# Re-construction and Virtual Fruition of a Fourteenth-Century Religious Building

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## Abstract

Old religious buildings in many urban centres often contain artistic treasures and perceptive enchantment. The latter trigger a journey of comprehension and involvement that users would be prompted to take if only the often precarious state of conservation and transformations in the architectural context did not prevent the broadening of the material environment, thereby precluding immersion in a spectacular, evocative space. The combination of several descriptive and communicative modes and a sensible use of the latest acquisition and digital elaboration technologies represent a fertile field of research and experimentation, especially as regards cultural heritage. In fact, they make it possible to generate images we could call "talking architectures"; these are images that visualise history and revive environments by creating temporally dynamic instruments that can critically manipulate data and develop tourist-immersive proposals. These tools include virtual and augmented reality; gesture-based interaction; localisation of multimedia devices and technologies; creation of itineraries combining real and virtual elements and turning fruition of a monument and all its decorative features into an active, engaging experience rather than a purely passive event. Within this methodological framework, the contribution illustrates the research conducted as part of the Workshop of Survey and Modelling (ReMLab) of the Department of Civil, Building and Environmental Engineering of the University of Naples. The study documents and virtually reconstructs the original spatial and artistic features of a rare fourteenth-century religious building—the Church of S. Maria dell'Incoronata—and what is left of its exquisite frescoes by the School of Giotto.

## 1 Introduction

Fresco is the most important pictorial technique used in wall paintings; after the thirteenth century, it was adopted extensively in Italy, especially in sacred buildings, to create extremely symbolic and spiritual, pseudo-perspective, polychrome images. Highly saturated colours without half-tones, with reference to the light and shadows generated on painted surfaces, bestow the expressive force of the "metaphysics of light" that characterised works by the School of Giotto in Angevin Naples where Giotto was active during the last years of his life and where he inspired numerous collaborators and followers. These works illustrate a faith that is logical construction, in which there is not necessarily a yearning to mystically identify the divinity, but dialectical clarity, inner control and adherence to everyday life always experienced as the expression of moral rigour.

Before perspective theories succeeded in producing absolutely rigorous and visually coherent images, several architectural representations with intuitive perspective connotations have been documented, for example in the Church of the Incoronata with its successful narrative of symbolic and allusive scenes. However, none of the frescoes (Figs. 1 and 2) that were present and conferred meaning and expressive importance to this space are still present on the wall surfaces of the Church. This superb architecture, built by Joanna I in the mid-thirteenth century presumably over the rooms of the Angevin court (Bernich 1904, p. 101), was later completed with the addition of a hospital. At present,

