Wood Inlays and AR: Considerations Regarding Perspective

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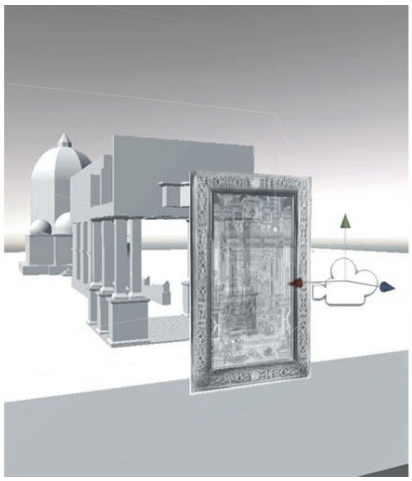
Abstract

The contribution reflects on the options provided by recent Augmented Reality (AR) applications to the knowledge and enhancement of a nationally and internationally renowned cultural asset: perspective wood inlays.
The methodology envisages two closely–connected stages initially involving perspective decoding and ensuing reconstruction of the illusory model, followed by the creation of a set–up for the AR pursuant to the digitalization of the three–dimensional model.
In AR, perspective is the ideal tool to virtually experience the space represented in the decoration; at the same time it provides the most suitable solutions required to optimise the AR project.

Keywords
wood inlays, perspective, augmented reality, immersivity, dynamic perception.



doi.org/10.3280/oa-686.44

Introduction

This contribution [1] focuses in particular on wood inlays that primarily use a perspective approach to create the image, i.e., early Renaissance and sixteenth–century intarsia that exploit an elegant perspective technique to produce wood decorations.
There have been many recent examples of AR/VR applications used in environments embellished by wood inlay decorations. In particular the ones in Federico da Monfeltro's studiolo in Gubbio and Urbino which were developed to virtually recreate the rooms' artistic quality [2]. Said studies focused more on communicating the cultural asset rather than speculating on the perspective–geometry used to create the illusory space, achieved due to the sfondamento of the plane of the wooden cladding.
This contribution will instead concentrate on the common projective origin of the two representative models: on the one hand the perspective model, on the other the digital model behind the AR experience that can be visualised on an ad hoc display.
Our goal regarding the projective and perspective features linking the perspective sfondato with its AR version is to verify whether these features are the key elements required to successfully recreate the spatial complexity of this particular artistic genre.
To test the methodology we selected an intarsia made by Brother Damiano Zambelli around the year 1530 and inserted in the backrest of the choir stalls in the presbytery of the Basilica of San Domenico in Bologna (opening image, left). When an onlooker looks at this intarsia, or at any other perspective inlays, he perceives an illusory space beyond the wooden frame, in this case a quadrangular hall with a Lombard–style coffered ceiling resting on two rows of three pilasters, the remains of a building in the middle ground, and a temple in the background [3].

Considerations Regarding Perspective and AR

Two features betray the similarities between perspective and AR: one involves the fundamental elements of projection, the other concerns the elements participating in the creation of the perceptive experience of amplifying space.
The first step is to verify parallelism between the centre of projection, the picture plane, and the model to be represented as crucial elements of the perspective, and, respectively, the virtual camera, the target, and the three–dimensional digital content in the AR.
The effect of amplifying real space is created by skillfully using the perspective technique; it is effectively similar to the AR experience after accurate correlation is established between perspective construction and the design of the virtual fruition application.
The illusory space conjured up in the wooden intarsia is possible thanks to the observer's sensitivity and visual and artistic knowledge, while the perceptive functioning of the AR is generated by superimposing suitably designed digital contents on real space; these contents are activated by establishing a specific target.
In this respect, we must carefully consider the element to be used as a target to recognise the virtual model that we can presume to be either the inlay itself or an orthorectified image of the inlay itself.
As we all know, perspective theory allows for endless positions of the model to be represented compared to the picture plane (in fact the object can be between the centre of projection and the plane, beyond the plane, or even astride the plane). Nevertheless,

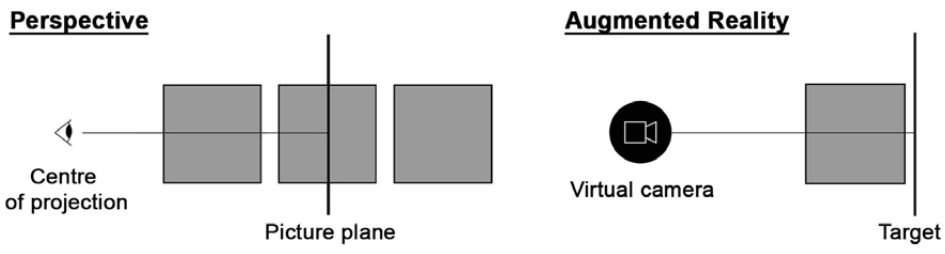


Fig. 1. Schematic drawing reflecting on the possible relationship between objects and the picture plane in perspective construction (left) and the model appearing in front of the target in AR applications (right).

