



Virtual Reality in World Heritage Gardens

Andalusia - Sicily - Jordan

Project iHERITAGE: ITC Mediterranean platform for UNESCO Cultural Heritage
ENI CBC Med Programme







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Partners collaborating in this publication:



About the ENI CBC Med Program and iHERITAGE Project:

The iHERITAGE project is co-financed by 90% by the ENI CBC Med Program with a total budget of €3.874.287,06 and has been recognized among the most strategically important projects of all 198 proposals presented throughout the Mediterranean basin. iHERITAGE is committed to assisting the creative industry and innovative startups in Italy, Egypt, Spain, Jordan, Lebanon, and Portugal by funding the creation of new augmented and virtual content in the leading sectors of culture and tourism, as well as engaging with local communities through free access to the Living Labs Program, trainings, awareness raising events, engagement seminars, and the opportunity to apply for grants.

The 2014-2020 ENI CBC Mediterranean Sea Basin Programme is a multilateral Cross-Border Cooperation (CBC) initiative funded by the European Neighbourhood Instrument (ENI). The Programme objective is to foster fair, equitable and sustainable economic, social and territorial development, which may advance cross-border integration and valorise participating countries' territories and values. The following 13 countries participate in the Programme: Cyprus, Egypt, France, Greece, Israel, Italy, Jordan, Lebanon, Malta, Palestine, Portugal, Spain, and Tunisia. The Managing Authority (MA) is the Autonomous Region of Sardinia (Italy). Official Programme languages are Arabic, English and French. For more information, please visit: www.enicbcmmed.eu

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This publication has been produced with the financial assistance of the European Union under the ENI CBC Mediterranean Sea Basin Programme. The contents of this document are the sole responsibility of El legado andalusí Andalusian Public Foundation and can under no circumstances be regarded as reflecting the position of the European Union or the Programme management structures.

Acknowledgements

From the Andalusian Public Foundation El legado andalusí, we would like to express our deepest gratitude to all the institutions and individuals who have generously contributed to this publication.

We would also like to extend a special thanks to all iHERITAGE partners for their invaluable input and contributions to the project.

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ISBN: 13-978-84-96395-61-9

Legal Deposit: GR 1400-2023

Printed in Spain

Index

- Communicating heritage in the digital era: Exhibition *Gardens. Heritage and dreams*. European Year of Skills. Interreg Next Med** 13
El legado andalusí Andalusian Public Foundation
- El legado andalusí: innovative technologies at the service of heritage interpretation. *Gardens. Heritage and dreams*** 17
El legado andalusí Andalusian Public Foundation
- Discovering gardens and buildings of Arab-Norman Palermo UNESCO World Heritage Site through innovative ICT products** 37
Rossella Corrao. Department of Architecture. University of Palermo (Italy)
- Insights on landscaped Gardens of Desert culture: the Umayyad and the Nabataean Gardens** 49
Naif Haddad, Fardous Al-Ajlouni, Leen Fakhoury, Khairieh Amr

Few places of our environment are so pleasant to us as gardens. They are inspiring spaces, places of rest, havens of freshness that allow visitors to connect with nature and to feel part of it. There are many shapes, sizes and styles of garden, but whether small or large, enclosed or open, intimate or monumental, they have accompanied any human habitat since the dawn of time.

And Andalusia represents this garden wealth in a very particular way. In addition to their intrinsic vegetal beauty, many of these gardens are outstanding because of their longevity and their capacity to last, or even survive, over the centuries. Such is the case of the Patio de los Naranjos (Orange Trees Courtyard), in the Mosque of Cordoba, probably the oldest living garden in existence, which has faithfully adorned the Caliphal city for 12 centuries.

In Granada, there are also gardens that have stood the test of time, such as the Patio de los Arrayanes in the Alhambra and the enchanting Generalife. The Patio de la Acequia, for instance, has been an ornamental garden continuously since it was created in the 14th century. These three stunning gardens, along with many others in Andalusia, Spain, and Europe, were also featured in the exhibition. Like the gardens of al-Andalus mentioned earlier, they have deservedly become part of the World Heritage and have been recognized by UNESCO.

