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Research Article

Giorgio Verdiani*, Alexia Charalambous, and Federica Corsini

Reconstructing the Past, Enhancing the Traces from Frescos

The Case of the St. Venanzio Cathedral in Fabriano, Italy

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Abstract: Architectures are always subject to transformation in time. When a historical building is seen by a tourist or by an occasional visitor, it appears like a complete and final artefact, showing its main characteristics like a clear example of a style or of an artistic phase. This interpretation may turn out to be mostly a simplification, while the building is often the result of a large set of interventions in time. It is the case of a large number of main and secondary architectures, changed according to the mutation of needs and tastes. In Fabriano, in central-eastern Italy, the St. Venanzio Church (later Cathedral) was subject to a significant transformation of the apse interiors during the XVII century, with the demolition of the original chapels' asset and their replacement by a larger unitarian space behind the main altar.

This intervention has afflicted all the frescos that were the decoration of those chapels, they were partially deleted by the new masonry works, covered by paint, or walled in the new shape of the church. Since its early discovery, this patrimony has received various restorations. The research for a virtual reconstruction was based on a detailed digital survey of the building.

Keywords: Allegretto Nuzi, Virtual Reconstruction, Virtual Restoration, Virtual Tour, Digital Survey

ACM CCS: Human-centered computing → Human computer interaction (HCI) → Interaction devices → Touch screens, Information systems → Information systems applications → Multimedia information systems → Multimedia content creation

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1 Introduction

The creation of a virtual tour inside the past aspect of the architecture needs solid bases and knowledge to be correctly defined. The present technologies allow the development of efficient and fascinating digital models: they can be both a digital representation of the state of fact, like a model resuming all the traces and evidence of a past condition of the building, but they may be also more theoretical, based on the interpretation and interpolation between existing elements, and their matching with specific knowledge and personal ideas/deductions. A virtual model based on evidence and deductions is a model building element based on the existing traces and developing a complete, or partial, hypothesis about a previous state.

The creation of a trustable base is then fundamental and can be well supported by an accurate digital survey. From such a detailed and sharp base all the remains from the past condition of the building can be used as a base for creating detailed virtual reconstructions, a perfect procedure to open the way to dissemination and sharing with the most various users of complex contents; but also a significant occasion for the scholars to verify their theories in specific virtualization of the imagined space "as it was" before any further transformation.

The approach needs procedures and systematic organization of the research/production, while the first will be the source of all the certainty, innovations, deductions moving to the following steps. In the case of the St. Venanzio Cathedral in Fabriano, the presence of clear evidence, like the remains of the medieval frescos and various fragments of walls and architectural details allowed to compose a reasonable hypothesis about the original setup of this building.

In the Fabriano Cathedral, dedicated to St. Venanzio, the transformations of the apses, brought to the demolition of the previous radial layout, based on a series of six chapels enriched by frescoes by Allegretto Nuzi (about 1370) [12], with some parts of extremely high quality and artistry, like the figure of St. Mary [5], and by Maestro di Staffolo, Giovanni di Corraduccio and other authors

(XV–XVI centuries) [10]. This original Gothic space received its replacement on the base of a new layout defined by Muzio Oddi in 1607, introducing a larger unitarian space behind the main altar.

This intervention has afflicted all the frescoes that were the decoration of those chapels, they were partially deleted by the new masonry works, covered by paint or walled in the new shape of the church, only four of the original chapels remained, the two in the deeper part of the apses were completely destroyed. In the XXth century, these artworks were rediscovered, and even if in some cases they were in very poor conditions, since the early interventions, the various restorations allowed to bring back extended parts even if in fragmented conditions, the restorations recovered all the parts still existing and protected them from further damages. Starting from this evident presence, the resulting concept for the virtual reconstruction was based on accurate reasoning, interpolating between all the traces, it was then in need to be matched with a well-detailed survey of the whole architecture. In this specific case, with the need about having complete and detailed documentation of the building and of the damaged frescoes, an intervention based on lasergrammetry and photogrammetry was planned as the first step for creating a proper base for any further analysis and virtual reconstruction.

2 Digital Survey

To create a reliable digital twin of the area under study, a specific digital survey was operated in June 2020 and then completed in February 2021. The pandemic situation influenced the possibility of operating in a faster way, creating various delays in the survey and reconstruction operations. The survey operations of the architecture were carried out with the 3D laser scanner unit Z+F 5016, the photogrammetric shots were taken with a digital medium format camera, a Fujifilm GFX-50s with a resolution of 50 Megapixel with the use of a Fiujnon 32–64 mm F4 zoom lens and a medium format sensor of 44×33 mm (therefore, with a surface of 1.68 times more than the professional full-frame format with consequent improvements in the final image quality).

Panoramic VR shots were taken with an Insta360 Pro II camera at 8 K resolution. It has six F2.4 fisheye lenses with six microSD plus one full SD memory support (here equipped with six 256 Gb and one 512 Gb fast memories). The available exposure modes are: Auto, Manual, Custom, Shutter priority (with photographs only), Iso Priority (with photographs only), with the ISO value that can range from 100 to 6400 and keeping an acceptable noise level up to 800 iso sensitivity. Insta360Pro2 automatically processes each photo taken by the 6×200 ° fish-eye lens and stitches it to single image at the resolution of 7680×7680 pixels.

This device can also be used by an app on a smartphone called Insta 360 Pro II. It allows complete autonomy in such distance to avoid photographing and filming the operators.