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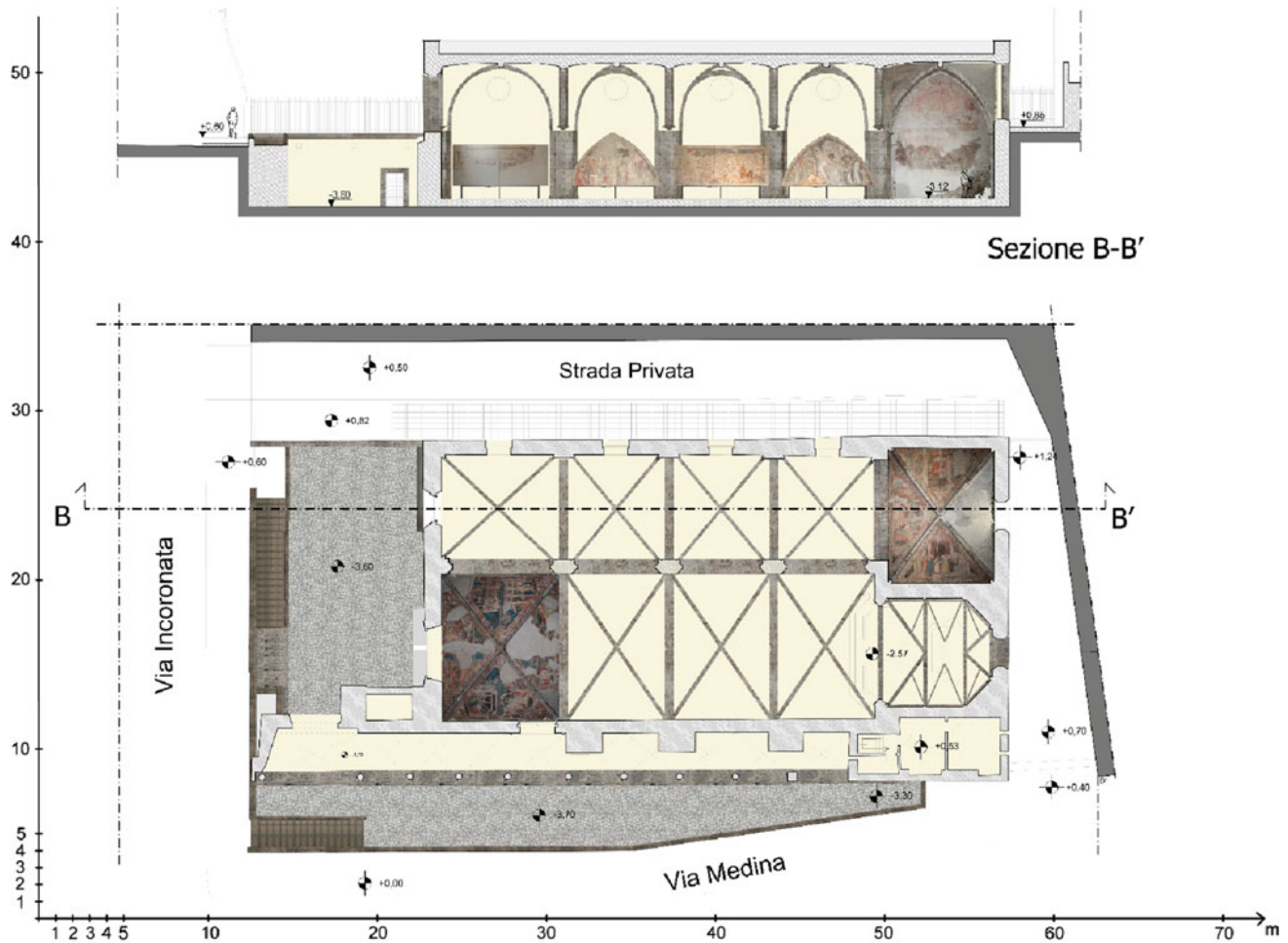A. Cerbone
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C. Gambardella et al. (eds.), *Advances in Utopian Studies and Sacred Architecture*,
Advances in Science, Technology & Innovation,

**Fig. 1** Church of the Incoronata: plan, with the projection of the vaults, and sections. The drawings show the current location of the remains of the decorative panels removed during restoration

the Church is used only temporarily (Papa and Antuono 2016, pp. 1529–1534).

### 1.1 The Cycle of Frescoes Between Liturgy and Iconographic Tradition

The objective of the study was to make the site accessible in compliance with architectural and conservative constraints; its first target was to develop ameliorative design solutions and strategies.

The combination of technological innovation and cultural heritage is undoubtedly the *focus* that inspired the idea of achieving broader fruition of an asset currently lacking most of its chromatic-figurative components. The digital model produced by a critique and interpretation of the object in question, coupled with its figurative–sensorial components, establishes virtual contact with the chromatic and symbolic importance of the fourteenth-century sacred space of the

Church. This process triggers communication with and knowledge of an asset which is now merely a closed container of the historical, architectural and artistic memory of the past.

Virtualisation and careful reinterpretation of archival and documentary material enabled the identification of most of the figurative–formal pieces and the order in which they were to be interpreted; it also led to their virtual fruition and full comprehension of the narrated episodes.