While these are the gardens that have been preserved, there are many other Andalusian gardens that have been recognized. Some are known specifically through archaeology, such as the gardens that existed in the palatine city of Madinat al-Zahra', while others are only mentioned in the numerous divans of Andalusian poetry, in which there was a whole genre devoted to the description of flowers. Many verses have been dedicated to these gardens, transporting us to beautiful and fragrant spaces covered with flowers where water is always present.

Andalusia is still home to many gardens that are direct heirs of the gardens of al-Andalus, such as those found in the Real Alcázar in Seville. The Andalusian garden heritage is intricately connected with the tradition of the gardens of Antiquity, including those of the Roman, Persian, and Byzantine empires. This heritage is still alive today, with new gardens being created that reproduce the models associated with the gardens of al-Andalus. These gardens include amazing pools, myrtle beds, citrus trees, cypresses, and other elements that make them truly unique.

The exhibition title itself reflects the combination of the concepts of garden and heritage, inviting visitors to reflect on gardens as ornamental and heritage elements. It immersed us in real and imaginary gardens made of paper, stone, sound, and music. There were gardens for children, gardens in engravings, paintings, and photography -gardens that have inspired all the arts. The exhibition also introduced gardens recreated using cutting-edge technologies, following the line marked by the European project iHERITAGE. ICT Mediterranean Platform for UNESCO cultural heritage.

The exhibition combined very assorted elements, which despite their heterogeneity, dialogued perfectly with each other: there were of course real plants, but also works of art, photographs, museum objects and books, and as a differentiating element, pioneering technologies such as holograms and Virtual Archaeological Reconstructions, which showcased the latest research results in heritage sites recognized by UNESCO.

Today, many of these historic gardens are part of the World Heritage List, with Andalusia being home to numerous examples such as the gardens of the Alhambra and the Generalife, the Alcazar Gardens in Seville, the Albayzin, the Royal Alcazar Gardens in Seville, and the courtyard of the Mosque of Cordoba. Inspired by the creative and renewing principles of the iHERITAGE Project, we feel somehow compelled to showcase and analyze these gardens, discovering how they have evolved and continue to inspire anyone who has had the good fortune to visit or frequent them.

María de la Concepción de Santa Ana Fernández

Managing Director

El legado andalusí Andalusian Public Foundation



Discovering gardens and buildings of Arab-Norman Palermo UNESCO World Heritage Site through innovative ICT products

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The main activities of the researchers from the University of Palermo involved as Partner in iHERITAGE project, have been aimed to qualify and improve the level of information, communication and use of the nine wonders of “Arab-Norman Palermo and the Cathedrals of Cefalù and Monreale”, listed by UNESCO as World Heritage in 2015, and of the other Norman artefacts (buildings, pieces of art and infrastructure, as the Arab underground water pipes named *qanat*) not yet included in the World Heritage List.

To extend the valorisation of Norman heritage in Palermo and abroad and to maximize the involvement of public (researchers, students, citizens, NEETs), augmented and immersive virtual experiences can be used: the innovative ICT technologies can be also useful for involving people with disabilities, overcoming the limits derived from the architectural barriers, without compromising the aesthetical integrity of monuments with ramps or elevators, promoting a more inclusive society. This specific topic has been addressed by University of Palermo with



On the previous page, 3D reconstruction of the *Cuba*, with the pond and the garden, University of Palermo for iHERITAGE.

On this page, representation of the original level of the pond in front of the façade of the *Cuba*, as it can be seen today.

the development of VR products that can be managed simply by using eyes.

Some of the nine civil and religious structures of UNESCO Arab-Norman Palermo site (two palaces, three churches, three cathedrals and a bridge), dating from the era of the Norman kingdom of Sicily (1130-1194), have been virtually reconstructed by giving evidence of their original aspect and functions, mixing scientific information and reconstructive hypotheses, with effects digitally created. Based on valid scientific investigation, laser scanning and photogrammetry data acquisitions, the relationships between the different buildings of UNESCO Arab-Norman Palermo and the other Norman buildings and systems not included in the World Heritage list yet – but worthy of attention for a future inclusion – have been highlighted.