The first session of photogrammetry surveys and the whole lasergrammetry was operated in June 2020, the VR shooting, and the second session of photogrammetry were operated in February 2021. The general structure of this documentation was based on well-consolidated procedures, similar to many other case studies [4] and trying to exploit at their best all the tools in use, optimizing their performance according to the effective architecture context.

2.1 Lasergrammetry

The survey of the cathedral was done in two days in June 2020, documenting all the exterior walls of the apse and all the elevations and inner space of that part of the cathedral. Particular attention was paid to the traces of old masonry and to the older parts of the building. So the scanner unit was moved following the helix staircase and in the isolated spaces in between the walls of the apse and in all the accessible spaces beneath the roof.

All the scans have been operated using a Zoller+Fröllich 5016 phase-shift 3D laser scanner unit (Figure 1), capable of an accuracy of two millimetres on normal reflective surfaces at a distance of 10 metres. The scanning range of the Z+F 5016 is 180 metres, more than enough for all the practical situations in the St. Venanzio Cathedral. This Scanner also offers a very good photographic feature, with the possibility of merging differently exposed shots and create High Dynamic Range (HDR) images to better remap with realistic colours the point cloud in any condition of light. Once more, the photographic camera of the scanner offers the integration of a led lighting system, making it easy to take excellent photos in very dark rooms and with an efficient calibration of the exposure at close and medium distances according to the size of the rooms.

The individual scans were then aligned using Autodesk Recap. This operation brought to the creation of a unique reference system for all the point clouds coming from the scanning operations. Once the alignment was done, a series of graphic elements were extracted in the form of orthographic bitmap images and CAD drawings.

Figure 1: 3D laser scanner survey (June 2020).

The aligned point cloud model was largely used by the research team to "visit" the cathedral during all the research phases, especially when the lockdown periods caused by the pandemic were limiting the mobility of everyone. Autodesk Recap in this was extremely practical and confirmed itself for being well-suitable for multidisciplinary teams. The possibility of having a double visual solution was very appreciable. The perspective view of the aligned point clouds worked perfectly to allow fast navigation in the model, the use of orthographic views helped in checking alignments of elements like walls, vaults and roofs exploring the "natural" transparency of the point clouds. The possibility to enter at any moment the panoramic view of the scan station helped in better visualizing the architectural space and operate virtual surveyor tasks, taking measurements directly in the point cloud, and better fix and check ideas. The reasonable efficiency of this software even when used online in "screen sharing" operations turned for the best in all the virtual meetings organized by the research team, a smart and clear reference that helped all the steps during the digital reconstruction process. For the creation of complex parts of the building digital twin, some specific procedures allowed to produce accurate models directly out of the point cloud. For example, the reconstruction of the outer tabernacle, a quite well-preserved part in front of its original state. It was done exporting from Autodesk Recap Pro the part of interest, saving it as a unified point cloud with a significant resampling of all the gathered points. The file was then reopened and exported in Autodesk Recap Pro in PTS file format. Afterwards, the file was imported into 3D Systems Geomagic Design. In this software, the polygonal mesh was automatically created, checked, cleaned, and edited closing all the remaining holes. Finally, the resulting model was combined with all the other parts created using more basic procedures, using classic sections and guidelines for creating the 3D model of the past aspect of the cathedral element by element.

2.2 Photogrammetry

The photogrammetry work was done in two steps: a first try based on single shots, about one for each "plan" of the frescos, taken in high resolution followed by using a process of rectification. This first solution revealed some limits, the extremely narrow space of some chapels (like the one dedicated to St. Lawrence and in the Chapel of St. John the Evangelist) (Figure 2) and the significant deformation of the plaster, acted against the definition of good results for various parts of the artworks, especially for those realized in the higher parts of the chapel.

A second intervention was planned in November 2020 (then postponed to February 2021 because of the new lockdown caused by the pandemic event), this second shooting session adopted the SfM/IM photogrammetry procedure to create a textured 3D model and then extracting the orthophotos of each plane of the frescos. The main issue connected to the production of high-quality orthophotos was the small size of the spaces in front of their height.

The elaboration of the first photogrammetric campaign started with the editing of the photos, straightening them geometrically accordingly to the 3D laser scanner survey. This was done using Autodesk Autocad with the Autodesk Raster Design plug-in software (Figure 3, Figure 4) and then using Adobe Photoshop for calibrating colours and minor defects. This method though was not satisfactory since the specific morphology of some surfaces combined with the restricted spaces caused deforma-

Figure 2: The small spaces of the remains of the chapels required the use of a wide-angle lens and the support of a couple of studio flash units to allow a homogeneous light condition.

Figure 3: Image post-processing in the first photogrammetry attempt: rectification of a single shot over the point cloud.

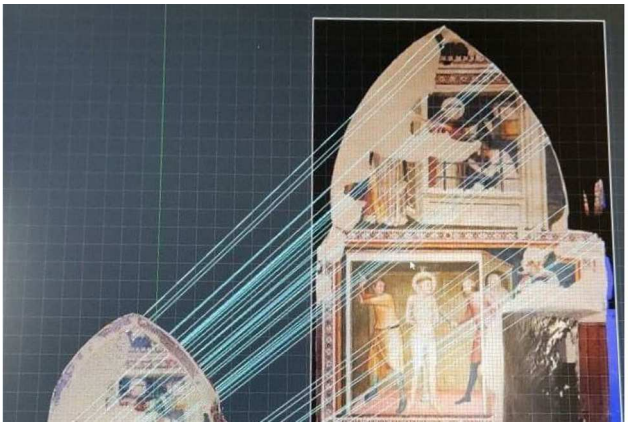

Figure 4: Image processing in Autodesk Raster Design: the orthophoto is corrected in its geometry according to the point cloud dataset.

tions in some of the photos, making them very difficult and poorly trustable to be elaborated appropriately.

