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Heritage for people

Sharing vernacular knowledge to build the future

versus plus
heritage for people

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DOCUMENTATION AND DIGITAL SURVEY OF TANGIBLE HERITAGE

Alessandro Merlo, Gaia Lavoratti
Università degli Studi di Firenze, Florence, Italy

The creation of reality-based 3D models of the tangible cultural heritage has become an increasingly common practice, which has been made only seemingly easy thanks to modern-day data acquisition systems. In particular, the use of structure from motion techniques based on shots taken either from the ground or by drone using commercial cameras, has made it possible even for non-experts in the field of digital surveying to carry out operations aimed at digitising (or virtualising) the existing heritage.
The production of so-called Digital Twins actually involves the development of generally complex workflows, the mastery of tools in the data acquisition (active sensors, such as laser scanners and passive sensors), management (point cloud management and digital photogrammetry software) and restitution phases (two-dimensional representation and 3D model editing software), as well as an in-depth knowledge of the objects to be documented in order to generate 2D and 3D products that properly bring out the morphometric and chromatic features of the assets under study. The survey is, therefore, a critical operation in which the technical and humanistic components must be properly balanced so as to obtain correct and, above all, useful results, in other words capable of satisfying the purpose for which the survey operations were carried out in the first place (Merlo et al., 2023).

opposite page
Digital Survey with 3D laser scanner at the *Viejo de la Mola* Mill, Formentera, Spain
(credits: CHM_Lab)

Reverse modelling

The creation of a polygonal model of an existing structure through a process of Reverse Engineering presupposes the prior consideration of at least two issues, which will condition the subsequent work pipeline: the morphometric and chromatic features of the asset in question and the specific intended use of its digital twin. In fact, the analysis of these two issues will make it possible to choose the most suitable parameters for digitising the asset, as well as to determine the most appropriate modelling techniques (or a combination thereof) for preserving, in perceptive and/or dimensional terms, the apparent shape and colour of the artefact.
Concurrent studies aimed at recognising the various different elements that compose them (semantic analysis), ranking them according to their function within the asset, the material with which they were made and the rules that subtend their form (taxonomic analysis), verifying the spatial relationships they establish with each other (topological analysis), and finally identifying their overall volumetric layout, will help guide the surveyor in the production of the 3D virtual copy and the resulting 2D drawings (Mandelli, Merlo, 2019).

Ortophoto of the east front of the Sa Senieta complex in Formentera, Spain

opposite page
Section A-A of the Sa Senieta complex in Formentera, Spain
(credits: CHM_Lab)

2D and 3D rendering

It is not redundant to stress how, in the very midst of the digital age, 2D representations made through the usual operations of projective geometry (plans, elevations, sections, and site plan) are still the basic procedure which cultural operators, including architects, rely upon, both in their professional practice and in research. The tools and procedures of morphometric data acquisition and rendering have changed and no longer refer to the real object but rather to its copy, obtained through digitising operations, yet the intended result has remained unvaried, in other words survey drawings (in digital format) that are generally still printed to scale on paper.

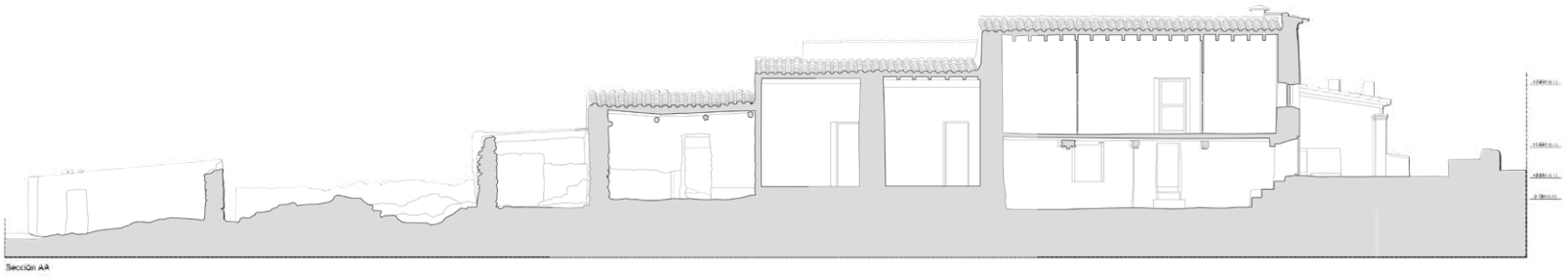
The new feature, therefore, is a digital twin, which one can view, navigate and study at will, through all the systems and devices that Information Communication Technology (ICT) provides. 3D models can be enhanced with additional information, also drawn from potentially unlimited external databases, visualised in neutral, real or fictional environments, decomposed into their parts (if planned during the modelling phase), divided into sections and inquired upon, until they become part of a virtual environment in which objects and avatars (digital versions of a user) can interact with each other (metaverse).

