An Immersive Virtual Reality Application to Preserve the Historical Memory of Tangible and Intangible Heritage

Lucio Tommaso De Paolis[a], Sofia Chiarello[b] and Valerio De Luca[c]
Department of Engineering for Innovation, University of Salento, Lecce, Italy
fi

Keywords: Cultural Heritage, 3D Modelling, Virtual Reality, User Experience.

Abstract: This paper concerns the valorization of a building that has been inaccessible for a long time: the Castle of Corsano, a small Italian village in the Salento area. Starting from the three-dimensional reconstruction of the rooms of the Castle and, in part, of its furnishings, it presents the development of a VR application with the possibility of interacting with the environments of the Palace and learning the historical information collected not only through bibliographic research but also through an act of remembering, which has involved, in particular, the elderly of the village. The goal is to create an archive of memory and make virtually accessible one of the most emblematic historical places of the urban network, which risks being definitively forgotten. Experimental tests were carried out on a heterogeneous sample of users to evaluate the factors characterising the sense of presence and the relationships between them. The results revealed a high level of involvement and perceived visual fidelity.

1 INTRODUCTION

This research work concerns the Castle of Corsano, a building that has been abandoned and inaccessible to its inhabitants for over thirty years, located in a small town on the Adriatic coast of Salento.

Accessibility plays a fundamental role among the aspects related to the fruition of Cultural Heritage. However, an increasing number of sites, both archaeological and natural, are in a state of abandonment and neglect or have already been destroyed, often intentionally. Fragility and degradation of artefacts, and poor protection or enhancement policies are only some of the causes that lead to the inaccessibility of a cultural site.

Therefore, physical access to a place, where there are no dangers, should be the main objective of heritage valorisation policies, with a view to involving the greatest number of people and creating participation. However, in cases where the state of preservation is poor, it is sometimes necessary to resort to other means that become tools for accessibility, or to flank and support a more traditional fruition. Among these, information and communication technologies (ICT) are taking over, ranging from Mixed Reality (MR) to Virtual Reality (VR).

The aim of the project is twofold: on the one hand, it aims to preserve the historical memory of the place through its material and non-material component, by exploiting the oral testimonies of the women who worked inside the castle; on the other hand, it aims to create a dissemination tool by helping to promote the knowledge of a site to professionals and, above all, to local people, thanks to VR technology.

The first part of the paper provides a historical overview of Corsano and its castle from the 12th century to the 20th century, with a particular emphasis on the role of the tobacco factory it assumed until the 1980s; the second part of the research examines all the phases of technological development, starting with the three-dimensional modelling of the places, up to the realisation of an application usable in VR through the "Oculus Quest 2" Head-Mounted Display. This stand-alone visor allows users to enjoy a VR experience even from home and without necessarily linking it to a computer. It was therefore the best choice to enhance a totally inaccessible building, like the Castle of Corsano.

[a] https://orcid.org/0000-0003-1274-9070
[b] https://orcid.org/0000-0002-2158-3976
[c] https://orcid.org/0000-0003-3018-7251

De Paolis, L., Chiarello, S. and De Luca, V.
An Immersive Virtual Reality Application to Preserve the Historical Memory of Tangible and Intangible Heritage.
DOI: 10.5220/0011791400003417
In *Proceedings of the 18th International Joint Conference on Computer Vision, Imaging and Computer Graphics Theory and Applications (VISIGRAPP 2023) - Volume 2: HUCAPP*, pages 279-286
ISBN: 978-989-758-634-7; ISSN: 2184-4321

2 RELATED WORK

The 1980s and 1990s saw the first technological experiments applied to cultural heritage, limited, however, only to the 2D virtual reconstruction of destroyed sites, monuments and ancient urban contexts, and then displaying them on screens, for the purpose of documentation.

From the end of the 20th century, the Cultural Heritage sector has begun to increase the use of immersive technologies belonging to the macrocosm of 'Extended Reality', a collective term for Augmented, Virtual and Mixed Reality technologies that provide sensory experiences through various combinations of real and digital content.