From this the need of planning a new photogrammetry intervention to be for all the remains of the frescoes.

For this second survey, the photogrammetry processing was done using Reality Capture software. In this way, a high-resolution prospect of each main plan of the painted walls was produced.

The orthophotos were obtained mainly by using Reality Capture and in some cases (when the result was giving some doubts in terms of quality) by Agisoft Metashape. In this way, the second solution created an alternative to be compared with the less successful results from the other software. The following step was the editing in Autodesk Autocad/Raster Design for the geometrical refining on the point cloud data. Each front was then associated with its part in the point cloud, aligned and defined by a specific reference system (UCS). The procedure of alignment between photographic data and following elaboration was time-consuming but allowed a further speed-up of any following procedure which came out much faster and easier.

The resulting high-quality textures from the photogrammetric processing and post-processing were then exported in their full resolution as TIFF files and used as bases for studying and reconstructing the missing parts.

The same images were also used to produce specific crops for multimedia purposes, allowing the virtual visitor to see details otherwise difficult to be noticed in such narrow spaces.

Finally, the mosaic of all the orthophotos, aligned one near the other, presenting a whole set of frescos "unfolded" from the architectural spaces, simplified the reading of the "story" told through images.

3 Digital Reconstruction

The use of digital technologies in Cultural Heritage has a specific area in the relationship between Virtual Realities and frescoes. This type of representation used in the treatment of the walls is closely related to the architecture of the building. It expands and enriches the space, tells stories, displays artworks, and creates the perception of a completely different environment. In a way, frescoes and mural paintings are ancestor solutions to a virtual space created based on a real space. They are a kind of early mixed reality that uses the technologies of the time and produces extremely valuable works of art. Recently, frescoes have gained some attention in the field of digital interventions. The structure of these masterpieces that have arrived in our time offers two main interesting points:

1. The frescoes contain many details, figures, allegories and even writings and symbols. The uses of VR and AR can improve the visualization of these elements and allow the visitor a better and faster understanding of the content from his device or in his place.
2. The historical representations can involve two significant reconstructive challenges, one is the reconstruction of the original aspect of the artwork when it has been modified by events, and the other is the transfer of the dimension of the painting into a three-dimensional space, with the possibility of moving within the scenes and obtaining a new and different reading of this representation.

From these considerations, the main experiences made with frescoes and VR/AR can be summarized in three main categories:

1. Digital solutions that allow access to a virtual space that reproduces the architectural space and the works of art as they are. Without modifications or specific reconstructions. More or less complex virtual tours with the integration of notes, details and multimedia to enhance the possibility of understanding the fresco as it is in the present.

These kinds of intervention are the most common, while they can base their main structure on the existing situation, enhancing and stimulating the visitor with the option of seeing details otherwise difficult to notice, and promoting a detailed reading using textual and/or multimedia annotations. The use of automatic panorama cameras and the continuous enhancements in image capture and visualization has made it easier and easier to produce excellent results from this approach. Obviously, the starting point is having an accessible and "photogenic" subject, while all the difficulties in reading, accessibility limits and alterations may work against a good result based on this solution/strategy. This kind of solution may resolve with a good compromise the access to difficult spaces, like hypogean tombs with frescos [3] or spaces with safety issues or at risk of permanent damage [14].

2. Digital solutions that present a reconstruction of an earlier version of the fresco and/or its architectural space, a step back in time that requires a meaningful reconstruction. The end result can be similar to case 1, but all based on a hypothetical "as it was" with more or less defined decisions about the reconstructed parts.

In between previous experiences in this kind of application, the VR reconstruction of the Roman Frescoes from *Boscoreale* (Bergmann, 2010), with the detailed digital modelling of the Villa of *Publius Fannius Synistor*, defined a valuable series of choices in the strategy of representation for the lost part of the frescoes [2].

Years later, the "Pestum project" brought on by the Kessler Foundation has faced a case study about Etruscan tombs where the partially damaged frescoes have been virtually restored and presented in VR environments [11]. This is the case of the reconstruction of the St. Venanzio Cathedral as well. In general, a subject rich in possible cases, but rarely faced in a complete way by the research teams or single scholars. The need for articulated collaborations and studies sometimes may be a limit to the operations. The complexity of certain situations is then extremely difficult to solve, presenting complex and apparently impossible to complete puzzles.

3. Digital solutions that create a virtual space from the space of the fresco by recreating a visit between the people and/or architecture represented in the artwork. In most cases, this is a very "direct" operation that requires a deep understanding of the rules of representation of the painted space.

These are probably the most spectacular ones, but the "special effect" is often at risk of stealing the floor to real understanding, moving and altering to mere "characters" of some sort of comedy, the components of the representations altering the original perception defined by the artist into something new, but not necessarily correct. Some early experiences in this field were seen for the presentation of an animated exploration of the "Veduta della Catena" (a view of the Florentine downtown attributed to *Francesco di Lorenzo Rosselli* and realized in the period 1471–1482, and then reproduced by the *Petrini* brothers in the XVIII century), in this work by 3Dsign Studio, the paint

is transposed in 3D models and the point of view moves around while the representations of the buildings move around to recreate an urban scenario from the specific projection using in the original artwork, even if more than ten years old, even though the resulting video is more than ten years old, it is still quite effective in presenting this virtual visit to Florence in 1470 [6]. More complex works involving the mixed-use of VR and AR tried to enhance the perception of the archaeological and artistic values starting from ruins and remains of frescoes, like it is for the pioneeristic research on Pompei just fifteen years ago [13].