Obviously, any analysis of an artistic work must start with knowledge, in other words with an initial critical analysis of its history, as well as survey and measurement; these actions make it possible to draft the ensuing analytical documentation. Photogrammetric survey techniques were used to reconstruct the scenes and pictorial images; this enhanced comprehension of the complex relationship between real space, pictorial image, context and the artists' concept of space. It also facilitated a more complete iconographic interpretation since comprehension of the complex

**Fig. 2** Section showing the current location of the restored decorative panels
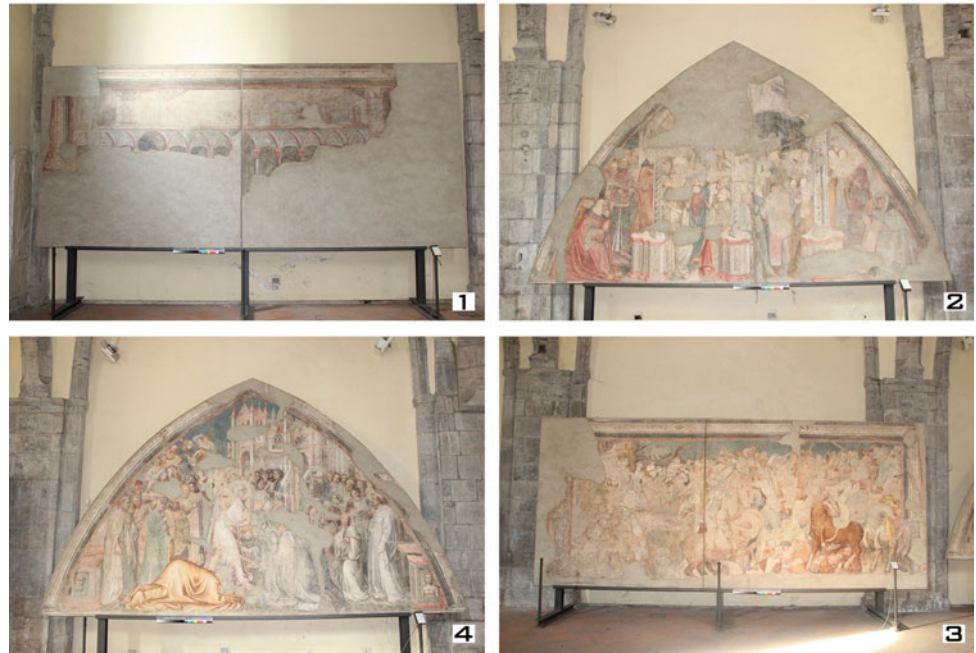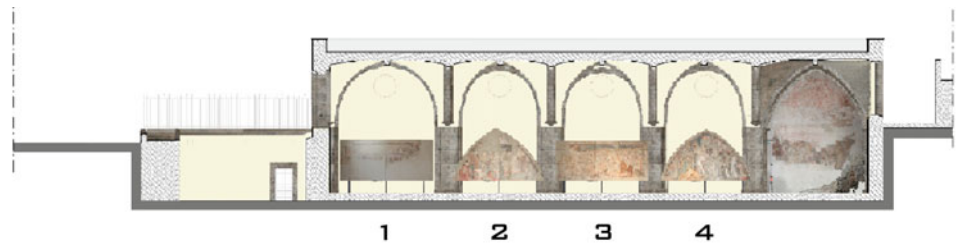


but extremely fragmented figurative scheme in the Church of the Incoronata does not facilitate contextualisation. In turn, what is still visible in the first span, next to the main entrance, was part of a much more extensive decorative scheme extending throughout the whole Church; this is evident in the traces of decoration in the adjacent vaults and was detected during the last restoration projects (Chierici 1930). Today, only the first span of the main nave (Fig. 3) and the last span of the side nave, the so-called Chapel of the Crucifix (Fig. 4), illustrates Christianity in fourteenth-century Naples.

Once past the entrance portal, the main theme of the frescoes is the "Triumph of the Seven Sacraments and Religion", the first known example of transposition of this theme in a monumental painting. Celebration of the "Sacraments" represents the most profound and ancient form of participation of the faithful in Christian rites: "Baptism" and "Confirmation", the sacraments of "initiation", are located in the panels above the main entrance where the biggest door is located: the Church entrance coincides with the beginning of the sacramental path. Baptism and Confirmation are followed by "Eucharist" and "Penance", the latter in the double form of auricular confession and

corporeal penitence, and the two so-called free or voluntary sacraments, Marriage and Holy Orders, because there is no absolute need for these sacraments (Longère 1975, p. 275) and, unlike the others, are administrated like those of "initiation", only once in a lifetime. The cycle ends with the "Anointing of the Sick" and the "Triumph of the Church": this latter scene, with the Ecclesia supporting the chalice, represents the beginning and end of the cycle.

