidden pathologies and elements.

And even if traditional survey methods and techniques have proved to be efficient but slow work, they must be complementary to the modern ones in any case.

Finally, in order to have a thorough knowledge of architectural heritage, a close direct experience of the building is needed. Written, graphic and cartographic documents found in archives and libraries will provide useful information, and help to fill in the gaps in the construction processes and dating (Chias & Abad, 2010).

All these different kind of datasets and databases, when georeferenced to 3D models, can implement a powerful architectural GIS. The new tool has acquired an inescapable role both in operational practice and as research instruments, but according to Prof. Centofanti, though the GIS applications developed since now on the architectural heritage preservation are not as effective as those for assessing risk evaluation, their utility is evident if “oriented to documentation, protection, preservation and enhancement of urban and architectural heritage” (Centofanti, 2006, p.8).
The book focuses on how digital technologies can favor architectural heritage knowledge, analysis, protection and exploitation, and provides an innovative updated perspective of the different methods and techniques in use. Necessarily the issue involves different disciplinary fields -such as information technology, computer graphics, surveying, etc- with the purpose of offering the specific contribution of expert scholars of historical architecture, which over the years have been involved in these technological topics at various scales –architectural and archaeological, urban and territorial.

The aim of the book is to bring the attention of the international community on the issues relating the application of digital technologies specifically to architectural heritage. As a starting point, it defines the state-of-the-art and the results achieved in key areas of the research. In fact, even if from a methodological point of view the discipline is well defined, applied research opens up numerous specific issues as surveying, analysis, modeling and representation processes, different from the ones related to other type of cultural heritage.

Architectural Heritage in particular has found place in many international conferences, and topics proposed for this publication recur in numerous conferences and publications in the international arena. They are the particular subject of several associations as CIPA¹, and the target of recent UHDE² publications. Furthermore the Proceedings of “International Conferences on 3D Imaging, Modeling, Processing, Visualization” published by “IEEEXPLORE Institute of Electrical and Electronic Engineers - Digital Library”, and the “Digital Libraries Initiative” of Digital Agenda for Europe of European Commission, must be mentioned.

More targeted at architectural heritage are the conferences promoted by Euromed³, and those promoted by ISPRS⁴, as well as the “International Congress on Digital Heritage” (2013).

For some years, the application of digital technologies became a full part of the topics studied by scholars of architecture; however, the outcomes are currently spread over numerous and varied interests, sometimes far from the academic circles. For instance, the companies which commercialize measuring instruments have a strong interest in problems related to architectural survey. At the same time, some software designers, which formerly produced their products to other scientific fields – mainly mechanical engineering, entertainment, land management, etc. – now show interest in their application to the study and representation of historical buildings.

Strengths and weaknesses of the various methods and techniques are deeply analyzed, particularly the differences in the degree of precision and accuracy between the latest state-of-the-art methods and the already well-established ones. And all the consequences are supported by the corresponding results of each case studies.

Therefore, the potential impact of the book can be of considerable importance, evoking the interest of all those are involved in the study or management of historical buildings, in educational or business activities related to architectural heritage.

According to the wide range of issues concerned by architectural heritage, the book covers both the recent theoretical fundamentals of each method, and the applied case studies.

It is particularly interesting and innovative the integration of various methods and techniques, in order to standardize the procedures of data collection, storage, management and representation of architecture. According to this target, the book describes the peculiarities and articulation of the different methods aiming at pointing out some conceptual issues involving measurement, representation, analysis, interpretation and diffusion.

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Terrestrial laser-scanner techniques are used since the 2000s to document the cultural heritage. Surfaces can be represented in a set of point clouds, which is spatially referred in a highly accurate way. Benli explores how this set of point cloud data can be transformed into three-dimensional modelling, and how mapping and rendering strategies can be applied to both architectural and urban surveying. Alligned with the researches on the scales of the cultural heritage, Cigola focuses on some experiences that combine an analysis on territorial, urban and architectural scale with computerised techniques of representation.

Multi-image monoscopic digital photogrammetry and the new different systems of automated digital photogrammetry, which have been recently implemented, are compared and analysed by Garfella, Mañez and Martínez, who evaluate the existing differences in accuracy from a practical perspective.

The combined use of laser scanning instruments together with the digital rebirth of photogrammetry (photomodelling), are reviewed and updated by Bianchini, Ippolito and Bartolomei, who investigate the methodological changes occurred along the last decade. Other combined techniques as digital photogrammetry and structure from motion -which presents similar problems as finding structure from stereo-vision- are analysed and compared by Ippoliti, Meschini and Securanza. Structure from motion refers to the process of estimating three-dimensional structures from two-dimensional image sequences which may be coupled with local motion signals.

Russo and Manferdini deal with the essential problem of integrating scales into a whole project. With this aim they test the reliability of different techniques and methods based on the structure from motion approach for the 3D digitisation, in order to produce digital representations at various scales.

GIS and ICT applied to the cultural heritage are also important topics. As GIS integrate databases with three-dimension models, they provide both geometric and topological information. But they can also manage and analyse a large amount of complex data, deriving from different surveying techniques, archival studies and other written, graphic and cartographic sources. Brusaporci’s contribution focuses on the suitability of non-linear spatial narrative of the 3D architectural models, which can be related to different kind of datasets. Thus, architectural modelling and database modelling correlate together, “and the whole system gives rise to a complex Informative Model”, which is both interactive and navigable. In addition, they can support a GIS-3D which becomes particularly useful for the building management and decision, but also for the cataloging of the architectural heritage by going down to the identification of all the constructive components, as Continenza and Trizio develop in the SIArch-Univaq system. Ferrighi takes advantage of the possibilities that GIS bring to draw series of thematic urban maps; among them historical series allow to understand urban evolution, and as a consequence, surveying and representation are linked with the discipline of urban history.