Among the first examples in literature, it is worth mentioning the virtual restitution of the Renaissance mansion of Dudley, commissioned by Queen Elizabeth II. The reconstruction was based on some existing ruins, as well as on historical films, written documents and also a voice that enriched the virtual tour (Messemer, 2016). It was one of the first examples of digital storytelling, which is the idea of combining the art of storytelling with the variety of digital multimedia such as audio, images, and video (Robin, 2006).

The use of innovative VR tools and digitisation activities have facilitated the dissemination of knowledge and access to Cultural Heritage in a more engaging and innovative way (Bekele et al., 2018).

Since the purpose of most cultural applications in VR is to revive a reality that no longer exists, the topic of "time travel" has always been among the most popular, although declined in different ways.

In 2017 a kind of "time travel" was realized from the Museo Arqueologico Nacional in Madrid, in collaboration with Samsung, within the project entitled "Vive el Pasado". It was an immersive tour in which visitors virtually walked through the history of Spain from Prehistory to the Modern Age, by using 3D visors like Cardboards (Sànchez Mateos, 2018).

In Italy, if we look at the Salento area where the Castle of Corsano is located, we find some interesting similar experiences. In particular, "The MediaEvo Project" was a VR project for edutainment in cultural heritage based on a serious game oriented towards the knowledge of history and society of a medieval town in Salento (De Paolis et al., 2011a). The project enhanced interactions among historical, pedagogical and ICT researchers by means of a virtual immersive platform for playing and educating. This platform, through the reconstruction of the old town of Otranto in the Middle Ages, has permitted the collection of feedback about the questions related to the educative use of ICT (De Paolis et al., 2011b).

Near Otranto, in 2021, the enhancement of an underground oil mill in the abandoned Masseria of Torcito, next to Cannole (Lecce, Italy), was proposed by means of a VR application and a MR application. The former can be used with Cardboard, through which it is possible to visit the oil mill from the inside with spherical photos. In the latter the 3D model of the olive mill is navigable through the technology of Virtual Portal (De Paolis et al., 2021).

The use of immersive VR for education or training offers a substantial improvement in the interest of learning in these environments, facilitating the understanding of complex concepts. This has necessitated the creation of new VR environments specifically for learning or training (Checa et al., 2020).

In the educational field can also be placed the project "VirgilTell", developed in 2021 by the Polytechnic of Turin, to make virtual accessible the impervious places of the Racconigi Castle in Piedmont, unreachable due to restoration. The experience exploited the use of the Oculus Quest visor. The rooms were modelled using the support of historians to verify the veracity of the information and visited together with the characters of the kings Carlo Alberto and Vittorio Emanuele II, who guides as a "ghost" the visitors in 1842 and 1920 respectively (Germak et al., 2021).

In the same domain, another project concerned the reconstruction of one of the most representative UNESCO sites of Lombard architecture: Santa Maria Delle Grazie in Milan, according to the Cloister of Dead part. By the means of Oculus Rift, users can discover the transformations of the Cloister over the centuries (before and after the bombing of World War II), which are gradually being lost in common memory. The aim of the research project is to hand down the historical phases and intangible memory of the monument to future generations, thanks to the tool of Virtual Reality (Banfi and Bolognesi, 2021).

On the contrary, the ultimate goal of the application developed for the Castle of Corsano is to enhance a tangible asset, even if closed to the public for much longer, by using as sources an intangible cultural heritage, mostly made up of oral testimonies, and above all by inserting them as virtual elements to interact with. All of this has been made usable through a medium that is also, in itself, intangible: Virtual Reality.

This dichotomy between real and virtual, between history and memory is the thread running through the entire project and constitutes its strong point.

Today, the adoption of VR solutions has turned out to be effective also in the museum world, to react to the impact of the forced closure of museums due to

the Covid-19 pandemic. Virtual visits and tours (including the Uffizi and the Vatican Museums in Italy) were highly appreciated by users, temporarily overcoming the inaccessibility of museums (Gatto et al., 2021).

