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An integrated information management system for consistent historic narratives and visualizations. Ghett/APP for the Venetian Ghetto

La gestione integrata delle informazioni per la costruzione di narrative e visualizzazioni coerenti. Il caso di Ghett/APP per il Ghetto Veneziano

The process of building narratives for cultural heritage involves heterogeneous information from multi-disciplinary sources. Consequently, in order to manage the complex transformation from information to narrative, the authors of the exhibition *Venice, the Jews and Europe 1516-2016* built a parametric BIM environment. This study presents the design of an application for mobile devices, Ghett/APP, able to direct the exhibition's contents to the real Venetian Ghetto. Without any development kit, the system uses the overlaying of spherical images to explore the city's past.

La necessità di comunicare in modo ottimale il bene culturale porta a dover affrontare simultaneamente informazioni caratterizzate da eterogeneità e multidisciplinarità. La complessità di questo processo ha portato gli autori della mostra "Venezia, gli Ebrei e l'Europa" a creare un ambiente di modellazione parametrico BIM che permetta di gestire il carico informativo per trasformarlo in una successiva narrazione. Il presente contributo dimostra la creazione di una applicazione per dispositivi portatili, Ghett/APP, capace di convogliare parte dei contenuti della mostra nel luogo reale, esperibile dall'utente. Senza ricorso ad ambienti di sviluppo complessi, il sistema sfrutta la sovrapposizione di immagini sferiche per mostrare i cambiamenti della città.

key words: App, Building Information Modeling, Ghetto, Visualizing Venice

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1. INTRODUCTION

Understanding the transformation of a city represents an important occasion to help people to think critically to the cultural heritage as a common monument (CHCFE CONSORTIUM 2015, p. 117). In order to publish the knowledge they produce, scholars need to work with the best visualization and informative tools, following funding limits and capacity of museums and organizations which manage the European cultural heritage[1]. The management system as described is often complex. Referring to mobile application market, despite the enormous number of them with touristic and cultural purposes, it is common to notice the obsolescence they suffer during time (Benyon, Quigley, O'Keefe, & Riva, 2014) (Dickinson et al., 2014) (Baggio, Sigala, Inversini, Pesonen, & Eds., 2013). Consequently, it is necessary to understand how to use mobile devices to support, for example, temporary exhibitions and events.
The exhibition "Venice, the Jews and Europe 1516-2016"[2], organized on the oc casion of the fifth centenary of the creation of Venice's Ghetto, aims to describe in a wider perspective the processes that led to the creation, implementation and transformation of the first "fence" for Jews in the world (Donatella Calabi, 2016). The research was possible thanks to a large pool of scholar of University IUAV of Venice, which interpreted documents and iconographic and cartographic sources. The research group of University of Padua[3], requested to produce some of the multimedia outputs, decided thus to organize its work with digital modeling and rendering tools to guarantee high quality in a complex process[4]. According to the methods adopted by the international project Visualizing Venice[5], researchers decided to support a new architectural modeling tool to complete what already did for the geographic and cartographic side (Ferrighi & Borin, 2016). In this sense, previous studies as the Eremitani church in Padua and Carpi's cathedral by the modeling group in Padua, and other international project, demonstrated as Building Information Modeling represents an effective tool (Bonsma et al., 2016).
The paper aims to study methods to create a mobile application, Ghett/APP (Fig. 1): it translates the contents of the exhibition into the real place. The Venetian Ghetto experienced continuous transformations to adapt to events: if during its implementation, buildings grew in height, after its opening, some of them were demolished. Even if the research underlines these events as specific, it is often difficult to read the past condition (Calabi 2016, pp. 19-35). Consequently, the mediated space, defined as the reality augmented by the information, could represent the past state and led the user to understand architectonic, construction and social features.