The digitisation of cultural heritage, carried out with the necessary scientific precision, can therefore meet multiple needs, among which those related to communication, dissemination and preservation through ICT and, in particular, through the WEB, which are increasingly gaining ground, also thanks to the support of EU policies.

To the well-established methods involving real-time navigation of digital models through screens or headsets, and their use and enjoyment by means of Immersive Reality (IR), Augmented Reality (AR), or Mixed Reality (MR), have been added other new modes, such as the Virtual Interactive Movie (VIM), which involves forms related to other areas of the creative industry, such as film, music, and video games, in order to benefit from Digital Cultural Heritage (DCH - D'Alessio, 2023).

Survey of the tangible heritage as part of the Versus+ project

As part of this project, several survey campaigns were carried out in the islands of Sant'Antioco and Formentera, in order to contribute to the knowledge of building and architectural features through a formal and dimensional - as well as typological, constructive and material - analysis of some buildings that



could provide information on the degree of resilience of the historical-cultural context in which they are located.

On the island of Sant'Antioco, and following a well-established morpho-typological tradition (Purini, 2021), buildings were selected which belonged to both a basic construction-type, in the town and rural areas (shacks), as well as to special construction-types: a productive structure (a tuna fishery, or tonnara), a defensive structure (tower), and a building used for cultural functions (*Ràixe*). Finally, a separate survey campaign was conducted of the urban section between via Marconi and via Solferino (from the Savoy Tower to piazza Pietro Belly), in order to document the layout of the Calasetta settlement – in other words, the conformation of itineraries and nodes (or poles) along which buildings have been arranged over time – as well as the processes and dynamics that occurred within the blocks themselves.

The documentation work carried out in Formentera involved instead a traditional dwelling (*Sa Senieta*) located at the entrance of the town of Sant Francesc Xavier, as well as a windmill for grinding grain at the village of La Mola.

The rendering work focused particularly on Sa Senieta, which consists of the merging of two casaments, whose typical original plan layout, with its outbuildings and enclosures, is still recognisable. Its oldest core (the casa des majorals, which dates back to the first half of the 18th century) is distributed on a single storey and occupies a central position, whereas the more recent section (the casa des senyors, dating back to the 19th century) is located next to it to the south and on two storeys.

Notes on the survey procedures

A CAM2® FocusS 70 unit was used for the survey operations, as well as an DJI Mavic Mini 2 drone (in Calasetta) and a DJI Mavic Mini 3 Pro drone (in Formentera), as well as 20 Mpx reflex digital cameras with an 18-85 mm lens. The scans of individual buildings, given the small size of the structures, were made using a resolution of 1/5 and a quality of 3x, which allowed for a reasonable compromise between acquisition speed and data density. In the case of the urban section, however, the parameters adopted were 1/4 (resolution) and 3x (quality). In order to facilitate alignment operations using Autodesk Recap software, special attention was paid to ensuring a good overlap between adjacent scans.

Point clouds concerning the top parts of the buildings were derived through structure from motion

Pointcloud of the *Viejo de la Mola* Mill in Formentera, Spain
(Autodesk Recap Prof, credits: CHM_Lab).

operations using Agisoft Metashape software from sets of images taken by drone; these point clouds, once aligned with the ones obtained by laser scanning, made it possible to produce an almost complete digital copy of the analysed structures.