There are no forms of dramatic concitation in each narration, just a calm definition of methods, a conscious combination inputting into the effectiveness of the composition of the scene. Every panel of the groin vault depicts a moment of the Church dispenser of sacraments: in "Baptism", the newborn is carried by three godfathers while the father holds the candle to the right; in "Confirmation" the child is instead accompanied by his mother, and in her arms is anointed on his forehead by the Bishop; in the "Eucharist", the faithful participates in the sacrament together with the communicants, kneeling with folded hands, who receive the host from the priest; in "Penance", there is a representation of three flagellants; in the "Marriage" scene, the numerous individuals in the procession accompany the bride and groom, undoubtedly of high birth given their elegant

**Fig. 3** Digital reconstruction of the first span of the main nave and its figurative images



**Fig. 4** Axonometric composition of the Chapel of the Crucifix with its figurative images. The sinopias became visible after removal of the frescoes, now positioned and exhibited along the side nave of the Church
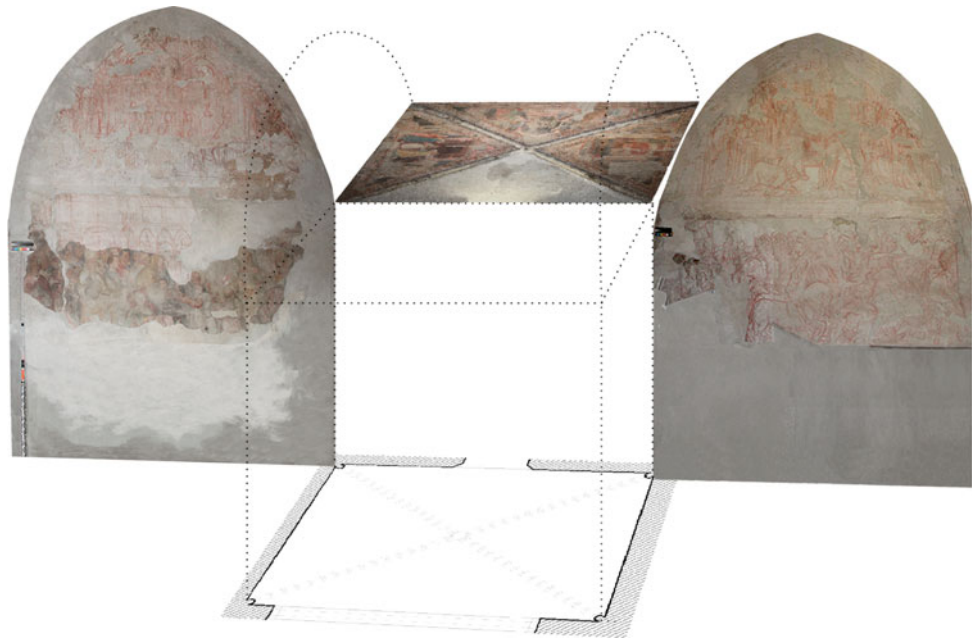


clothes and precious ornaments, earrings and elaborate headdresses; in "Holy Orders", all the orders are present in front of the pope; in the "Anointing of the sick", the sick person, who appears rigid and vaguely unconscious, is held up by a relative while the priest, next to his assistant holding a lighted candle, anoints his senses and a group of women pray around him.

In the "Sacraments``, the author Roberto da Oderisio, inspired by Giotto, but also influenced by the work of the School of Siena, inserts several iconographic solutions

typical of Giotto's figurative repertoire: the choir of the singing monks in the "Holy Orders" and excerpts from other contexts; the 'Washing of the newborn` in the Baptism, normally present in scenes of the Nativity; the confirmant child caressing his mother, reminiscent of Jesus' gesture towards the Madonna in several fourteenth-century panels. The theme of the "Sacraments" is the climax of a narration that continues downwards, with symbolic rather than narrative traits, and illustrates episodes of "Biblical Stories" which are however fragmented and have no coherent narrative theme.