2. INFORMATION MANAGEMENT TO ARCHITECTURAL HERITAGE VISUALIZATION

Enriching the research in city past is a complex task because of the extreme heterogeneity of information required. Indeed, managing multiple disciplines is essential: history of the city, the construction and the architecture, architectural representation, topography, etc. In this regard, the European Commission considered that "an integrated approach to heritage conservation, promotion and valorization, is needed in order

Fig. 1. Ghett/APP cover (StudioPolo1116).

to take into account its manifold contribution to societal and economic objectives, as well as its impact on other public policies" (European Commission, 2014). In digital modeling, the key is represented by the use of tools which integrate heterogeneous data, as historical documents, historical cadaster and digital survey, iconographic sources, CAD digital models, etc. In the same way, a precise knowledge management[6] seems to guarantee different high quality outputs, such as images, videos, smartphones applications, 3D printing objects[7].
The research group decided to use Building Information Modeling to model digital building during the past (Fig. 2), trying to improve those methodologies already tested within the Visualizing Venice project[8]. Designed to manage complex information workflow, BIM authoring software fulfil the requirements imposed: geometric coordination with georeferenced data, visualization subdivided as urban and architectural scale, parametric features to guarantee instant revisions and propose rapidly different scenarios[9]. As-built buildings are thus transformed in a semantic architectural objects (walls, windows, roofs) and placed in a level-based geometric structure. This procedure is called taxonomisation of the real world, which enriches the well-known reverse engineering process in architecture[10] (Giordano, Borin, & Cundari, 2015).

3. APPLICATION'S PURPOSES AND REFERENCES

The exhibition "Venice, the Jews and Europe 1516-2016" gives the research group the opportunity to support the visit with an application for smartphone or tablet and a website. In this particular case, the augmented reality could allow the user to experience simultaneously the narrated space, as it was in the past and now partially recognizable, and the present, as the result of the past transformations, well described within the exhibition. In this way, each element has its domain: the historic reconstruction, virtual, overlaid to the real image as framed by the device. The process of recognition of the place as it is and the consequential evaluation of a precedent phase, guarantee the improvements of the renovations' intelligibility, linking narrative to real object[11] (Barry, 2006) (Mason, 2013). Furthermore, the application allows to transfer some of the contents of the exhibition to an external device: this feature makes best use of contents created, enabling their utility before or after the visit.
According to the research group Visualizing Venice, the methods and technologies required to develop the tool has been submitted to a list of requirements[12]. Initially, splitting narrative and technological requirements to produce the web application (Empler 2015,

Fig. 2. BIMsync Cloud-based environment. The platform shows a past phase through IFC files.

p. 61) finds the best solution and the future developments. Indeed, the design of Ghett/APP represents a test for future narratives (Fig. 3) involving research of city past. Considered main features were: low cost without use of SDK and API development, rapid delivery times.
At the same time, it was necessary to understand how other examples of augmented reality work. In particular, we explore those related to international research project. As a matter of fact, they use to structure different topics and researches within the application. Other particular examples were represented by well-designed application for their visual or user interaction peculiarities[13].
Recently, the project ITN-DCH (Initial Training Network or Digital Cultural Heritage) launched the Asinou Mobile Application. It shows the typological, historical, and spatial studies of the Church of Our Lady of Asinou in the Troodos mountains, Cyprus. The application describes analytical models along a visit path. The user could explore the models thanks to filters which show/hide geometries by element typology, construction task, construction technique, etc. At the same time, visitors could use augmented reality to explore the same features described above. TAG CLOUD (Technologies lead to Adaptability & lifelong enGagement with culture throughout the CLOUD) creates touristic application using a path along favorite stops, started by the design team and then adapted by the interaction with people. Consequently, it represents a reference to organize the virtual tour, particularly from the user point of view, in a strong relationship with social networks. Roma MVR demonstrated how to display the city transformation, making clear for any user the historic phase analyzed (Empler, 2014). For what concerns graphic and academic features, it seems important the new application developed for Ara Pacis Augustae. The narrative takes advantage of augmented reality to overlay colors and description to the real sculptures in a virtual reality environment.