Once all the bases documenting the state of the church and the remains of the medieval artworks reached their completion, this set of images, 3D models and various drawings became the base for an accurate process of reconstruction. The process followed two main paths: the reconstruction of the architecture and the reconstruction of the frescos.

The use of digital modelling and the high quality of orthophotos turned out to be excellent solutions for checking in detail the various possibilities. The reconstruction of the church required particular attention to all the evidence and specific elements remaining from the previous asset. A methodical process and continuous debate were constantly brought on by the research group, defining and verifying the various options in shaping this specific image of the past. The general logic of the reconstruction started from the architectural part, it was extremely important to understand the evolution of the building and all its radical changes.

To support this process all the notes taken in place during the inspections and the ideas formulated in place and during the online meetings of the research team were organized to check the digital model. Isolating parts, verifying the alignments of remains, virtually removing more recent structures, like walls, horizontal elements and decorations. This process brought to a fragmentary, but extremely useful system of references. The strong changes that happened in the cathedral forced a robust level of imagination for defining the hypothesis of the original aspect, especially for the central part of the apses, where the transformation has completely deleted any trace of the original asset. In this case, reasoning about the "design logic" was important, with a specific reflection about the overall "shape" and its coherence with possible project choices from that time. At all the effects, the system of remains of the chapels, even if hardly compromised in the parts arrived in the present, is enough to define four of the chapels at the left and right side of the original construction. Extending the graphical plot of these chapels from the accurate digital survey to the "emptiness" of the

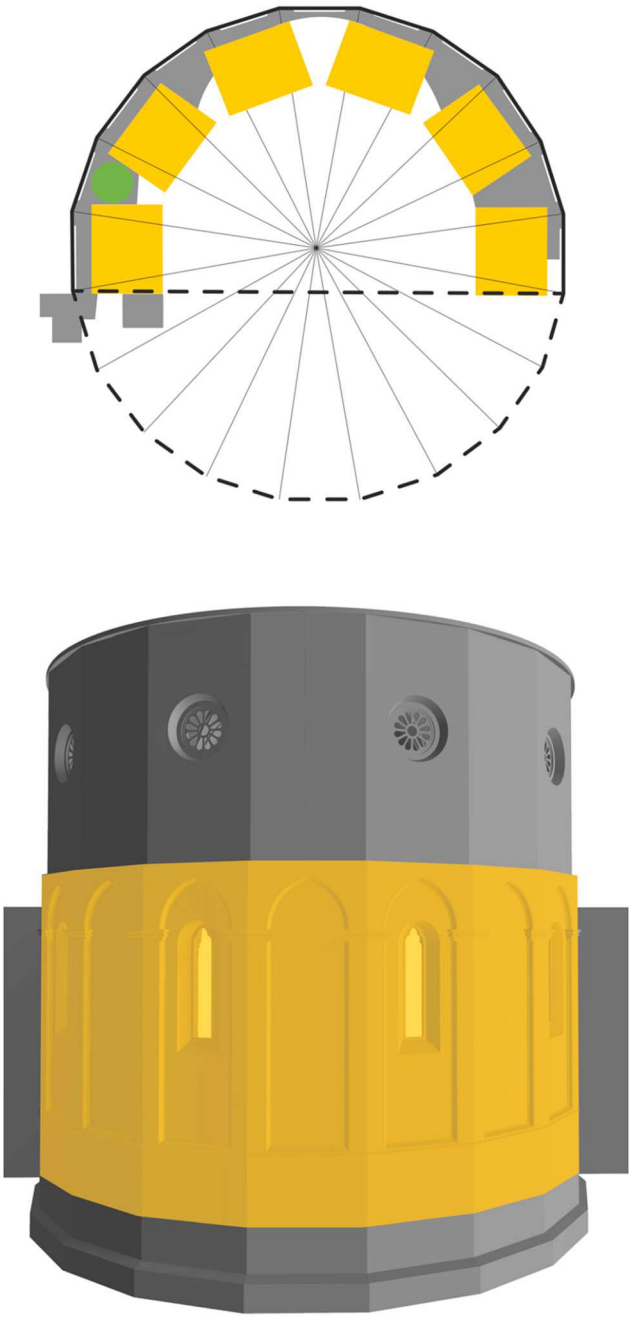

Figure 5: Virtual reconstruction of the apses in its original configuration.

demolished/replaced area, allowed the creation of an efficient system of guidelines driving the following virtual reconstruction by a realistic layout.

It was obvious that the central space of the tribune between the chapel of St. John the Evangelist and the chapel of St. Lawrence was not large enough to accommodate more than two chapels (Figure 5). The chapels of St. John the Evangelist and St. Lawrence, which were less structurally altered by the seventeenth-century renovations, al-

Figure 6: Early output from the photogrammetry session of February 2021, right front of the St. Lawrence's chapel with the frescoes by Allegretto Nuzi.

lowed the identification of a basic scheme that was used for the overall modelling of the six chapels. Each chapel is characterized by a cross-ribbed vault with a rectangular span and ogival semi-circular arches and diagonal semi-circular arches.

