Digital technologies for neglected spaces preservation

The church of Santa Lucia Novella

Sofia SAPUCCI, Dipartimento di Architettura, University of Florence, Italy
Ylenia RICCI, Dipartimento di Architettura, University of Florence, Italy
Andrea PASQUALI, Dipartimento di Architettura, University of Florence, Italy

Contextualization of the artifact

Neglected spaces consist of that multiplicity of sites marked by ancient structures with potential artistic value, left completely at the disposal of weather, carelessness and degradation. The architectures have always been subject to the action of time, changing needs and tastes, have remained silently to observe the transformations, transforming themselves as well, and this is enough to secure the right of memory and future. The church of Santa Lucia Novella, also known as San Domenico, represents a valuable heritage both in its structures and in the valuable series of frescoes inside, which are now at risk due to the earthquakes that occurred between August 2016 and January 2017 in central Italy.

The church of Santa Lucia Novella is located in Fabriano, in the province of Ancona, a town situated among the picturesque valleys of the central Apennines, and is crossed by the Giano torrent, a key element in the development of the settlement, which dates back to the sixth century AD. Fabriano was marked by a lively cultural season between the 13th and 14th centuries, where multiple personalities met, such as that of Allegretto Nuzi, author of the frescos present in the church of Santa Lucia Novella.

The church of Santa Lucia came into being following a series of events that began in the mid-12th century, with the foundation of a rural church dedicated to the saint by Benedictine monks stationed outside the walls. Between 1220 and 1240 the inhabitants of the countryside decided to move inside the walls, and shortly afterwards the monks also decided to relocate their settlement. During the last decades of the 1300s the order of Dominican preaching friars settled in Fabriano, where they built their own convent and church. In 1300 a legate of the Pope handed over the properties of Santa Lucia Vetere to the Dominican friars, with the intention of promoting the order's settlement and expansion. In the mid-14th century, the Dominicans carried out major additions to

their primitive complex, assigning it the new name of Santa Lucia Novella to support popular devotion.

The most important interventions carried out between 1363 and 1365 involved major structural changes, resulting in a structure with clear Gothic forms, still visible today in the triangular brick decorations above the blind arches, which follow one another modularly over the body of the apse up to the northwest side wall. This is where the ancient splayed entrance portal and the rose window above it are plugged. To the same period belongs the construction of the sacristy and the two chapels located on either side of the altar. In 1741 Fabriano was hit by a violent earthquake that resulted in the need to make interventions to the structures, erasing the earlier Gothic forms in favor of new 18th-century forms still visible today inside the church.

From survey campaign to digital twin

Laser scanner surveying

The survey campaign took a total of three days, and first covered the exterior of the church of Santa Lucia Novella, and then the interior rooms. The survey was carried out with Z+F Imager 5016 phase variation 3D laser unit, and Cam 2 Focus 70S phase variation 3D laser scanner unit. A total of 157 scans were made, 67 of which were taken with a photographic shot for the projection of point cloud colors, while the remaining clouds were kept in reflectance values, a particular color scale of grays derived from the amount of light signal reflected from the measured material. The church has a main hall divided into several barrel-vaulted bays, flanked by a row of chapels on each side; on either side of the altar are two chapels covered by ribbed cross vaults, which were originally intended to be in the same shape and size. Today the chapel to the right of the altar is in a better state of preservation, with a fresco series painted by Allegretto Nuzi on three of the walls. The chapel to the left of the altar presents a division into three distinct rooms due to multiple remodeling. A further significant room is that of the sacristy, divided into two cross-vaulted bays, entirely frescoed by Nuzie his atelier.

Digital photogrammetry

Fifteen hundred and fifty-nine photogrammetry shots were taken involving the Chapel of St. Ursula, the Chiavelli Chapel and the sacristy, rooms where cycles of frescoes or fragments of them can still be seen. The shots were taken with Fujifilm GFX-50s medium-format digital camera with a resolution of 50 megapixels, operating both freehand and with a camera on a tripod. The high-quality textures produced by processing the photographic data enabled a more accurate study of individual sacred history scenes, and specific cutouts of the same scenes were used for multimedia purposes in the VR environment.

**The "digital twin" for the study of shapes and works of art**

The combination of the metric data acquired through the scans, and the material data, acquired through the photographic shots allowed the creation of a digital twin of the same artifact. The use of Autodesk Recap and Capturing Reality software enabled the most accurate study of the structures and individual scenes represented. The cycle of sacred history, as well as the remaining fragments of scenes created by minor artists within the Chiavelli Chapel, have a close relationship with the space in which they are inserted, expanding and enhancing it. They date back to the second half of the 14th century and were rediscovered under 18th-century drabness only in the 20th century. Today, technology allows us to digitize cultural heritage, creating a database of information that is essential for the purposes of preservation, enhancement, as well as the most detailed study.