4. GHETT/APP, FEATURES AND STRUCTURE

The requirements' analysis of existent solutions showed the impossibility to use augmented reality's advanced techniques. Consequently, the research group decided to work with different technologies which guarantee the reuse of the contents already produced for the exhibition[11]. With a proprietary solution, the project was developed in time, without design the user interface and whole experience. Indeed, this phase usually finds issues in usability and application's obsolescence[14]. The design reveals how visualization for cultural heritage it is not associated to the last improvement and advanced techniques, as augmented reality and videogame environments. Scholars need to focus on developing narratives and contents, supported by consistent multimedia visualizations.
As already stated, the production of the application meant the virtual translation of exhibition narratives within the device[15]. Particularity, Ghett/APP work linking the experience to stops (Fig. 4), which work as gatherers of multimedia information: texts, images, panoramic images, videos, audio (Fig. 5, on the left). Establishing the criteria of associability of the exhibition narrative to existing building, the application develops two different narrative strategies.
In a first case, the content could be linked to an existing building. The application gives users the information to orient within the physical space by observing Venetian architectural elements (mullioned windows, synagogues' features, etc.) or through a spherical image, emphasizing the analyzed building.
In a second phase, the user reads a description which introduces the experience of the multimedia contents, linking them to those inside the exhibition's path.
Alternatively, if the contents are linked to past building, it is important to provide users a way to learn urban transformation, linking it to the contemporary space.

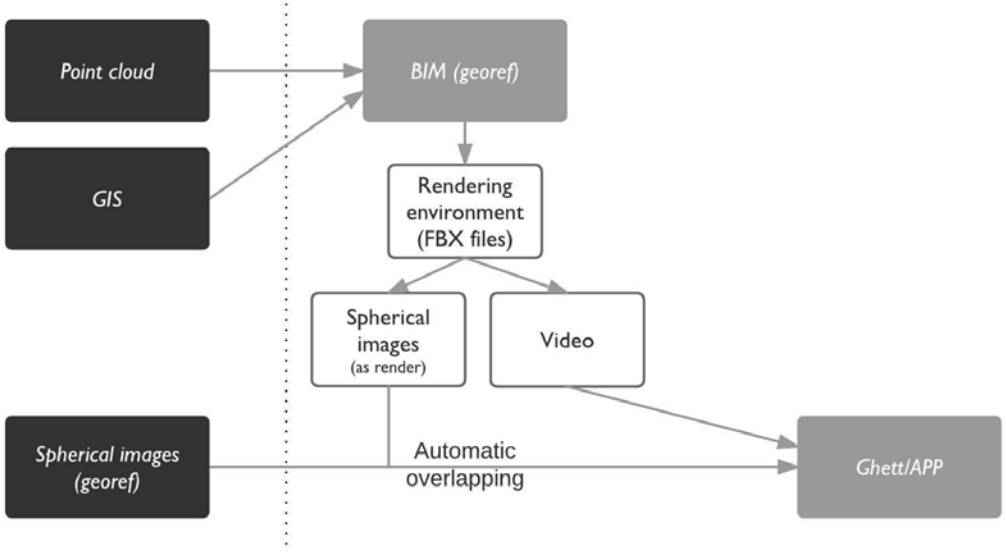

Fig. 3. From BIM to APP procedure.