The holographic reconstructions carried out by fellows enrolled in iHERITAGE project have been developed by exploiting the results of analyses and studies of the

researchers and the external experts involved in the Seminars of the Living Lab launched in March 2020. In the exhibition developed by PP8-El legado andalusí in Granada entitled *Gardens. Heritage and dreams* the holographic reconstructions of two Norman *solatia* and a *qanāt* are visible. They testify the close connection between nature and architecture in the Norman Era in Palermo.

The role of vegetation and water in the Norman *solatia* was strategic as well as in many Islamic buildings where they were often placed –generally in courtyards or patios– for activating the passive evaporative cooling system –usually through water flowing on grooved marble surfaces or in fountains with gushing. Norman *solatia* of Palermo were built always near water sources like rivers, artificial lakes and/or underground water channels (*qanat*) and/or irrigation channels that characterized the so called “Piana dei colli” (a wide plain in the north of the city delimited by the hills that surrounded it and the slopes of Pellegrino Mountain), at that time full of gardens. In his *Liber De Regno Sicilie*, Hugo Falcandus, in his narration of the history of the Norman kingdom of Sicily between 1154 and 1169, wrote: “... Who will ever be able to sufficiently admire the marvellous buildings of this illustrious city [Palermo], the richness of the springs scattered throughout the territory, amenities of evergreen trees or aqueducts useful to citizens for every use? Who can praise enough for the extraordinary beauty of the plain that stretches for nearly four miles between the city and the mountains? [...].

Here you admire flourishing vineyards for the abundant richness of vegetation and for the generosity of the famous fruit, there you see valuable gardens for the admirable variety of fruits and towers suitable for vigilance and the pleasure of rest [...] the water then flows from the channels towards the various cultivated spaces, irrigates them and makes small cucumbers grow, the longest watermelons and melons of an almost spherical shape and the plants of pumpkins that spread in the pergolas of connected reeds. If you then turn your gaze to the various species of trees, you see the pomegranates, sour and sweet, with the grains hidden inside and protected on the outside against bad weather by the hard skin. You see cedars [...] You see lemons that with their sourness can give flavour to food, oranges [...]. What about walnuts, almonds, figs of different species and olives that provide the oil that is used to season foods and to fuel the flame of the oil lamps? What about the pods of the siliqua [...] the tall tops of the palm trees and the dates that hang from the top of the bare stem?”¹. The gardens described by Falcandus and referred to the period between 1154 and 1169 were productive gardens, as also described by Ibn Hawqal, Muslim traveller that visited Palermo in 977². These productive gardens, due to the expertise of the Arabs in the construction of the numerous channels for the irrigation which made the entire area very luxuriant, were strictly connected to the three large parks –*Gennat al-ard*, *Fawarah*, *Menani*– where Papireto, Kemonia and Oreto rivers flowed, partially realized by Arabs but extended by

Normans and filled with wild animals and raptors (among which griffin stands out) for carrying out their primary activity of pleasure: hunting. In these large parks, *solatia* were built too.

Al-Aziza (“The Splendid” in Arabic, *Zisa* in Italian), *Qubba* (“Dome” in Arabic, *Cuba* in Italian), *Uscibene* palaces, Altofonte castel, *Fawarah* (“Bubbling source” in Arabic, *Favara* or *Maredolce* in Italian) are the main

solatia still visible today even if not always in their original configuration and, unfortunately, totally engulfed by the buildings of contemporary city.

For a better understanding of the buildings’ characteristics and their original context, 3D reconstructions have been developed by University of Palermo, also for the holographic exhibition dedicated to Gardens in World Heritage Monuments, entitled *Gardens. Heritage and*

dreams. *Zisa* and *Cuba* palaces, and their immediate surroundings, have been reconstructed by considering the results of studies carried out by experts in the field of history of architecture, architectural engineering, agronomy and botany as well as the imaginative reconstructions of painters of the 18th and 19th centuries.