Above the vault of the Chapel of St. John the Evangelist, the second chapel on the left, there are still traces of a room with a cross vaulting, reached by a spiral staircase. From this cross-vaulted room, a narrow corridor leads to another narrow, small, partially vaulted room, in which a plinth is still preserved at the top left part of the ceiling, confirming the presence of another upper chapel, connected to, and adjoining the previous one.

The presence of these two interconnected rooms, both of which have remnants of similar cross vaults and perfectly match the vaults of the chapels below, has enabled us to establish with certainty that the Gothic tribune was supplemented by a functional upper gallery. This upper gallery was thus modelled above the six radial chapels previously described.

The main 3D modelling was developed using a "classic" solution: the main 3D model was created in Autodesk Autocad (exploiting the point cloud inside its working space together with tools for sharp drawing) and then in Autodesk 3D Studio Max (exploiting a versatile software capable to control texturing and modelling with extreme efficiency).

The study of the point cloud allowed the correct interpretation of the architectural organism and the identification of all those "clues" that were useful for the recomposition of the old Gothic structure, now barely recognisable due to the reconstructions of the XVIIth century. The point cloud was cut vertically and horizontally at different heights, applying several cutting planes at the most useful points to obtain the most important sections for the reconstruction.

The virtual exploration of the point cloud was extremely important to visualize the entire architectural complex and understand the structure of all its parts, even those that are difficult to access, such as the spaces in the subroof.

Near the extrados of the current vault was found the trace of the old roof, which was taken as a reference to define the slope of the roof slopes and the total height of the reconstructed apse, which is 17.5 meters above the floor of the radial chapels.

For the reconstruction of the frescos, the orthophotos were used as bases for the graphic definition of the missing parts.

This was done in full 2D mode, using Adobe Illustrator for tracing the wireframe completion of the missing parts

Figure 7: Final version of the wireframe representation of the virtual reconstruction, right front of the St. Lawrence's chapel with the frescoes by Allegretto Nuzi.

and Adobe Photoshop to edit, clone and integrate where needed the final representation. The process was divided into three phases. In the first phase, the painted parts were "trimmed" to eliminate virtually all missing parts and to create a unified background on which the scenes could be completed, if possible.

The second phase involved the reconstruction of figures in wireframes, architecture, and geometric patterns, provided there were enough elements and traces of painting to assume their completeness.

Finally, in the third phase, the geometric patterns, including faux marble decorations and mouldings, were integrated with backgrounds in undertone colours. The architectures and geometries were restored with a constant thickness of lines, while the figures were restored with modulated lines, alternating thin lines with thicker ones. The walls with the restored paintings were inserted into the model as textures. This way of processing the fragmented frescoes was operated by the research group on the basis of well-consolidated previous experiences on other artworks with similar conditions [1, 7, 8, 9].

All the reconstruction "approved" by the research team were then used as textures of the virtual model of the past cathedral and verified in this hypothetical space. The model, with all the texturing coming from the interpretation and interpolation of the fragments, was then used to produce the virtual environment for a specific visit to the St. Venanzio Church in the present and in the past.

4 Virtual Visit to the Cathedral

The artworks in the present cathedral have a difficult reading and interpretation, the visitors see interesting elements and recognize parts, but the sequence of the pictures is difficult to get, their fragmentation and partial deletion is truly a limit. At the same time passing directly from the present state to a full reconstruction may be tricky and impose the solution to the observer. For example, the story of the Martyrdom of St. Lawrence are developed in frescoes which develop along the walls of a narrow chapel, but it is intended to stay in a space with well-defined proportions, it is a "site-specific" work of art, if the space that contains it changes its fortune, the modification of the space brings damage similar to the loss of certain parts, making difficult to understand and read correctly the sequence of scenes.

To better help the interpretation from the users, it was preferred to have a reconstruction articulated in three steps: the present state (based on panoramic views taken

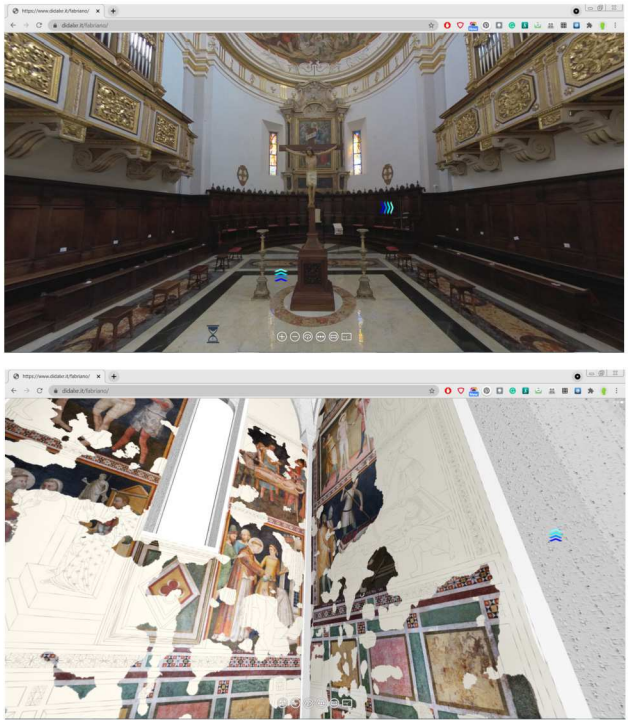

Figure 8: The virtual tour: two images from the visit between present and past (view of the intermediate reconstruction of the frescos).