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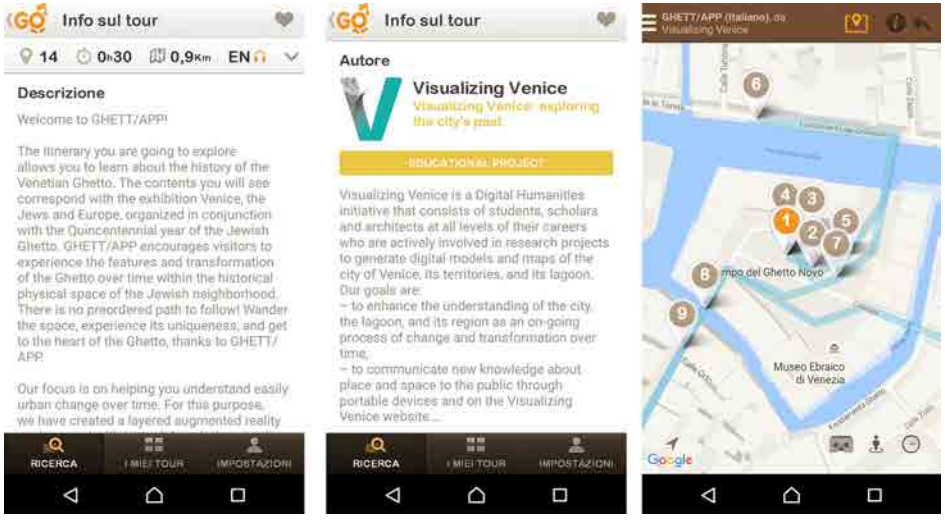
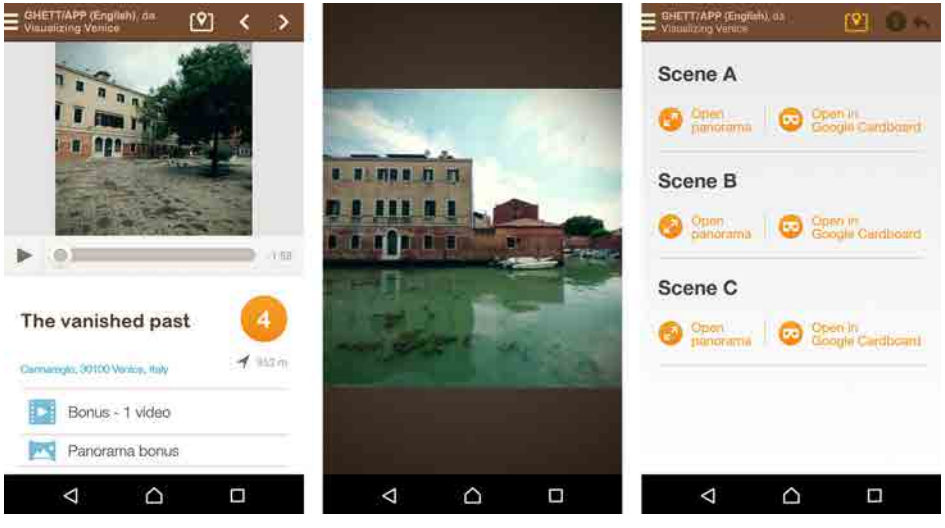


Fig. 4. Application home and research presentation (text by PhD Ludovica Galeazzo). On the right, the designed path in the Ghetto Nuovo.

Fig. 5: Content sample for each stop: a cover, a reference image with the audio file reading the description, the menu to select spherical images.



In this sense, the use of augmented realities seems to represent a fundamental opportunity because they allow to see the past overlaid to the contemporary. Literature used to associate the application's effectiveness to the contents organization (Huang, Alem, and Livingston 2013, p. 112). Unfortunately, the application is often unbalanced to visual scenic effects, not supported by strong narratives to help users to understand the transformed space with right steps (Mason, 2015). During the learning process, Ghett/APP uses a series of three spherical images[17] (Fig. 5, on the right). The first image displays the present condition, helping the user to align its sight to the virtual space on the screen. The second spherical image represents the reconstruction superimposed to the contemporary image. Here people learn transformation by comparison. A third image describes the space as it was in the past. Using the spherical image, the user's point of view is always coordinated to the device projection, giving it the opportunity to explore the visualization from the position's stop. As future implementation, the tool can overlap text to images: a tagging system links part of the text previously described to images, building a stronger storyline[18].