VR technology also came to the aid of small local realities, such as the Castle of Corsano, not only to limit the problem of its use during the pandemic but, more generally, to promote its accessibility while waiting for physical access to be permitted. In this scenario, a user experience study was also conducted using a questionnaire to assess the sense of presence, defined as the subjective experience of being in a particular place, independently of where the user is actually located (Witmer and Singer, 1998).

3 THE CASTLE OF CORSANO

The castle of Corsano was used for different functions over the centuries.

Although the building has never been the object of any archaeological, artistic, or architectural study, further historical research has been carried out on the basis of the few archival and bibliographic sources available.

3.1 From the Origins to the 17th Century

After the Norman domination of the feud of Corsano, the Castle appeared as a defensive fortress. A previous thesis on this subject contributed to hypothesize the external structure of the fortress in the 15th century, with the presence of plumb lines, still visible today in the facade (Ciardo, 2014). As for who lived there, the Palace passed, first, in the hands of the Count of Caserta Della Ratta and then of the noble families of Securo and Cicala. A deed of sale dated to 1636 described the cession of the Land of Corsano, including the Castle, to the Capece family, of Campanian origin.

Figure 1: Part of the stucco decorations in the Castle, still visible today.

Of particular note is the stucco decoration, preserved in the rooms of the south side of the Palace (Figure 1), probably commissioned by Giovanni Tommaso Capece, the most active member of the family in terms of artistic and architectural (Ciardo, 2014).

Another important source is an Inventarium Ereditatis written by a notary, dating from the same period, with the description of the furnishing of the rooms.

The Capece baronate ended in the XIX century, with the last descendant of the family who married Giuseppe Galluccio. He turned the baronial residence into a tobacco warehouse.

3.2 The Tobacco Warehouse

The project of arrangement and modification signed by Galluccio in 1958 has provided important information about the arrangement of spaces, because of its architectural plan with a descriptive legend.

Moreover, the oral testimonies of the “tabacchine”, the women who worked the tobacco inside the Castle of Corsano during the 19th century, gave us the possibility to reconstruct the phases of the tobacco leaves processing, one of the most important and popular productions of the south in the last century. The tobacco was imported into Italy from Portugal around ’500, but it gradually ended in the ’80s of the 19th century, because of the fungus Peronospera.

In that period, the Tagliaferro family bought the factory of Corsano, without making substantial structural changes and leaving the tobacco machines inside the building (Figure 2).

Figure 2: A conveyor belt still inside the Castle, dating from the last phases of the tobacco factory.

In 2015, the Palace of Corsano was declared of cultural interest by the Regional Commission of Cultural Heritage of Puglia.

However, a slow process of decay and neglect still applies today and the access to the Castle continues to be severely compromised also by the external scaffolding.

4 THE VR APPLICATION

The poor state of conservation of the castle's rooms proved to be a critical factor during the work phases, making it impossible to stay inside them for long periods of time. Nevertheless, some inspections inside the Castle and some photographic acquisitions were carried out in order to model in a realistic way the ancient halls and the furniture, and to design the whole storytelling, before the development of the VR application.

4.1 The Design of the Experience

The established storyboard concerns the reconstruction of the Castle's environments in its three main periods of occupation:

- the 15th century, when it is hypothesized that the castle of Corsano was a little fortress with plumb line in the facade, sold to the count of Caserta. Since there is no documentation regarding the internal partitioning of the rooms of that period, it was decided to make it visitable only from the outside (Figure 3);
- the 17th century that saw the building as the main residence of the baronial family Capece, who commissioned stucco decorations in the halls (Figure 4);
- the 20th century when the castle was transformed into a tobacco warehouse (Figure 5) and a lot of employed women worked inside.

Unlike the fortress, the fruition of the '700 and '900 takes place inside the rooms, giving the possibility to the user to interact with pop-ups, photos and information panels.