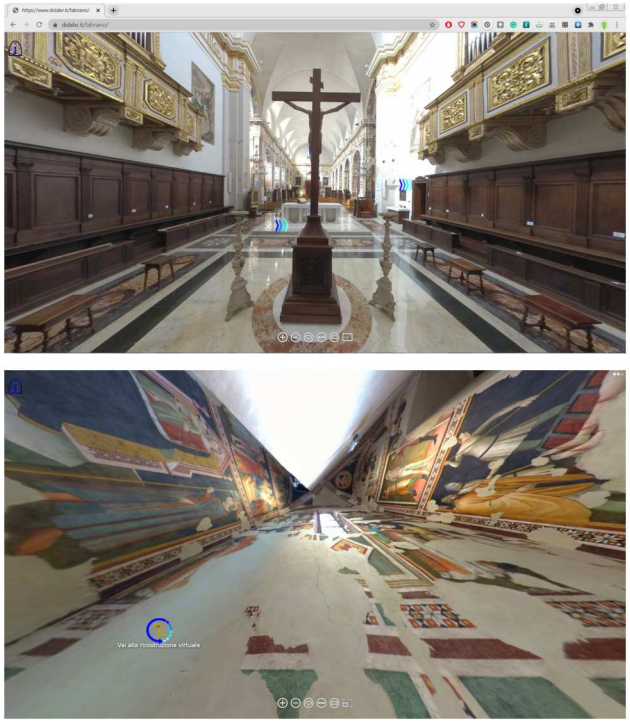

Figure 9: The virtual tour: two images from the visit to the present state of the Cathedral, in the lower image the "turn the hourglass back" icon indicates the access to a virtual reconstruction of the scene.

with an Insta360 Pro II camera at the resolution of 8 K.); a series of views of the cathedrals in its previous state, with all the reconstructed frescos completed using only wireframe lines (so to show clearly the process of completion and interpolation); a series of views of the cathedral in its previous state with all the reconstructed frescos presented with flat colours interpolated from the still existing parts (so to have a better perception of the original aspect, but having a sharp division between fragments and reconstruction). The definition of the solution for sharing and presenting the virtual "Tribuna Gotica di San Venanzio" was the object of an accurate reflection.

The option of a completely online solution was preferred above all the others while it makes simpler any update of the contents and allows immediate sharing with almost any device.

It was decided to structure everything on the basis of a virtual tour, starting from a very simple and easy to read instruction menu and then presenting the cathedral as it is today.

The menu presents the function of the buttons used to "move" between the present and the reconstruction of the past Cathedral. Each panorama view included in this virtual tour allows to consult extra contents and information, and most of them allow accessing the "time machine" to enter the "as it was" model.

All the construction of the interface and of the multimedia contents was done using Garden Gnome Pano2Vr 6.1 and then exporting the final virtual tour in HTML format.

The final version includes automatic detection of gyroscopes (for real-time change of the point of view orientation when using smartphones and tablets) and a switch button for passing to the stereo 3D mode for VR viewers like Oculus Rift/Quest and HTC Vive (or for simpler adapters based on the use of a smartphone). The variety of contents is structured in a free path left to the choice of the users, letting them decide how long they want to continue the virtual visit and how in detail they want to go in the exploration.

The virtual tour was enriched by hotspots and sensible areas giving access to enlargements, info panels, graphic schemes, short videos, and other contents aimed to integrate and enhance the quality of the experience (Figure 9 and Figure 10).

The virtual tour was presented on a specific website (available at www.didalxr.it/fabriano) to fit and work properly on smartphones/tablets, notebooks, or other devices.

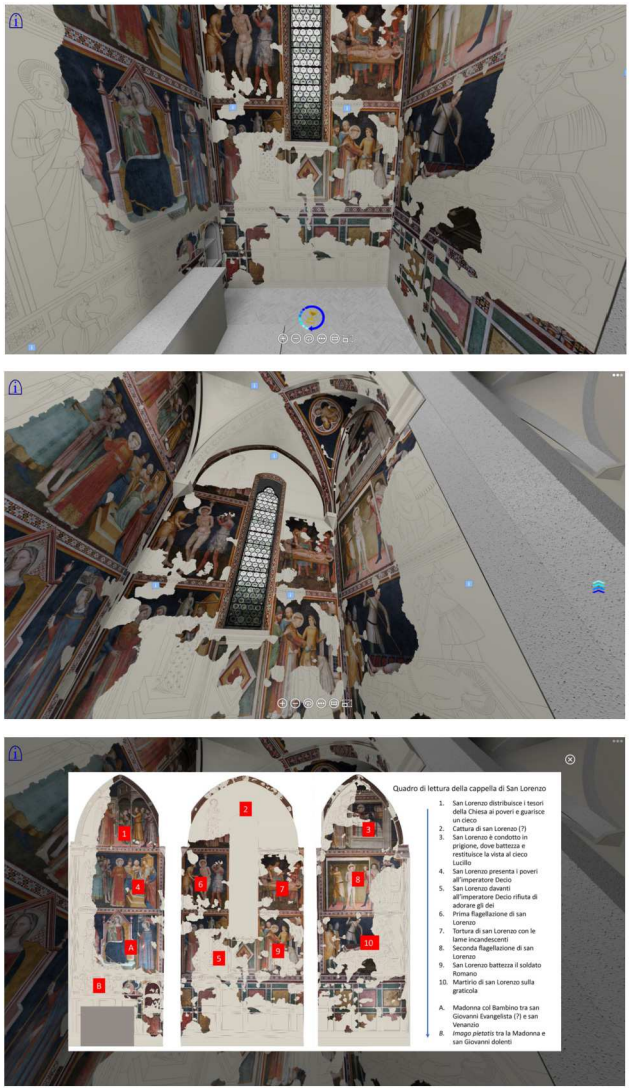

Figure 10: The virtual tour: two images from the visit to the virtual reconstruction of the Cathedral, the icons with the arrows up indicate the possibility of moving higher the viewpoint; in the lower image the access to the reading scheme of the whole Martyrdom of St. Lawrence in the frescoes by Allegretto Nuzi.

