A.I.M. - Informative Archives for architectural renovation

Simone Garagnani
University of Bologna, Italy.
simone.garagnani@unibo.it

Roberto Mingucci
University of Bologna, Italy.
roberto.mingucci@unibo.it

Abstract: *The information technology applied to the architectural surveys makes the environment documentation possible through multimedia data, which can be processed using a "Multimedia Informative Archive" (A.I.M.), designed for Institutions interested in cultural heritage preservation. An A.I.M. system can manage analytical information embedded into digital databases, referencing a visual exploration path to several technical data, documenting the context in which a monument, or an historical building, is placed.*
The framework can be ported to mobile devices in order to allow a wide number of data gathering stations, connected to the same central archive, making easier browsing and storing architectural information.

Palabras clave: Digital 3D modeling, architectural information technology, virtual heritage documentation, multimedial building database, immersive data modeling.

The search for communication models, intended as translation processes between concepts and reality, leads to several possible digital languages belonging to different cognitive sciences (Schmitt, 2004).
Documenting reality in architecture is a matter of heterogeneous contexts, situations and choices often managed through simplifications framed into paradigms in which complexity can be traced back to discrete domains (Bertoline, 2003). In this way, the existing architecture can be studied and represented in detail gathering information in form of drawings, 3D models, images, text files and interviews which need to be organized in order to be helpful, independently from the device used to examine them.
The aim of this work is the introduction of a logical process destined to the acquisition and storage of such elements using a digital framework called "Multimedia Informative Archive" (A.I.M., from the Italian definition Archivio Informativo Multimediale), destined to Museums and Institutions interested in cultural heritage preservation.
A.I.M. can manage analytical information by means of digital databases, referencing data in geometric environments and arranging visual paths in order to document several characters of a monument or an historical building.
Knowledge's representation using relational systems has been studied by many authors in scientific literature so far (Codd, 1990; Date, 1995), however the original approach of an A.I.M. is the application of rules, proper of the architectural semantic, consisting in fields and records for searching, filling and updating information on building components and how they are connected to each other.
Investigated components are placed into a hierarchical framework routed to a central database to keep data not replicated and not ambiguous (Garfield, 1997), which can be compiled and finalized directly from the survey site, through optimized stations expressly developed to harvest digital contents.
Due to more and more sophisticated existing computer technology, huge amounts of data can be easily processed without computational slowdowns or limitations, storing them into digital formats intended for textual or audio-visual contents (Garagnani, 2010).
Analyzing specific archiving needs for existing building's elements, two different precision levels were prepared in order to collect significant data: a preliminary survey stage and a definitive one, both of them converging into a structured A.I.M.
The first stage is mainly dedicated to graphic surveys, produced by photographic shots in order to obtain pa-

noramic views to identify main characters for examined buildings; these images, easily taken in difficult circumstances too, are used as virtual digitalizations for scenes which are subsequently layered as table of contents for components hyperlinked to analytical files, hosting much more detailed information.
Since this seems to be the most interactive way to study and document quickly and effectively the context in which a building is placed, the decade-long work on photographic virtual panoramas was further on developed (Mingucci, 2003), taking advantage of the proven immersive technology QuickTime Virtual Reality (QTVR) by Apple (Mingucci and Muzzarelli, 2006), though abandoned in behalf of Adobe Flash and HTML5 web systems.
The central aspect which fostered the choice of these technologies was the achievement of results which can be integrated at a later time with increasing accuracy, through simple operations and using handy, affordable and versatile instruments.
An useful and well known feature is the generation of entire scenes beginning from individual stitched landscapes, which are called nodes, linked together in a virtual pathway, identifying for example different façades or internal rooms connected in a logical sequence. Navigation points (hotspots) can be placed within single nodes, allowing the panoptic views to be conceived as a sort of general index, useful for the identification and subsequent analysis of individual components.
Hotspots can be set as area links essentially characterized by three distinct numerical parameters: pan (parameter indicating the horizontal angle of view), tilt (angular parameter indicating the vertical direction of view) and field of view (parameter indicating the level of specific magnification view).
Even if in Flash or HTML5 these parameters have different syntax, they follow basically the same identifying concept: pan, tilt and field of view can be easily tracked in the geometric system which defines the scenario and thus associated to meta information through specific database records.
FileMaker was used to produce this kind of support, in which specific fields derived from cultural heritage codes were isolated and connected to panoramas; even if MySQL was tested too, FileMaker can be quickly ported to mobile devices, allowing an A.I.M. to be much more usable.
The dense relationships network built between photographic images and multimedia database, if existing, provides the ability to control, plan and manage all relevant documentation activities in an integrated manner. In addition, the A.I.M. framework's flexibility allows to fill in the database fields in a structured way: the archive is subject to change so different operators can interact with it through a unique set of login credentials for every user.
The A.I.M. information system produced this way, in which scenes are related through parametrical nodes, can quickly reproduce architectural spaces directly on survey, allowing control on documentation acquired. Tasks as photo capture, stitching, blending and scene rendering are possible using modern hardware technology: the survey station used testing the A.I.M. process for example was made by digital reflex cameras (DSLR) with appropriate fisheye lenses, connected to an Apple MacBook Air laptop equipped with PanoTools and PTGui software.