As described above, without any spatial references, the understanding process becomes more complex. The narrative system is thus adapted. In the first phase, the application explains the instructions to find, in the present Ghetto, the points of interest. The user is then invited to took part to a mixed experience: reading texts to learn how the transformation occurred and analyzing spherical images which overlaid the past condition, transparent, to the present. During this task, the tourist relates the demolished buildings to the real space, both geographically and semantically. In the Venetian Ghetto experience, this phase is even more significant. Before the first half of XIX century, the area was characterized by porticos and building higher than typical Venetian structures. Thanks to the comparative image, people link the typical architectural elements, achieving a more comprehensive knowledge. The last phase starts with watching the spherical image of the past condition, linked to an in-depth description. It ends with the vision of the multimedia content, already visited during the exhibition.

A meaningful example to describe the process of design and realization of Ghett/APP is represented by the northern part of the Ghetto Nuovo. This area was investigated both from 1516-1797 and after the Ghetto opening, the 13th July 1797. Thanks to the archive analysis and documentation, the research group digitally reconstructed two demolished buildings. The reconstruction consents to show some typical features of the apartments internal setting, tenants' families and typical architectural elements, such as stairs and wooden floors (Galeazzo, 2016). At the same time scholars studied the transformation after the Ghetto opening. Particularly the demolition of the northern elevation and the building of the Casa Israelitica di Riposo (Ferrighi, 2016).
The Ghett/APP stop number 5, called "buildings as social microcosm", fully describes this approach. The preliminary description talks about this building as a learning device, represented during the exhibition by a double section (Fig. 1). In fact, once analyzed the economic and cultural categories of the tenants' families, the drawing shows both the geometric and the social domain of the building. In the final part, the text asks the user to find the commemorative bas-relief on the wall: this is the narrative instrument to convey the user's viewpoint to the first spherical image, which represent the contemporary state. The narration continues requiring to watch the image C (Fig. 6), that shows the condition of the Ghetto Nuovo in 1770, and it ends with the description of the Jewish people, their shops and business, inviting users to see the video, as already seen during the exhibition.
Similarly, the visit path continues to show how the Ghetto Nuovo was from the *rio di San Girolamo*. Image 7 shows the equirectangular transformation of the present condition and its counterpart in the past. The figure is particularly efficient to realize how the area appears inaccessible and convey the sense of enclosure and densification, before XIX century transformations.

5. RESULTS

As demonstrated, building the application involves a particular translation of the results of the historical investigation, in order to convey the narrative message in a more intelligible and appropriate mode. The example presented, Ghett/APP for the Venetian Ghetto, allows the research group to create a visualization system to understand city and building transformation over time. During the experience, the user has the opportunity to compare application-specific images on a mobile device or website.
In order to face the extremely fast process of obsolescence of digital tools, the study demonstrates how important is the design and maintenance of a knowledge base, shared among researchers, developers and exhibition's curator. The Visualizing Venice project demonstrated that structuring the interpretative models and producing multimedia outputs are consequent phases, not interchangeable. Therefore, updating multimedia productions is consequent to a new structure of documents and models: changing the visualizing aspect, update the platform used for augmented reality, adding new studies correspond to a new setting of the same knowledge base. It thus becomes more and more strategic that scholars manage the procedure of publishing and visualization, even by means of proprietary solution to reach the designed results.
The future development of this research is represented by the integration of 3D tracking tools, combined to videogame based software (Battini & Landi, 2015). This improvements, in the case of Ghett/APP, leads to a complete augmented reality application as synthesis of three factors: combining real and virtual images, aligning virtual graphics to real objects with the help of live interaction between the two systems (Azuma, 1997) (Huang, Alem, and Livingston 2013, p. 3). The last point represents a key feature: it allows to read the urban changes while people explore the present space, increasing the viewpoint and learning possibilities. For example, it will be possible to visualize the internal space of buildings, showing the whole research from the urban to the architectural scale. Concluding, the integration of Building Information Modeling and videogame software generates, within a unique developing environment, a direct and automatic link between some information of the model and the augmented reality application (construction period, link between architectural elements and documents, construction material, building properties, etc.) (Fassi et al., 2016). Far from being the double of the model, this aspect enables a more agile system to support the visualization of information, improving the quality and reliability of narration.