There is one particularly complex element in the unitary interpretation of the cycle of frescoes in the Chapel of the Crucifix, executed by an artist from the Marche region known as the Master of Stories of Saint Ladislaus. In the early fifteenth century, the artist painted the "Stories of the Virgin" in the panels of the vault, the scenes of the "life of Saint Ladislaus" on the walls and the "entrustment of the hospital Church of the Crown of Thorns" to the Carthusians by Queen Joanna I (the religious complex formerly acted also as a hospital). Although very little of the original decoration is still in place, the fact that the themes and level of interpretation are quite complex is more than noticeable: one involves the fourteenth-century phase, the other concerns the next phase, the early fifteenth century. Two distinct but perfectly coherent phases interconnected by numerous cross-references successfully conveying the building's double role. The themes involve the Crown of Thorns, source of salvation for men, in line with what was then the role of the Church as well as a symbol bestowing holiness on the temporal queenship of its foundress.

The main portal—with its hunting and grape-gathering scenes, the Eucharistic lamb on one side and the crown of thorns held up by angels on the architrave—is a powerful conceptual synthesis of the Christian message represented in the unitary design of the decorations inside, the starting point for a path of initiation and education towards Christianity.

## 1.2 Image Acquisition Methodology and the Geometric-Perspective Analysis of an Utopian Reality

A research and knowledge-gathering strategy to support the configurative analysis of the pictorial images was necessary in order to provide a more in-depth critical assessment of the figurative and symbolic images in the sacred area of the Church. An initial documentary and archival research phase was followed by acquisition of the metric and photographic data required to develop a photogrammetric model that could accurately establish the spatial features of the areas in question.

A digital *Reflex Canon EOS 600D* camera with a *EFS 18-55mm* lens and a *Reflex K&F Concept TM324* tripod were used in the survey campaign. The instruments were chosen and used to obtain high resolution images of the flat and vaulted surfaces, including a special focus on the survey of the colours; in fact a *Kodak Grey Scale* and a *Kodak Colour Control Patches* were inserted in each frame to mitigate the dominant colours. The survey, also as regards the instruments used, concentrated in particular on the acquisition distance in order to ensure a superimposition of at least 60% of the ensuing frames. Dedicated software (Agisoft Photoscan) made it possible to create a digital model complete with photographic textures subsequently used to obtain post-modelling elaborations in support of the geometric-perspective analysis of the frescoed surfaces (Figs. 5 and 6).

Let us now focus on the cycle of frescoes in the Chapel of the Crucifix (Minieri 1845). Note the very precise geometric partition of the side walls. Each pictorial composition is divided in two superimposed registers with scenes in which the human element prevails over the architectural element. This complicates identification of reference elements indicative of an intuitive perspective; instead the very few geometric elements and the connotation and position of the figures provide food for thought. For example, in the story "Saint Ladislaus going to Church for the coronation" (Fig. 7), the only architectural elements that can help establish the perspective construction are the bases in the foreground, on either side of the scene and another pair of bases behind them. Analysing these elements reveals the use of a multifocal approach; the lines orthogonal to the picture plane establish the lower part of the base in the foreground and converge in a central vanishing point on the vertical axis of symmetry of the painting; all the other lines defining the upper part of the base, or the one behind it, reveal a construction with several vanishing points in the upper left part of the fresco.

This kind of perspective does not correspond to codified rules, but does make it possible to govern optical depth and thereby preserve the recognisability of the painted space and figures present, each with their own roles and meanings. It was impossible to consider the geometry of the lower part of the bases because they are partially hidden by the fake frame around the fresco. The artist perhaps intended to compose, organise and give visibility to the figures in the scene as well as confer depth on the architectural–figurative space.