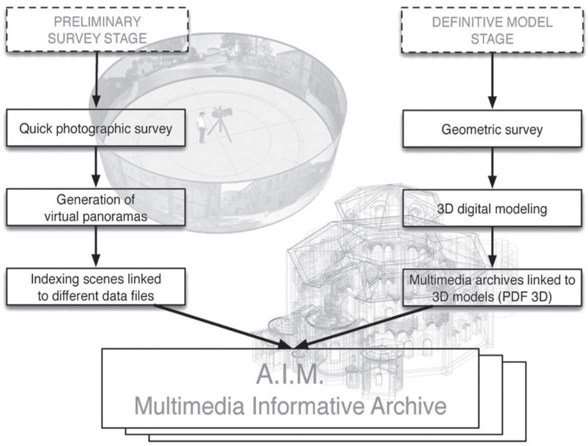

Fig.1 - Two different stages converging into an A.I.M.
A preliminary stage where a quick photographic acquisition becomes the graphical index for database contents, and a definitive stage where the archive is completed by a geometric 3D survey with digital models directly linked to panoramic views. The A.I.M. documentation system can be used from several electronic devices such as laptops, tablet PCs, cell phones and PDAs.

Therefore, at the end of the first preliminary investigation stage limited to the photographic acquisition and database connection, the whole dataset stored into A.I.M. becomes available for interactive communication systems, with an additional layer of information introduced including the geometric nature of the investigated areas: the initial A.I.M. evolves in its definitive stage.
Pushing the aforementioned flexibility and openness of

the system, digital models of buildings can be produced if needed through more accurate surveys by laser scanning, total station or digital photogrammetric techniques derived from panoramas as well.
This way, much more numerical information can be added to the A.I.M database, linking models directly to the graphical virtual index. In this case the best interaction between final user and A.I.M. is granted by a common 3D file format, namely the Adobe's Portable Document Format commonly abbreviated in PDF, in its 3D version based on compile-independent hardware and software.
Digital models are often represented by vector format (Gaiani, 2003), thus PDF3D was considered the best option since it's able to display complex geometries and heterogeneous database information using a simple reader which can be freely downloaded from the web. The Universal 3D (U3D) file format in fact, core of PDF3D technology, is a compressed standard for computer graphics contents introduced to ease the exchange of different kinds of data using a widely shared archiving format. Taking advantage of this potential (a single PDF3D file can embed text, vector graphics and raster images at any resolution), several three dimensional items can be inserted into the database, stored as vector objects and draped with texture derived from panoptic preliminary photo shots.
The expected result is a structured point's domain in a Cartesian space, suitable for the determination of geometric measurements through the assessment of their mutual distances, together with a detailed mapped model where architectural material's conservation can be documented.
These two different acquisition stages generate a data container through a process tested in two functional prototypes presented below.
San Vitale, the elected site for the first architectural A.I.M. prototype, is an Italian church in Ravenna and one of the most important examples of early Christian Byzantine architecture in Western Europe. A photogrammetric survey was realized together with natural lighting evaluations inside the church, while some archaeoacoustic analysis were carried out through derived models, as presented and documented by David Knight (2010).
Through the two declared stages and various applications communicating together, survey knowledge about San Vitale was summarized into a growing model in form of a nested 3D PDF file linked to preliminary panoramic views. The A.I.M. has been compiled allowing deep exploration from the main 3D model which could be even presented on web: photographic VR panoramas from the survey campaign, light analysis of sun rays on interior mosaics or a simulation movie of how could appear the church in VIth century, can be all easily consulted, together with a link to analytical files. Patently, those elements were gathered during different phases and managed by different software.