Figure 11: The touchscreen at the Art Gallery in Fabriano on the opening day of the specific space dedicated to the virtual reconstruction of the Frescoes from the Gothic Cathedral.

The same virtual environment was also optimized for using it in a large touch screen set up in the Art Gallery of Fabriano, just in front of the Saint Venanzio Cathedral. The touch screen set up in the Art Gallery is an 86 inches display by Philips (Signage Solutions line, model 86BDL3012T), connected to a PC and giving direct access to the online version of the virtual tour (Figure 11).

The positioning of the monitor was optimized to allow the easiest and practical access to the touch function to any kind of user, the main menus were placed in the lower part of the screen, and the height of the display for regulated with the centre of the monitor about 1,5 metres from the floor, thanks to the large size of the display and the gesture functions this makes easy to control the virtual tour effortlessly for any user, even in the case of children or people using a wheelchair.

The solution of the online access was preferred for the main reason of allowing a direct and fast update of the contents without any need for file transfers or moving to the Art Gallery in Fabriano for the updates. In a certain way,

the visit was created both in "site-specific" and in "global access" mode.

The freedom in the tour navigation allows full personalization of the visit at the mere risk of "losing something", thus the possibility of accessing the same contents at any time from a personal device creates three interesting situations: in this virtual tour, the cathedral can be explored as it appears today and displays both the reconstruction in its oldest appearance in wireframe format and with the geometric details coloured after the identification of traces of the frescoes. (Arrows) with these icons you can move between the various viewpoints of the virtual tour.

(Hourglass) these two icons allow to switch the view between the actual view (counterclockwise hourglass) and the virtual reconstruction (clockwise hourglass). Finally (i) these icons allowed us to insert and access additional information about the frescoes and the cathedral.

1. The user can access the contents before entering the cathedral and get prepared to a better understanding of the place during the real access. While in place, the option of loading again the virtual tour to support the visit can be a valuable contribution in terms of learning and understanding.
2. The user can access the contents after the visit or in alternative to the real visit, accessing spaces closed to the public for safety or practical reasons. The access in post or alternative may stimulate interest in the subject and have valuable importance for scholars or other people interested in the subject, but far from the place.
3. The contents may be used by a presenter to teach and instruct about the artworks and the place, using the full multimedia as needed to build an efficient and personalized visit.

During the development of the research, it was clear that the main focus was the reconstruction result, its scientific value and the accuracy of the adopted method with important spots on the interdisciplinary debate on evidence and deductions. But an eye was always kept on the "secondary" but "locally" fundamental aspect of the "site-specific" setup. In fact, having correct content is mandatory, but having it just online and demanding to personal devices from the visitors all its features was considered a limit to the full success of the operation. For this, it was defined the specific setup in Fabriano's Art Gallery, rich in interesting artworks from the age of the first cathedral and placed just in front of the cathedral. The large monitor, quite spectacular in size and general effect, gave "that touch" to capture visitors, pushing and promoting the value of the frescoes otherwise at risk of being neglected.

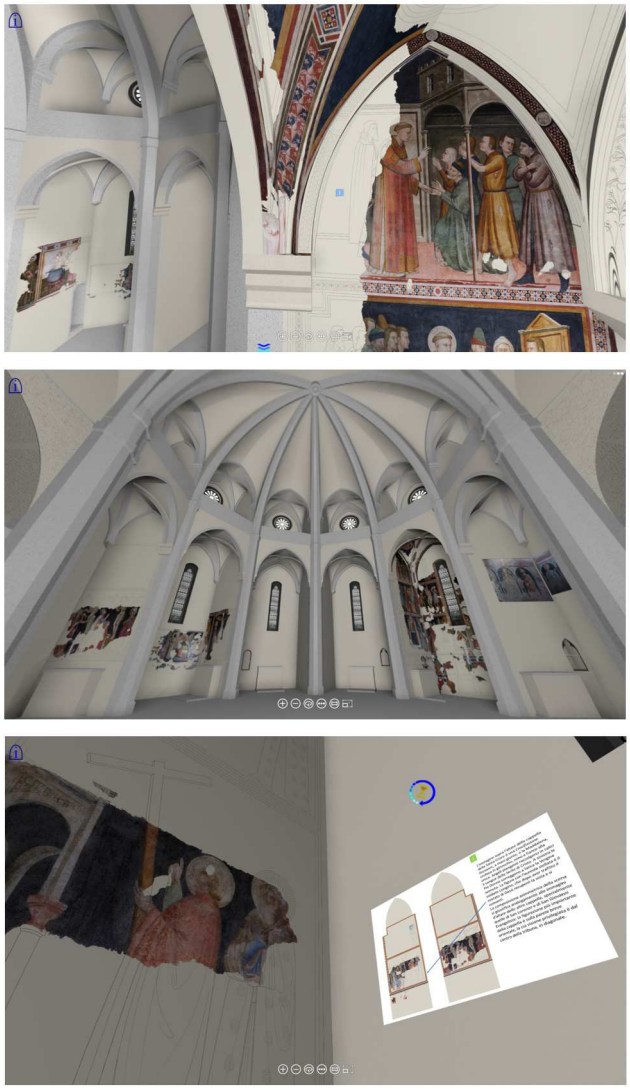

Figure 12: Other views from the virtual tour in the virtual reconstruction of the Gothic Cathedral; the lower image shows some animated panel inserted in the virtual environment to present detailed information about the artworks and indication about their reading sequence.