The author prefigures an intuitive-symbolic perspective, less rigid than an arrangement with a single vanishing point and capable of nuancing the foreshortening in the pictorial sections furthest from the focal point of the scene. Furthermore, the final effect is probably also related to the way in which the fresco is viewed and interpreted; the scene was

**Fig. 5** Three-dimensional reconstruction of the current configuration (below) and original configuration (above) of the frescoes on the side walls of the Chapel of the Crucifix



**Fig. 6** Plan of the ceiling with rabattment of the side views of the Chapel of the Crucifix in the current configuration (**a** and **b**) and the virtual reconstruction (**a1** and **b1**)



originally painted on the side wall to the right of the entrance to the Chapel of the Crucifix: the author portrays most of the actors in a very forward position to the left of the scene, arranging them in a predetermined order on a virtual inclined plane. His intent was to ensure visibility when the scene was viewed from below and from the side.

Although the connotation and position of the figures convey simple messages, they reflect composition control techniques that make the episodes look as if they were designed as choreographies. The effect of depth and spatial dilation is also enhanced by the shrewd use of colours, brighter in the foreground and then gradually less brilliant.

Elements of geometric–compositional continuity are also present in the partition of "Saint Ladislaus venerating the crown of St. Stephen", part of "St. Ladislaus' battle against the Uzes" and in "Saint Ladislaus going to Church for the incoronation" that complete the pictorial cycle of the side walls of the Chapel of the Crucifix. While in the former, the scene is architecturally framed, and in the other two the perspective layout and narrative pathos are emphasised by the position and grouping of the figures as well as by the use of colour. Here again, the perspective construction appears to be linked to the perception of space vis-à-vis the observer's position and where he is located in the sacred space.

**Fig. 7** Geometric-perspective analysis, in relation to the fruition mode, of the frescoes "Saint Ladislaus' battle against the Uzes" and "Saint Ladislaus going to Church for the coronation" in the Chapel of the Crucifix
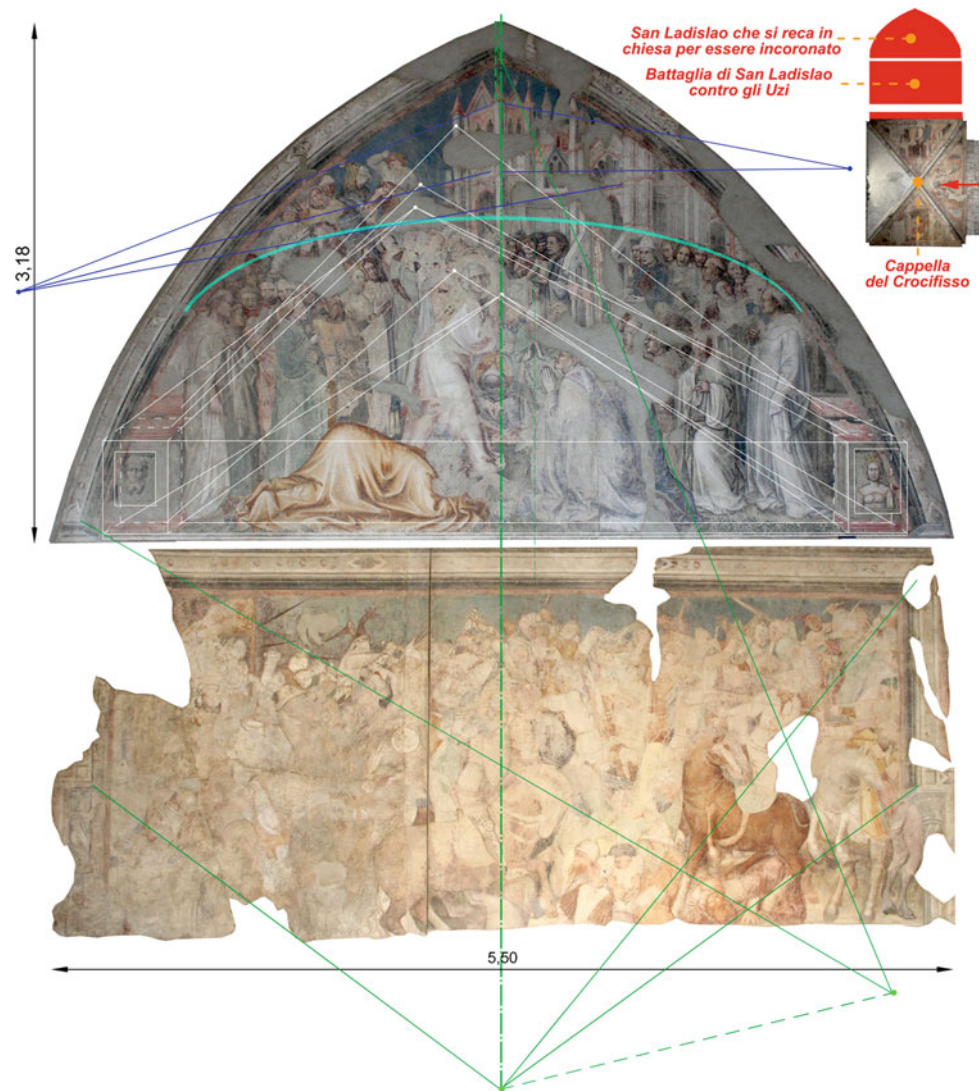