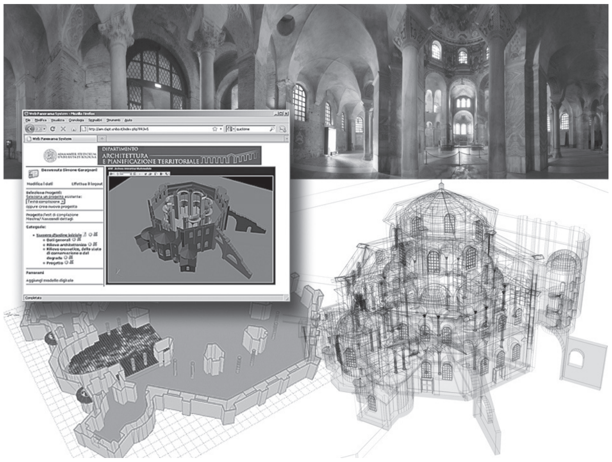

Fig.2 - The Church of San Vitale is one of the most important examples of early Christian Byzantine Architecture in Western Europe; the building is one of eight Ravenna structures inscribed on the UNESCO World Heritage List.
An A.I.M archive was generated to document several aspects, from lighting behaviors on mosaics to geometric dimensions and built patterns.

Even Palazzo Albergati, the second prototype introduced referred to one of the most important building of the Renaissance in Bologna, has been studied using A.I.M. to coordinate survey's results.
The monumental building, attributed to Baldassare da Siena, suffered a devastating fire in 2008 during which upper levels and roof were nearly destroyed.
The scientific restoration and renovation project, however, could not be undertaken without first preparing a detailed survey campaign which implied a significant number of technical resources committed to document the state of elevations and interiors, including the valuable "Red Room", located at the main floor of the building.
The preliminary photographs, made with panoramic technology, paved the way to the subsequent stage, consisting in a virtual simulation of the reconstruction beginning from deteriorated area's survey.
Operating conditions in Palazzo Albergati allowed an

intensive use of digital photogrammetry, given the technical versatility and stability of the method compared to the object under investigation and the conditions for shooting photographs.

The model was prepared with direct measurements and, in the case of more complex stuccos, with DSM photogrammetric technology (Dense Surface Modeling), producing point clouds with a good geometric approximation for corners and edges detected.

In the particular context analyzed, attention was focused on some decorations in the chapel and in the "Red Room", both characterized by the collapse of painted ceilings and frescoes. In order to obtain a profile of the survived portion of ceiling over the larger room, several images from different angles, corrected by a total station referencing the survey, were acquired to determine how to rebuild faithfully the lost part.

The result of this work, culminating in the creation of several drawing destined to document the existing building and allow restoration operations directly viewable through the A.I.M. interface, provides the information needed to evaluate the potential of the system and the process used to generate it.

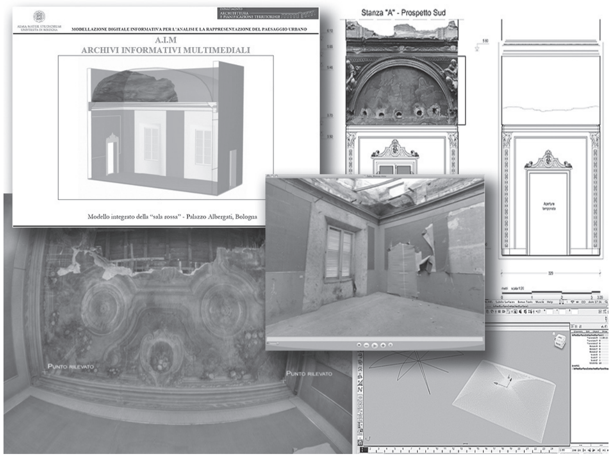

Fig.3 - Palazzo Albergati is an important building of the Renaissance in Bologna attributed to Baldassare da Siena. On August 2008 it was partially destroyed by fire, during some works on the wooden roof. A dedicated A.I.M. was generated to document the existing conditions and to prepare materials destined to restoration processes.

In our conclusion, A.I.M. is substantially a tool destined to designers for built environment, specifically prepared for building restoration themes. Possible further developments of this framework include generation of operative flow ported to mobile devices: the increasing versatility and reliability of PDAs, mobile phones and hi-tech tablet computers allow a wide number of data gathering stations, connected to the same central archive, making easier collecting, viewing and storing architectural information.

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