5 Conclusions

The small chapels of St. Venanzio, with their fragmented artworks of huge artistic and cultural value, represented a challenge for survey procedures and multimedia presentation. The work done to create a result with easy access features and proper communication qualities followed the logic of giving solutions while presenting procedures to the visitors, so that they may get not only the final result but also the main steps done in passing from the present state of this architecture to imaging its past condition. The logic of this passage is simple: a full virtual reconstruc-

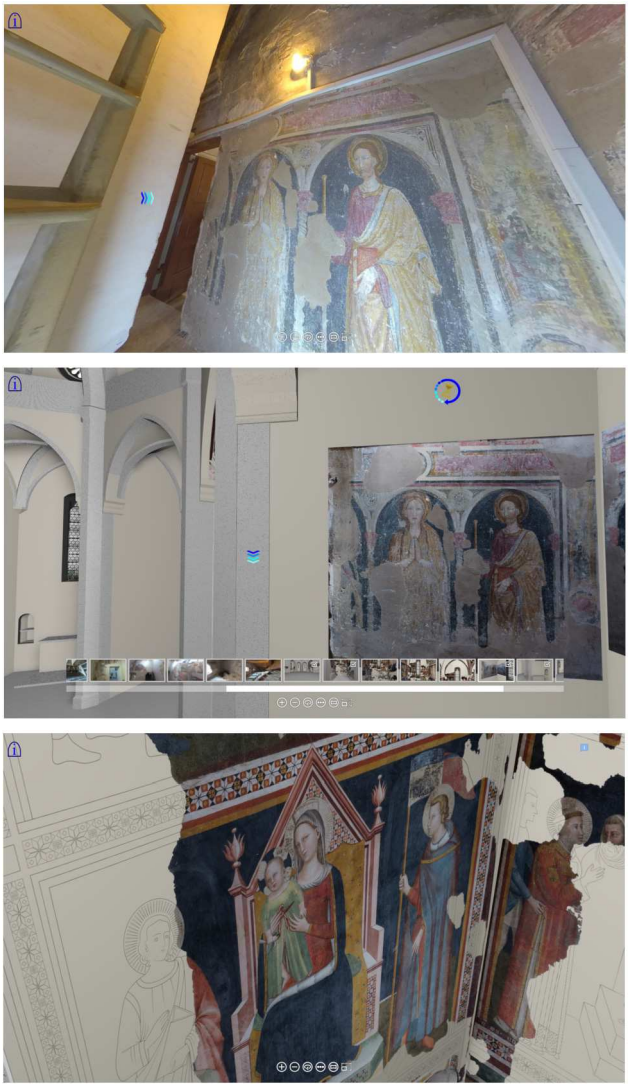

Figure 13: Other views from the virtual tour in the virtual reconstruction of the Gothic Cathedral; the top images show the present state of the Chapel dedicated to St. Magdalene, with the frescoes by Maestro di Staffolo and its virtual reconstruction.

tion, with all the details in place, with all the reconstructive elements done and presented in their final stage, can be nice, interesting, spectacular, but gives the same level of certainty to all the elements, creating the illusion that all that is now missing is clearly known and solved. But this thing is not.

At the same time, extremely appreciable "certainty maps" are extremely useful for scholars and should be mandatory in any real scientific study, but a multimedia presentation may result fascinating for limited public and from "too specialistic" to "boring" for all the others. Instead, leaving a step between the present state of the place and its reconstruction seems an efficient solution.

Something that may help a better understanding of how mutable and fragile the cultural patrimony is and at the same time how knowledge and digital strategies may help in preserving and enhancing the communication of the cultural heritage values. At the moment the full structure of this virtual visit is operative and online, but it can be considered as subject to new updates and refinements, some of them foreseen in a short time, following the feedback from other scholars and users.

In the "to do" list there is the enhancement of the visit to the "matroneo" (upper gallery) level, to help a better reading of the original architecture; the integration of some animated schemes showing the design pattern that probably guided the architectural layout and was followed during the virtual reconstruction process; the integration of the frescoes visualization with higher resolution imaging of the artworks (the quality right now is quite satisfactory, but keeping an eye on the next evolution of the visualization pass by higher resolutions too); creating an English version of the whole virtual tour (which thing was in the plans since the beginning, but suffered from a certain shortage of time in the last steps before the public presentation in Fabriano).

For all the participants to this research one of the main results from the St. Venanzio cathedral in Fabriano digital reconstruction is finding how interdisciplinary teams may work together in a real balance of competency and constructive balance and produce a result that is well-calibrated between scientific accuracy, "turning into spectacle" needs, dissemination aims and the creation of learning with quality. A point that is worth mentioning and worth being repeated.

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