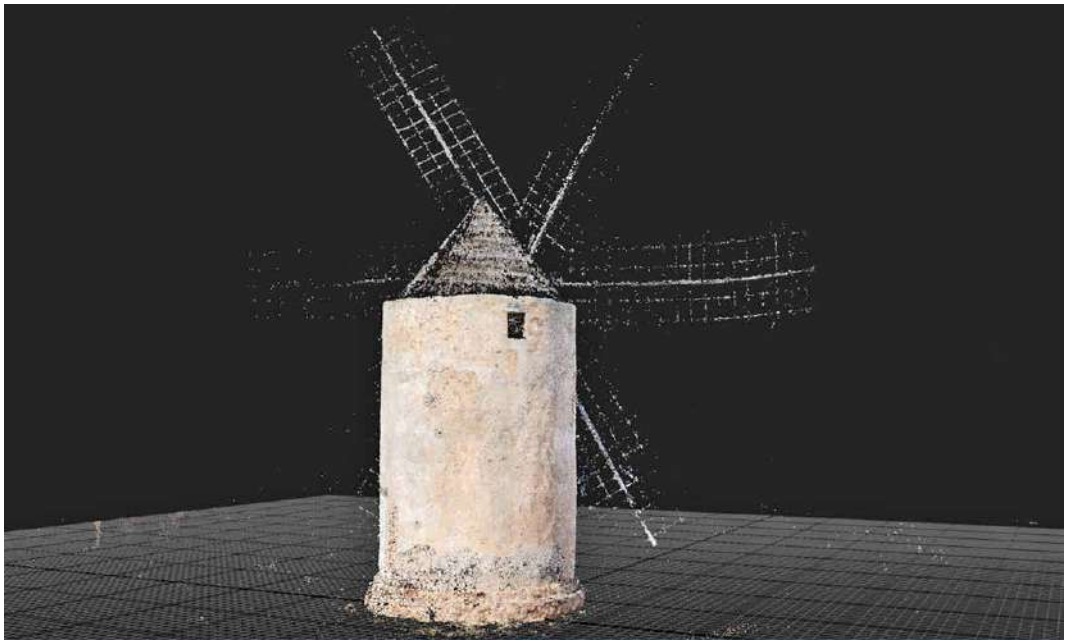
The images taken by drones, as well as those taken from the ground, properly balanced using a colour checker placed when the photo sets were made, were also used to document the colour data. Also using Agisoft Metashape, orthomosaics were produced which, once scaled and oriented, were used both to obtain orthophotos and to texturise the 3D models. The latter were generated with Blender - a free and open source software that also allows UV mapping - from 2D data obtained from point clouds, using, as alternatives to each other, the Autodesk Autocad or the Leica Cyclone programmes.

The morphometric accuracy of the 2D data processed and vector rendered from point clouds was accompanied by 3D models, which, although less geometrically and dimensionally reliable, made it possible for artefacts to be visualised in real-time through graphics engines such as Unity (Unity Technologies).

Conclusions

Documenting the built heritage in an urban context with the purpose of studying the processes which, over time, have guided the transformations of the layout, as well as of the fabric and building types of a settlement, is an operation which, although considered to be essential, has become mostly relegated to an end in itself.

The principle of hic et nunc, which characterises the modus operandi of contemporary society, increasingly encourages even professionals in the sector to plan future interventions without due regard for the lessons of the past, to which the present is undoubtedly indebted.



Dense cloud of the *Viejo de la Mola* Mill in Formentera, Spain *(Agoisoft Metashape, credits: CHM_Lab).*

Heritage conservation and protection must, therefore, be based on the analysis of the historical processes that have generated and conditioned it to this day, as well as on the study of its actual state, so that it may be possible to intervene with the awareness necessary for both preserving it an handing it down to future generations.

The more information is available, the more possibilities there will be to suggest a range of valid solutions from which to select the one that better satisfies the preservation requirements, as well as those, equally legitimate, that regard the need for adaptation, and therefore change, in order to ensure the use and enjoyment of the assets, in the firm belief that a use compatible with the asset's "vocations of use" constitutes the best formula for its preservation (Germani, 2021).

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The publication presents the results of the project 'Versus-Heritage for People', funded by the Creative Europe EU programme. The main aim of the project was to actively involve a broad audience and raise awareness among it concerning the value of vernacular knowledge in shaping more sustainable and resilient models of development. The material and immaterial elements constituting a vernacular heritage (encompassing local materials, construction methods, models for living and social interaction, technical and environmental knowledge for the management of territories, natural resources, settlements, etc.) have enormous potential for generating forward-thinking models that can improve the environmental and social quality of our habitats, foster a sense of identity and belonging, and relate in a balanced way to the capacities of our planet. The book explores strategies and tools for managing and transmitting knowledge and the values associated with vernacular heritage. It includes concrete examples and good practices for engaging people in processes of knowledge and the enhancement of vernacular heritage values for sustainability. The outcome is the result of the collaborative efforts between the five academic institutions involved in the project – Universitat Politècnica de València as coordinator (ES), University of Florence (IT), University of Cagliari (IT), CRAterre-ENSAG (FR) and Escola Superior Gallaecia at Universidade Portucalense (PT). A total of 63 authors, comprising both external scholars and professionals, contributed to the book.

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