This figurative choice is adopted, in particular, in the fresco on the left side wall depicting the old portico of the Church along Via Medina which can be seen from the main nave and seems to almost emerge from the plane of the fresco.

The relationship between the pseudo-perspective representation and the observer's position is particularly obvious even in the frescoes in the first span next to the entrance portal. Every story, considered as a instrument of religious persuasion, is embellished by an iconic–symbolic component and is positioned so as to ensure maximum visibility and easy interpretation.

Only the fake frames link the pictorial cells to the built space; thanks to their shadows, these frames appear three dimensional and establish visual and stylistic continuity with the Chapel, just like the stories painted by Giotto for the Basilica in Assisi or the frescoes in the Scrovegni Chapel in Padua (Fig. 8).

In some ways, this elegant expedient implemented between 1403 and 1414 by the anonymous artist from the Marche region links pictorial and real space; it appears to figuratively preceed Alberti's definition of a painting considered as a "window from which the historia is seen" (Grayson 1980, p. 7). The pictorial surface is no longer a limit but becomes a filter/threshold between reality and virtuality (Feiner 2002), required to establish the optical/perceptive relationships that were soon to be scientifically established.

This sacred space contains an ensemble of images that should be interpreted one after another like the pages in a book, in other words they are structured in a perfectly logical sequence: the use of an intuitive perspective sustains the goal of the narrative hidden behind the iconic images alluding to an ideal religious space characteristic of fourteenth-century culture (Galante 1872).

**Fig. 8** Left "St. Francis in front of the Sultan (or Test of Fire)" the eleventh of the twenty-eight scenes in the cycle of frescoes in the Stories of St. Francis in the Upper Basilica in Assisi, attributed to Giotto; right, the compositions of the Triumphal Arch in the Scrovegni Chapel, with the following enlargements: "The Angel of the Annunciation", "Annunciation to Mary", "Judas' Betrayal" e "Visitation"

## 1.3 Augmented Reality, a Comprehension and Fruition Tool

Multimedia-interactive displays providing visual navigation of a digitally recreated simulated reality (Brusaporci 2006, pp. 16–21) satisfy the need to enhance and communicate precious historical–figurative assets linked to changes in the Church's interior, from its construction and alterations made over the years. Mobile systems and interactive applications create new perspectives and lead to extremely interesting applications in the field of simulations and virtual reconstructions (Empler 2015, pp. 60–69); they are also very helpful during restoration projects. If on the one hand, these visualisation instruments reveal details which would otherwise be difficult to see using two-dimensional representation, on the other there is still much to be done in studies and researches to reconstruct and visualise the reproduced scenes and chromatic data, especially as regards applications in which the original image has to be reconstructed (Ippoliti and Meschini 2010). Involvement in this experience and degree of interactivity are proportional to the quality of the sensorial information provided to users by the technological device in order to capture their attention and enhance the acquisition of knowledge in the illusory space in which they are immersed (Bisogni 2014).