when we look at a wooden intarsia the perceptive effect sought after and recreated by the artist is to place this space 'beyond' the physical limit of real space, i.e., beyond the inlay, which, in turn, can be equated to the perspective picture plane (fig. 1). Instead in AR, after activating the application the digital model appears in front of the target (fig. 2). In perspective intarsia applications this disorients the onlooker who no longer easily perceives the continuity between the two–dimensional perspective image and the reconstructed space in the digital model (fig. 2).
To restore the immersive effect a solution could come from the nature itself of the wood inlays and their dimensional characteristics. In fact, inlays are primarily framed by a scansion of the wood surface so that the dimensions of each sfondato corresponds to that of an opening (door or window). The space imagined beyond the wooden plane appears to be divided into as many sfondamenti as the number of perspective panels, usually bordered by a compositional element that acts as a frame for the intarsia. This allows us to theorise that the latter is the element tasked with mediating the shift from the perspective image to its digital reconstruction by inserting, in the model, an element present in the target.

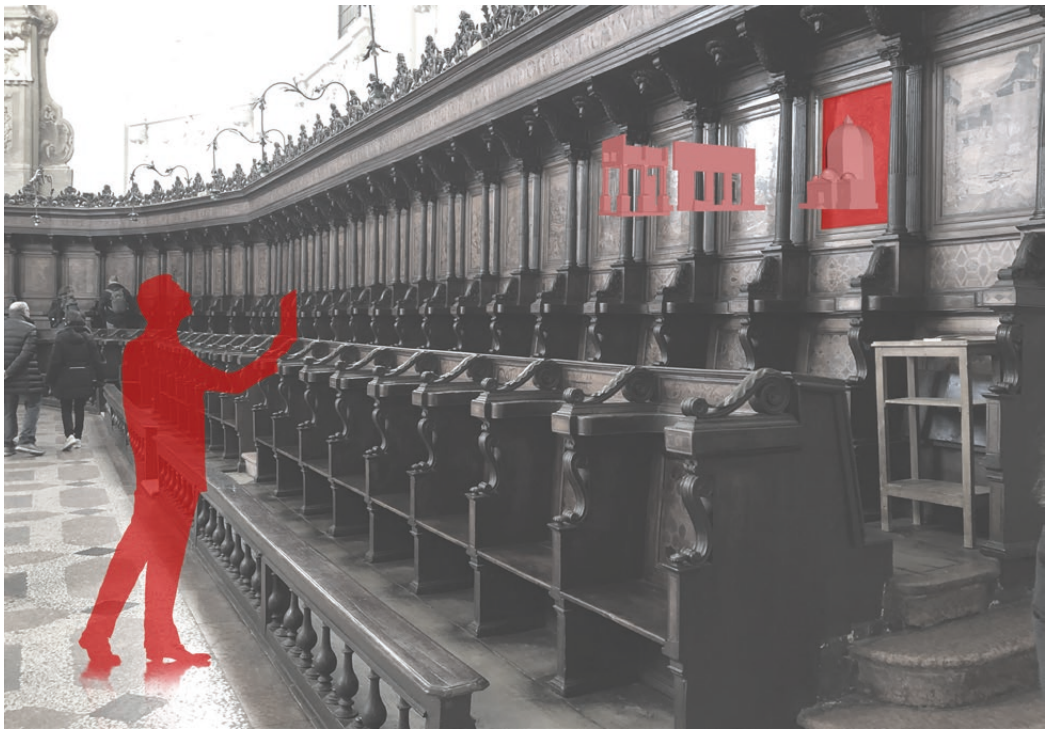


Fig. 2. Concept view, inside the choir of the basilica of San Domenico in Bologna. The image shows user perception of the application of AR in the case the necessary changes are not made to obtain the perspective *sfondamento*.

Let's now focus on the case study, i.e., the inlay in the choir stall in the Basilica of San Domenico. We have outlined the aforementioned considerations because in AR the digital model is visualised in front of the target; the chosen target is in fact the intarsia itself, while the one perceived by the onlooker is a model that does not 'pierce' the wooden plane, but instead exits it and is projected forward into real space, nullifying the illusory effect of spatial depth beyond the inlay. To eliminate this undesired effect, a decision was taken to make part of the target (i.e., the frame around the scene) an element of the model produced for the AR application. The outcome was a virtual frame perfectly superimposed on the physical target in front of said urban scene.
Solving the issue of the target is the first step in achieving successful restitution of illusory space. Another inconvenience is the presence of elements in real space that conflict and are visualised with the ones in the digital model – possibly including the target itself.
Once again, the solution was found in the common projective origin of the wooden sfondato and AR application. In this case, the applied strategies were instigated by the perspective used in theatrical stage sets and photography.