Virtual tour of the church of Santa Lucia Novella

The use of digital applications has made possible the creation of a virtual tour, which allows a new accessibility of the asset, the church of Santa Lucia Novella, today inaccessible due to past seismic events. The virtual tour returns the object and the works contained within it in their actual proportional relationships, without specific modifications or reconstructions. The construction of the interface was structured on the Garden Gnome Pano2Vr software, which allowed the union of the panoramic shots taken during the same survey campaign through the Insta360 Pro II camera. On this occasion, the presence of a wooden staircase was verified, which dominates the space of the chapel of St. Ursula, causing the overall view, reading and interpretation of the fresco cycle to be irretrievably lost. The chapel a cornu Epistolae because of the remodeling is accessible through a steep wooden staircase, and has dimly lit rooms making it difficult to grasp what remains of the fragments of wall paintings present today. The virtual tour becomes an opportunity for exploration, it allows to use tools that are not innovative as such, but how much more in the purpose pursued. The visitor (user in virtual mode) has the possibility to freely explore the space, easily navigate each compartment, having the opportunity to access additional content that provides an in-depth study of the artifact itself and individual scenes. It is possible here to grasp the close connection between structures and works of art through the simple use of personal devices.

Augmented reality for tangible experience of saint Ursula's chapel

The last phase of the research resulted in the optimization of the textured digital twin, from which it was possible to reconstruct one of the rooms inside the church of Santa Lucia Novella, the Chapel of St. Ursula. Errors generated in the mesh processing phase were fixed through the 3D System Geomagic 2013 software where defects were removed. The physical model consists of a cross vault with ribs made of PLA, a biodegradable plastic obtained from corn protein, which took a total of 25 hours of 3D printing, while the walls that make up the compartment were made of white Plexiglas processed with the laser cutting technique. The results obtained allowed the close connection between the space and the artworks to be explored in depth, the fresco cycle spanning the three walls. The proposed research offers an enhanced experience of the real, where the user has the opportunity to widen their sensory experience through new digitally conveyed content (Fig.1).

a   b
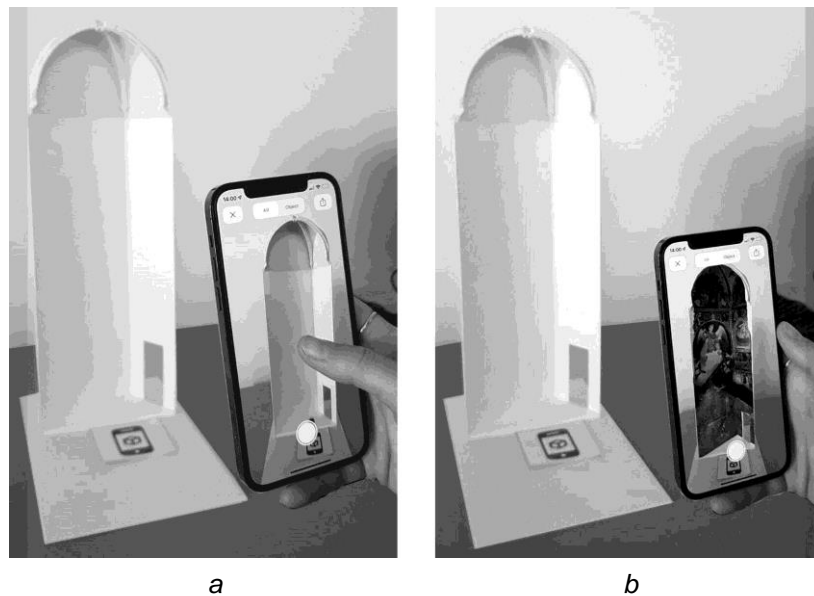
Fig. 1. Reality overlay a) before the target recognition; b) after the target recognition;

The creation of a reality overlayer recreates the suggestion of this space, attesting to the state of the art, as well as the need to accentuate awareness of the issue. The augmented reality experience was structured through ARkit software and the extensions within it, Reality Composer and Reality Converter, which allow the creation of a beta application accessible from a personal device. The new content enriches reality and offers the user the perception of the materiality of these works, of their being an integral part of a place.

Conclusion

The church of Santa Lucia Novella represented an important challenge in the use of new technologies applied in the field of cultural heritage. Digital applications and devices have made it possible to highlight how fragile and changing the Italian cultural heritage is, and how much it needs urgent interventions, directed not only to conservation and restoration but indirect interventions aimed at raising awareness of the issue. The possibility of creating new content in terms of virtual reality and augmented reality makes it possible to preserve the memory of what remains today, enhancing the forms and improving the communication of the values embodied. The ease of accessing and navigating this content freely makes it desirable to disseminate it to an ever-widening audience, as well as to use it as a powerful tool for educational and scholarly purposes. Our contemporariness teaches us how digital media allow for the breaking down of distances, and how these when used in a greater variety of ways point to a wide range of users, who enjoy them from informational purposes to cultural and educational insights.

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Author Contributions

Conceptualization: <Giorgio Verdiani, Andrea De Marchi>

Data curation: <Sofia Sapucci, Ylenia Ricci, Andrea Pasquali, Alexia Charalmbous>

Funding acquisition: <Giorgio Verdiani>

Investigation: <Giorgio Verdiani, Margherita Soldaini, Sofia Sapucci, Alexia Charalmbous>

Methodology: <Giorgio Verdiani, Giulia Spina, Ylenia Ricci, Andrea Pasquali>

Software: <Sofia Sapucci, Ylenia Ricci, Andrea Pasquali>

Validation: <Giorgio Verdiani>

Visualization: <Sofia Sapucci, Ylenia Ricci>

Writing – original draft: <Ylenia Ricci, Sofia Sapucci, Andrea Pasquali>

Writing – review & editing: <Ylenia Ricci, Sofia Sapucci, Andrea Pasquali>