The digital model is therefore integrated in the field of cultural heritage; by combining the virtual reconstruction of past environments, and enabling comparison between what exists and what existed, all users can interpret the changes wrought by time. It is still possible to be amazed by the recomposed cycle of frescoes in the intrados of the panels of the spans of the naves of the Church of the Incoronata. Only some of the figurative images removed for restoration have been replaced; however, the chromatic compositions of the ones *in loco* reflect the surrounding architectural forms and create overall environmental features that are often precious and unique, whether observed close-up or at a distance. Documenting and understanding these images can, albeit virtually, allow reinsertion in a reality devoid of its original figurations and become part of a unitary recomposition of the artwork as close as possible to the spirit of the place.

The exemplification implemented in the ReMLab advances in synch with the theme of "integration": integration of the omissions in documentary evidence, integration of communication, integration of our culture of accessibility (Papa et al. 2014). The feeling of immersion and presence in the recreated environment is even more meaningful when the asset can only be enjoyed episodically.

The repositioning of the recomposition of the cycle of frescoes in an application that can be used immersively is the last step in a process involving an initial phase of data collection and elaboration from an onsite survey and archival research. Together with the interpretation of the signs and traces still visible on the wall surfaces, this data enabled not only the reconstruction of the three-dimensional model of the Church, used for virtual fruition, but also simulation of an augmented reality application (Fig. 9), useful to enhance the user's sensorial perception thanks to data that in general is manipulated and electronically conveyed. The generated flow of video live images (taken by a smartphone or tablet) enabled modification of the vision of space and added virtual contents and animations in real time (Simonetta 2012).

The AR application uses computer vision techniques to determine the position and perspective of the user in the real world. This position can be absolute (a specific place in the world) or relative (when the position is deduced based on the

**Fig. 9** Example of the augmented reality application, with a smartphone, to reinterpret the original configuration of the frescoes in the Chapel of the Crucifix

presence of a certain element). To activate computer vision, the sensor needs a camera that "sees" the real world and, based on the information it receives, can determine its position and direction compared to the overall scene; then the software analyses the images recorded by the camera and "positions" the virtual elements in the surroundings. When creating the augmented effects, called "AuRAs", it is important to establish the initial image that acts as a trigger as well as the multimedia contribution that will be overlaid on it; in this case the former are the sinopias actually present on the wall surfaces of the Chapel of the Crucifix while the latter are generated by the photogrammetric reconstruction of the restored frescoes currently positioned on special easels along the wall of the side nave (Fig. 2).

The new visualisation tools allow to recover the chromium, the spatiality and the symbolic value of the sacred fourteenth-century environment of the Church of the Incoronata, thanks to the virtual relocation of details utopically perceptible in reality that allow you to fully understand the episodes told. The implementation of such a guided route aims to lead the visitor through a utopian journey aimed at re-reading the frescoes, with an extensive multi-sensory approach between amusement and edutainment (Cervellini and Rossi 2011), in other words a source of education and comprehension of the historical and cultural value of the Church and its pictorial images.

## 1.4 Conclusions

Pursuant to the study of the multiple relationships between architectural and figurative elements, the virtual simulation experience is an original form of immersive communication enabling assessment of the most appropriate management tools required to communicate the material and immaterial components currently either partially compromised or lost. Integration between these descriptive and communicative modes contributes to the acquisition and dissemination of unusual data (Papa 2014).

The objectives of protection, conservation and requalification of historical–architectural heritage can be achieved by using modern digital technologies; the latter provide incredible options to visualise and "narrate" cultural assets based on the multiscalar organisation of knowledge and the construction of temporally dynamic tools that can manipulate data and structure tourist-immersive proposals. These technologies can also be increasingly used to provide disciplinary assessments and execute experiments regarding the effectiveness of communicative strategies, including from a remote position.

In this context, augmented reality, during the drafting of visitors' itineraries combining real and virtual elements, undoubtedly turns the fruition of a monument into an active and captivating experience rather than purely passive event.

The contribution was developed, in equal measure, by the authors L. M. Papa and G. Antuono, with the collaboration to the editing of the images of the Ing. Antonello Cerbone.

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