A box–like environment inspired by photographic box sets was created to isolate the urban scene beyond the frame and stop the real environment from being considered as a background. This involved creating a delimited digital space characterised by neutral textured materials in which the rounded corners did not reveal the change in position of each plane. Inserting the digital model in this box eliminates the presence of real space elements that are thus inserted in virtual space, helping to reinforce the perceived effectiveness of the AR experience (fig. 3, left).
Nevertheless, the digital model and the box set in which it is inserted are both a certain size and can be visualised as an insertion in real space; this is the third element that helps to weaken the illusory sfondato of the wooden surface. Once again the solution lies in the perspective–scenographic origin of the two models, the perspective model of the intarsia, and the illusory AR model; it is reminiscent of the proscenium arch in many theatres or mobile stage sets. When a foreground frames the scene it amplifies the perceptive effect of depth; this has been common knowledge ever since antiquity, especially in the theatrical world; the 'trick' is used both in the field of perspective and that of photography.
In a theatre, the proscenium arch in the foreground plays a dual role: apart from framing the stage and interrupting continuity with real space, it makes the space of the stage less immediately 'measurable' and isolates the parts of the scenery and machinery that spectators should not see.

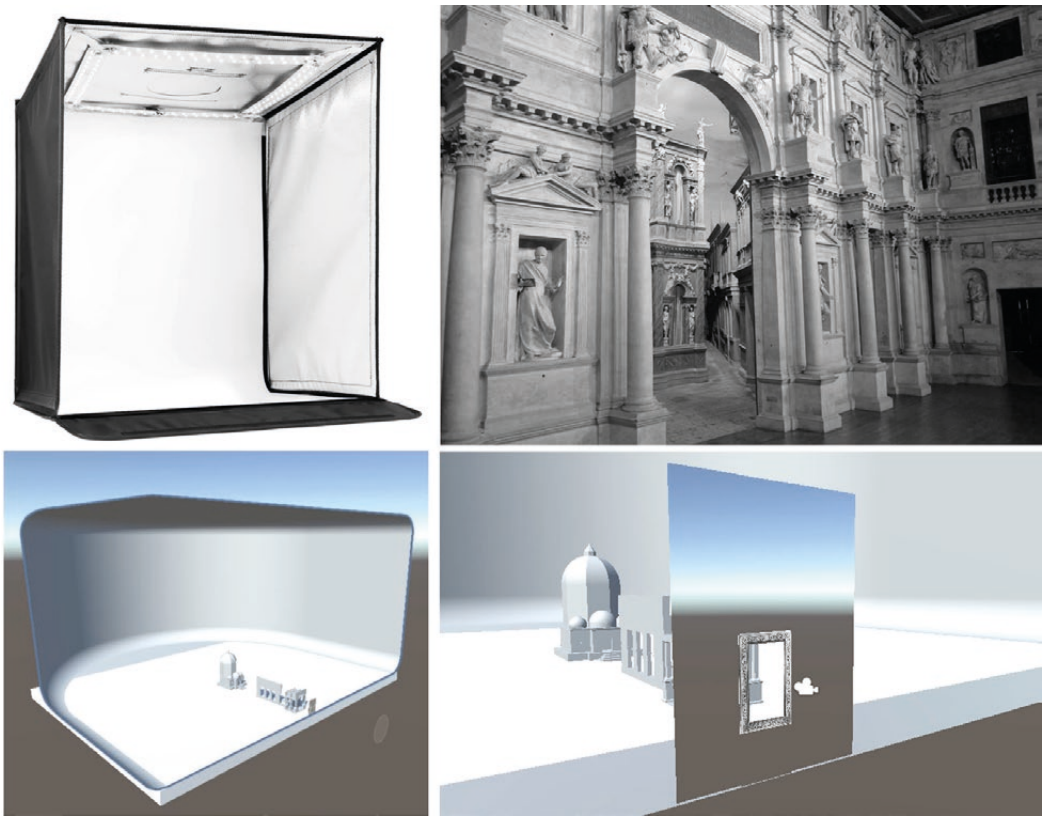


Fig. 3. Box set (top left) and proscenium arch (top right) applied to the virtual model (bottom).

Placing this element in the model elaborated for the AR application involves inserting a sort of screen and assigning it certain characteristics and materials so that it isolates the model, but cannot be seen when the application is used. In our case study, for example, this additional insertion of a screen in the foreground, was appropriately cut to show only the part of the sfondamento that the onlooker was allowed to see (fig. 3, right).
The presence of an element of the target in the digital model, coupled with the creation of the box set and insertion of a screen, facilitated seamless exploration of the space of the AR with fruition of the real space where the inlay is situated; it also facilitated a comparison between the digital model and the perspective image.