HBIM (Historic Building Information Modelling) are another step in the process of architectural knowledge and management. BIM is a process involving the generation and management of physical and functional characteristics of buildings. As GIS, they are a set of files which can be exchanged or networked to support decision-making. Garagnani investigates a BIM based methodology that is able to express semantic and parametric interconnections among elements, translating real shapes into smart digital architectural elements. Dore and Murphy explore the way HBIM is a new approach developed mainly from remotely sensed data, which speeds up the slow process of plotting library objects to survey data. Furthermore, HBIM can convert a historical construction into a smart building, as Osello’s team in Turin are developing an interdisciplinary approach that could have significant economic impacts. Discussion: libraries of parametric objects can be used to model classical architectural elements, but as far as they introduce automation in the modeling techniques, they do not fit always with the old structures, and must be adapted to their particular needs.
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Useful rendering visualization tools are essential in cultural heritage knowledge dissemination and assessment. 3D model construction from reality based data look for high visual accuracy. With this aim, researches led by Gaiani focuses on perceptual fidelity, which is mainly related to color beyond the simple visual aspect. On the other hand, virtual journeys are new efficient ways to highlight some particular features of a historical building, as the stratifications superposed for centuries; the experience proposed by La Mantia for Vitelleschi Palace in Tarquinia is particularly outstanding, as produced through 2D and 3D elaborations recorded with range-based and image-based method.

Other case studies are based on the solutions given when surveying difficult to access architectures or elements. Galizi, Lo Faro and Santagati describe their experience with the tower of Mongialino in Sicily, were they focused also in the critic reading of ancient materials and building techniques, together with the geometric analysis addressed at the virtual reconstruction of the original shapes.

Conceptual analysis and representations go far beyond the simple visual aspects of the architectural survey, as Barbato indicates in opposition to the consequences of the strong standardization of infographic technologies. A definition of a documentation which guarantees the quality and accuracy of the scientific survey operations is needed, as exposed in the case study of Sant’Angelo bridge in Fasanella.

Among the theoretical perspective, architectural shapes appear as principal goals for the surveyor. According to Paris, “any shape is based on stringent geometric rules that the current digital methods of data acquisition do not detect directly”, and raw data must be automatically or manually processed to generate either 3D models or 2D representations. The instrumental characteristics of each method affect directly the relations between the real shape and its representation.

Finally, the possibilities that ICTs bring to document and diffuse the cultural heritage are varied: virtual museums, digital archives, Cloud libraries, augmented reality, can be cited among others. Researchers as Fatta, Spallone; Maggio, Franchina and Vattano, and the team of researches of The University of Marche guided by Clini, cover an interesting range of applications as those related to the virtual reconstruction of destroyed, unfinished or imagined buildings. Casu and Pisu emphasize the importance of 3D reconstruction of partially lost or never accomplished built heritage, in order to interpret all possible configurations as described by fragmentary historic sources. In turn, Chiavoni explore both the expressive and analytic possibilities that bring the superimposition of watercolour drawings from life on the results of a laser scanner survey.

Historic urban landscapes and infrastructures are also digitally recovered through the proposals by Amoruso; by Sousa, Lopes and Ribeiro; and also by the teams of the University of Marche, the University of Cassino and Southern Lazio, and the University of Tehran.

Far from being a book just for experts and practitioners of architecture, another one of its added values is the didactical purpose. The style is clear and easy to understand, even to inexperienced readers or simply lovers of cultural heritage.

Pilar Chias Navarro
University of Alcalá, Spain
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Pilar Chías Navarro. Doctor in Architecture, Full Professor and Director of the School of Architecture in the University of Alcalá— is a specialist in the documentation and diffusion of the Cultural Heritage, and in the History of Cartography, the ancient civil works, and the construction of the territory and the landscape. She is chair person in numerous national and international congresses, and has published several awarded books and articles related to Cultural Heritage, among which the following stand out: ‘A GIS in Cultural Heritage based upon multiformat databases and hypermedial personalized queries’; ‘A GIS in Ancient Cartography: A New Methodology for the On-Line Accessibility to the Cartographic Digital Libraries’; ‘Local Maps in Civil Disputes: Documents in the Chancelleries of Valladolid (Spain) and Nueva España (Mexico), 15th-18th centuries’; ‘More than the Usual Searches: A GIS based Digital Library of the Spanish Ancient Cartography’; ‘Precedents of the 19th Century Cartography of the Coasts of Florida, Mississippi, Alabama, Louisiana and Texas: Spanish, English and French Maps and Charts, 1500-1800’; ‘Spatial Data Infrastructures and Spanish Cultural Heritage: the INSPIRE Framework applied to the Monastery of El Escorial’, and ‘The Peninsular War 1808-1814: Unpublished French and Spanish Cartography of the Guadarrama Pass and El Escorial’. She is member of Ibercarto, and of the Task Group “Patrimonio Cartográfico de las IDEEs” (Infraestructuras de Datos Espaciales de España) of the Consejo Superior Geográfico and the International Cartographic Association (ICC). She currently directs the Task Group “Open Source in use for the Cultural Heritage communication process” del CIPA – ICOMOS), and has supervised fourteen Ph.D. research works.

REFERENCES


ENDNOTES

1 The International Committee for Documentation of Cultural Heritage, http://cipa.icomos.org/