For the exterior digital reconstruction of *Cuba*, fishpond, and garden, that probably surrounded it when it

was built in 1180, reference was made to perspective drawings made by Gally Knight³ (18th century), De Prangey⁴ and Adolf Goldschmidt⁵ (19th century) and studies conducted by Fazello, Giuseppe Caronia⁶ and Vittorio Noto⁷.

Regarding the large roof of the central hall of *Cuba*, the existence of a dome is debated. A digital model hypothesis has been formulated, supported by insights from



On the left, *Cuba*, by Rocco Lentini, 1922. Oil on canvas. On the right. 3D-virtual recreation of the *Cuba*, with the pond and the garden, University of Palermo for iHERITAGE.



3D-virtual recreation of the *Cuba*, with the pond and the garden, University of Palermo for iHERITAGE.



360°-photo of the *Zisa* today with the new garden.
The works began in 1993 and were completed in 2011.



Veduta con Castello della Zisa (A view of the *Zisa* Castle), by Rocco Lentini, 1935. Oil on canvas.

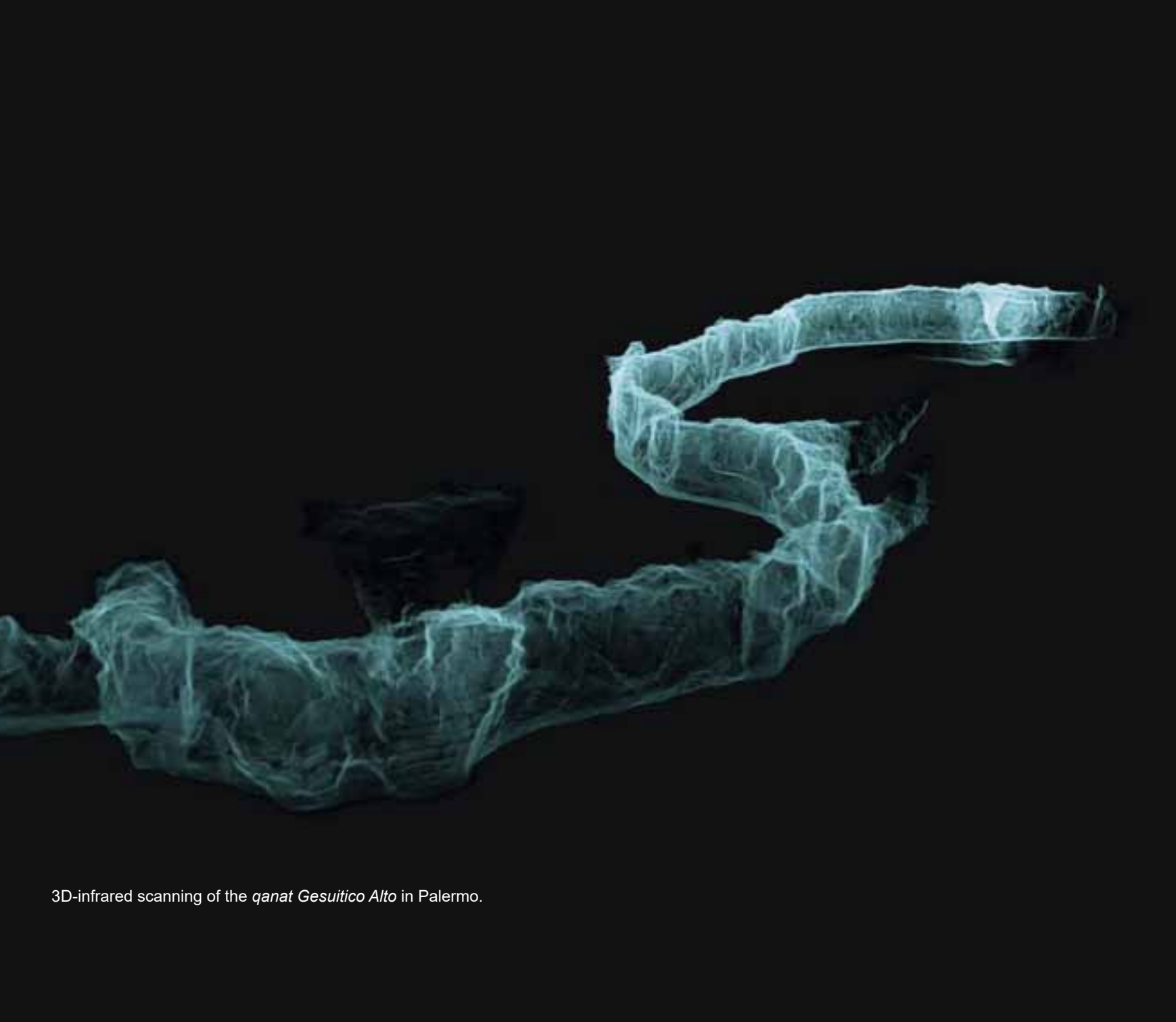


3D-reconstruction of the *Zisa* to be screened using holographic imaging. University of Palermo for iHERITAGE.

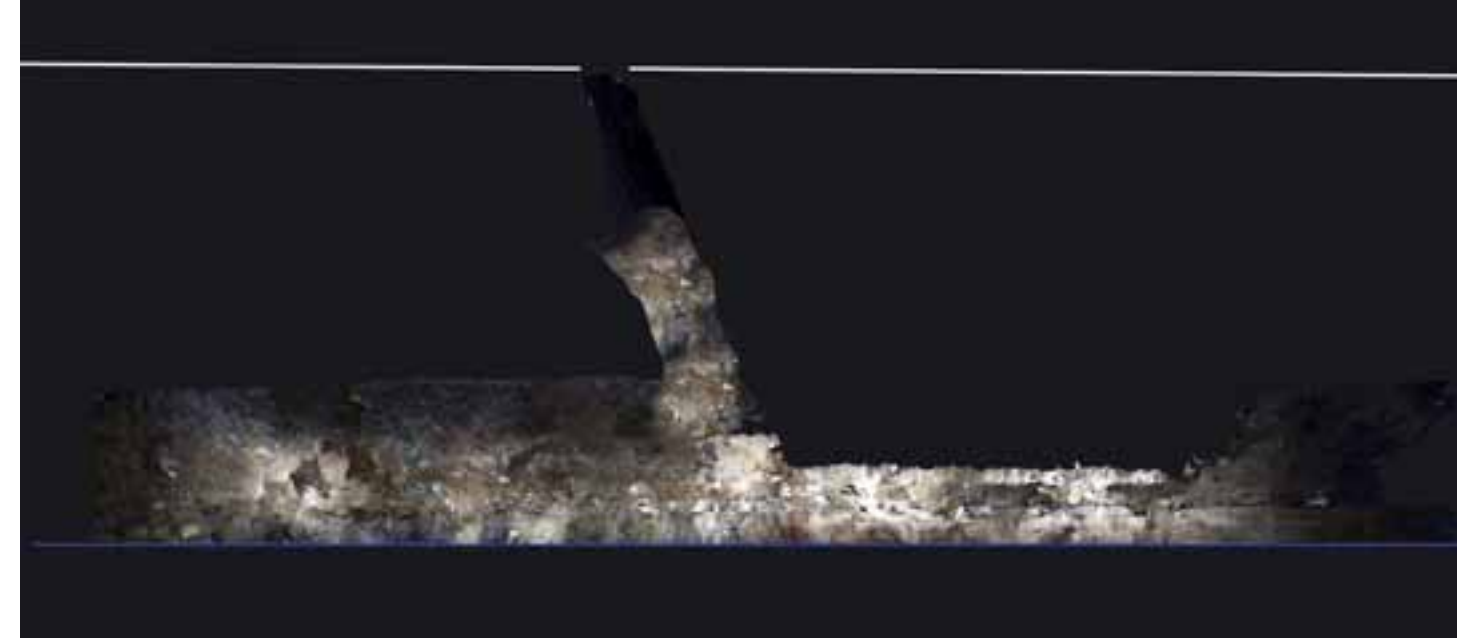
scholars such as Hittorf⁸, Valenti and historical and typological considerations of buildings prior to *Cuba* compiled by scholars Giuseppe Caronia and Vittorio Noto.