Conclusions

The use of AR in perspective applications and, in particular, in wood inlays, raises several questions; a suitable solution lies in the realisation that the two systems share a projective origin. Bearing this in mind, and focusing on the world of theatrical stage sets and photographic technique – two technical–artistic mediums with the same roots and same scientific evolution – provides us with important knowledge and helps solving some of these issues.
Obviously this contribution ignores other aspects that are nevertheless crucial and should be considered in a much broader study.
In fact, it will be necessary to tackle the question of the implementation of materials, lights and texture in the model for the AR application; these elements can be identified by analysing the inlays themselves, but will have to be correctly managed.
Another aspect not tackled here, although inevitable, is the relationship between the position of the observer of the perspective (presumed to be stationary in the environment) and the kinetic nature of AR exploration.
Nevertheless, once again, in the case of perspective inlays, AR proves to be the right tool to enrich the experience of all those who wish to enjoy cultural heritage thanks to an approach which, by increasing perceptive options, also includes scientific contents – all too often relegated to the back burner.

Notes

[1] Although all the authors participated in the whole research, the study of the wooden intarsia, their perspective construction and specific case study was performed by M. Fasolo; the part regarding the relationships between perspective and AR was performed by L. Carlevaris; in–depth operational studies and the creation of the models and contents of the AR application were performed by F. Camagni. The conclusions are part of the joint research project.

[2] Regarding the *studiolo* in Urbino, see: Roberto Mantovani, <https://www.youtube.com/watch?v=kShbXHYI7G0> (consulted on 11th February 2021); the project *Lo studiolo di Gubbio: tour virtuale e ipotesi ricostruttive di un microcosmo umanistico*; Paolo Clini, *Lo Studiolo di Federico da Montefeltro. Fruizione del Cultural Heritage attraverso nuove tecnologie di realtà immersiva*: <https://www.facebook.com/watch/?v=690533685114053> (consulted on 11th February 2021). Regarding the decorations in the *studiolo* in Gubbio, currently housed in the Metropolitan Museum in New York, <https://www.youtube.com/watch?v=8MTgRlEuHBg> (consulted on 11th February 2021).

[3] Cfr. Alce 2002.

References

Alce Venturino (2002). *Il coro intarsiato di San Domenico in Bologna*. Bologna: ESD.

Bertocci Stefano, Farneti Fauzia (eds.) (2020). *L'architettura dipinta: storia, conservazione e rappresentazione digitale*. Firenze: Didapress.

Bianchini Carlo, Fasolo Marco, Camagni Flavia (2020). Dimensioni, scale e rappresentazioni: un'eterna ghirlanda brillante. Dal 3D al 2D e ritorno. In *Paesaggio Urbano*, 2, pp. 149-157.

Bixio Antonio, Radogna Veronica (2019). La Certosa di Padula "officina" di ricerca: le Tarsie dei cori lignei della chiesa di San Lorenzo. In Belardi Paolo (ed.). *Riflessioni. L'arte del disegno/il disegno dell'arte*. Roma: Gangemi Editore, pp. 385-394.

Fasolo Marco, Camagni Flavia (2020). Imagination and Image in Renaissance Wooden Inlays. In Cicalò Enrico (ed.). *Image and Imagination*. Cham: Springer Nature, pp. 759-772.

Friso Isabella, Bernardello Rachele Angela, Piccinin Giulia, Dalla Longa Mirka, Giordano Andrea, De Rosa, Agostino, Monteleone Cosimo, Faresin Emanuela (2020). L'architettura dipinta della Scoletta del Carmine a Padova. In Bertocci Stefano, Farneti Fauzia (eds.), *L'architettura dipinta: storia, conservazione e rappresentazione digitale*. Firenze: Didapress, pp. 218-227.

Luigini Alessandro, Panciroli Chiara (eds.) (2018). *Ambienti digitali per l'educazione all'arte e al patrimonio*. Milano: FrancoAngeli.

Mantovani Roberto, Serafini Francesco (2008). Lo studiolo virtuale di Urbino. In Emmer Michele (ed.). *Matematica e cultura 2008*. Milano: Springer.

Rossi Michela, Russo Michele (2020). Dipinti di legno. Le tarsie prospettiche del coro di Santa Maria della Scala in San Fedele a Milano. In Bertocci Stefano, Farneti Fauzia (eds.), *L'architettura dipinta: storia, conservazione e rappresentazione digitale*. Firenze: Didapress, pp. 35-46.

Valenti Graziano M. (ed.) (2014, 2016). *Prospettive architettoniche. Conservazione digitale, divulgazione e studio*. Voll. I, II. Roma: Sapienza Università Editrice.

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