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Fig.6. Stop 05, sequence of spherical images.
Fig.7. Stop 07, present condition, demolished building, present and past condition superimposition.

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NOTES

[1] On this subject see the European project INCEPTION (Inclusive Cultural Heritage in Europe through 3D semantic modelling).

[2] The exhibition, curated by Donatella Calabi with the contribution of a large pool of scholars, took place in the Doge's Apartment in Palazzo Ducale, from June 19 to November 13.

[3] The research group at University of Padua is composed by prof. prof. Andrea Giordano as supervisor, PhD Isabella Friso, Paolo Borin, Federico Panarotto.

[4] Particularly, it refers to multimedia installations which combine images, videos, 3d printed models, project mapping, etc. Exhibition's multimedia contents are curated by Studio Azzurro. They are produced by the research group at University of Padua.

[5] Visualizing Venice is a Digital Humanities initiative that consists of students, scholars and architects at all levels of their careers who are actively involved in research projects to generate digital models and maps of the city of Venice, its territories, and its lagoon. Begun in 2009, Visualizing Venice is collaboration between Duke University, the University IUAV of Venice and the University of Padua.

[6] Knowledge management is represented by a digital model, which is capable of linking external sources, such as historic images, and describing geometries changes during time (a so-called 4D model).

[7] The analysis of the typical workflow, highlights some issues: the more urgent was about quality losses caused by lack of interoperable within system (GIS-CAD). Indeed, every information exchange makes quality checking between visualization and documents more complex. Moreover, the lack of interoperability makes even heavier any request of model's revision. For a detailed study see (Ferrighi & Borin, 2016)

[8] In order to check model quality and make visualizations consistent to documents, scholars work with collaborative tools. Particularly, using tools dedicated to the construction industry, allows them to monitor the model production (i.e. the use of BCF, BIM Collaboration Format, was extremely helpful).

[9] Within his master's thesis, Arbor Paja explored the information exchange for historic urban and architectural analysis between BIM and GIS (supervisor prof. Andrea Giordano, co supervisor PhD Alessandra Ferrighi, tutor Paolo Borin)

[10] During the modeling process, the user has to decompose the historical architecture in its construction elements within a geometric structure. These objects, as architectural components, are organized in a constructive catalogue (for example windows, furniture, decorative apparatus). This procedure shows the construction/assembling technique: a clear example is represented by the connection between walls and floors, which is a distinctive trait of historic architecture.

[11] For Maldonado, the object recognition and its deep learning are consequential to a sensorial experience (Maldonado, 1992). In this sense, the difference between the built space and the explained space within the exhibition, could lead to a misinterpretation.

[12] In this phase I thank prof. Caroline Bruzelius and PhD Victoria Szabo for the scientific support.

[13] To a detailed study of augmented reality application in mobile devices see (Garau, 2014)

[14] The used proprietary platform has been GuidiGO (https://www.guidigo.com/). The solution allows easily to create a sequence of georeferenced stops to develop a museum path. The system provides a structure in order to organize multimedia contents (GuidiGO studio)

[15] To analyze the representation and philosophical complexity of users interfaces within mobile device see (Bergamo, 2013)

[16] In this phase, special thanks go to PhD Ludovica Galeazzo

[17] The term spherical image refers to figures produced by different procedures, as photographic images created by fisheye lenses as well as renderings, then assembled by proprietary stitching procedures and software. People use easily these images, thanks to the device's sensors and the recent popularity in social networks. Thus, a vertical rotation of the user's sight corresponds to a rotation on the device screen, aligning the exploration of the augmented space and hiding the images' lateral distortion.

[18] Overlaying text and images is possible within the developing environment or directly during the process of creating the image. The user could deform the text projecting it on an exterior spherical surface, capable of balance the deformation of the spherical image.

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