The methodological procedure was applied allowing, at the end of the process, to obtain 3D models with a good sampling in terms of geometric-formal definition and quality of the applied texture. The goal has been to create

digital products that meet the requirements of the cultural heritage dissemination standards. We preferred to develop the process within the open-source working environment Blender (stable version 2.93 and beta version 3.0). Particularly interesting has been the phase involving texture mapping that includes multiple preliminary processing, such as mesh partitioning, mesh parameterization and



3D-infrared scanning of the *qanat Gesuitico Alto* in Palermo.



3D 360-photograph of the first level of the *Gesuitico Alto qanat* in Palermo.

texture transfer, which are interrelated and affect the result. As known, in the texture mapping phase the most common problems, due to the often not ideal gripping conditions, are low texture resolution; gaps and undercuts; photographic inconsistencies (variation of light and reflections) and topological errors due to the formal geometric complexity. The libraries available within Blender software use an automated procedure to create Ultra Violet maps. The tool is called the “Smart UV Project”.

Before assigning texture to the edited surface (baking), a new material component was created through procedural techniques within Blender’s “Node Editor”. New information encoded in 2D maps, shaders (displacement map, lightmap, cavity map, etc.) was associated with the component properties. In the final step, after baking, some areas of interest have been selected with the Texture Painting mode tool and emphasized (by creating masks) editing some parameters such as: saturation, contrast, and brightness.

The procedure described above allowed to recreate the context in which the *Cuba* was built, and the landscape surrounding it, as well as the large fishpond that allow people (both visitors or remote users), by comparing the building as well as exists today and the 3D reconstruction visible also in holographic way, to easy understand the original height of the building, distorted today by the lack of the fishpond. During their visit, visitors wander around the building by walking on the bottom of the original fishpond that corresponds to the actual level of the street from which the building is accessible, so they visually perceive the building 2-meter taller than the original.

The same procedure has been followed for the reconstruction of *Zisa* and its fishpond, according to the ideal reconstruction of the painter Rocco Lentini (*Veduta con Castello della Zisa*, 1935) and Giuseppe Spatrisano's⁹ ideal drawings (1982), which combine the survey with a description of the monument by the 16th-century Bolognese monk Leandro Alberti¹⁰.

Since water is strictly connected to *solatia*, as already discussed in other paper¹¹, *qanat* have been 3D-reconstructed also for allowing people with disabilities to have access to these spectacular underground infrastructure that fed the fishponds of Norman buildings.

The potential of the laser system (wearable mobile laser systems) has been exploited, considering the many logistical challenges of capture (presence of humidity, restricted and narrow areas, lack of light, absence of GPS

signal, inability to stand or survey, etc.) and with the aim to detect complex surfaces with high geometric resolution. 3D reality-based surveying instruments and techniques offer new and effective solutions for the 3D modeling of hypogeal environments. The phases of the acquisition process, 3D data analysis, management and optimization of the digital model set up have enabled us to obtain a realistic scenario of the hypogeal architectural system for the creation of a virtual tour in gaming modality (UnReal Engine by Epic Games) and a holographic projection of the three levels of *Gesuitico Alto qanat*.

Acknowledgements

Thank to Professors Francesco Di Paola and Vincenza Garofalo, for providing details about the methodology adopted for surveys with laser scanner and photogrammetric techniques; iHERITAGE fellows: Marco Geraci, for data acquisition and processing, and Yury Alogna, for the exterior digital reconstruction of *Cuba*; arch. Francesco Ferla, for the creation of Interactive 360 Photography of *qanat*; prof. Calogero Vinci, for assistance in managing the different phases of surveys and the design of iHERITAGE products.

Notas

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MULTIMEDIA CONTENT

3D recreation of *Castello della Zisa*



Scan this QR code to view a 3D recreation of *Castello della Zisa* in your mobile device.

3D recreation of the *Cuba*



Scan this QR code to view a 3D recreation of the *Cuba* in your mobile device.

3D infrared scanning of *qanat Gesuitico Alto*



Scan this QR code to view the 3D infrared scanning of *qanat Gesuitico Alto* in your mobile device.