According to this design idea, the application starts by default in a corridor with the user's position facing a doorway on which an old map is affixed that allows the temporal switch between the three eras. This corridor connects the rooms referring to 1700 and 1900, respectively a room decorated with a stucco vault for the baroque period, and the main room considered the main environment of the tobacco factory, together with the adjacent rooms, probably the dressing rooms of the workers.

Figure 3: 3D model of the hypothetical fortress in 15th century.

Figure 4: 3D model of one baronial bedroom in the Castle during the 18th century.

Figure 5: Reconstruction of the main hall of the Castle where tobacco was processed in the early 1900s.

4.2 The 3D Modelling Phase

Once the experience of the VR application was designed, it started modelling the environments in Blender. It is a free and cross-platform 3D modelling software, which also allows rendering and animation of 3D objects.

The first step focused on the reconstruction of the walls, thanks to the main information from the plans of the land register found in the public archive.

In the second phase, all the furnishings were modelled: for example, we followed the descriptions reported in the Inventarium for the 18th century, while for the 19th century furniture, the reconstructions of the tobacco machines were based on the workers' interviews.

Once the mesh was ready, we texturized everything using the images acquired inside the Castle as references (Figure 6).

The same textures were also exploited for the modelling of the eighteenth-century stucco vault, to obtain the three-dimensional photogrammetric model of the vault, in the Agisoft Metashape Professional

Figure 6: Comparison between a photo showing the press still in the Castle and its 3D reconstruction.

software. This software creates a dense cloud of points and a mesh with textures until obtaining a very realistic model, then imported into Blender.

Photogrammetry is a surveying technique that allows to reconstruct and define the position, shape and size of objects, using the information contained in appropriate photographic images of the same objects, taken from different points (Cannarozzo et al., 2012).

The whole realised three-dimensional environment was exported in ".fbx" format to be imported into the Unity software.

4.3 The Implementation in Unity

The development of the VR application for the Castle of Corsano had to deal with various aspects, from the management of the user's movements in the virtual world to the presentation of content through sounds and illustrative pop-ups.

4.3.1 Device and Software Settings

The Oculus Quest 2 Head-Mounted Display (HMD) turned out to be the most congenial device to safety run the VR app since it is equipped with the "Passthrough+" system that guarantees the free movement of the user, without colliding with real objects during the experience.

To configure the HMD on Unity (a cross-platform graphics engine) it was necessary to associate the inputs from the user movements and rotation to the controllers of the Quest 2, installing the Open XR plug-in from Unity. Open XR is an open royalty-free standard that aims to simplify the development of Augmented and Virtual Reality applications by allowing developers to easily move between a wide range of AR/VR devices, including, also, the Oculus Quest 2. In order to manage Open XR, it was necessary to install the XR plug-in management packages and the XR Interaction Toolkit, which contains a set of preset actions connected by default to certain buttons on Oculus controllers.

4.3.2 User Interactions

The interactive component and the tracking of the player's movement are at the base of the described application, as both have a significant impact on the experience in the virtual environment. Studies confirm that, compared to gesture-based touchless devices, controllers connected to visors reveal a better usability, also influencing the user's perception of immersion in VR (De Paolis and De Luca, 2020)(De Paolis and De Luca, 2022).

For the user's movement, the "teleportation area" system was chosen: as soon as the controller ray intercepts the floor, it turns white and allows the user to move to the exact point where it ends, by pressing the grip button of the controller. This kind of teleport enables the free exploration of the virtual world.

To increase immersion in the VR experience, in all the three virtual worlds the user is given the opportunity to interact with pop-ups or panels showing historical content that contextualizes the objects in the environments and some vintage photographs.

Moreover, since the main aim of the project is to integrate part of the tangible cultural heritage (archival documents and previous thesis work), with much of the intangible heritage (consisting of folk songs, interviews and memories of the village), during the VR experience in the 19th century the user can also listen to the voices of some tobacco workers interviewed, accompanied by animations and music in background (Figure 7).

Figure 7: Visualization of an interactive panel in which users can listen to the oral testimonies.

5 USER EXPERIENCE EVALUATION

Various studies have been proposed on the reliability of questionnaires for assessing the user experience in virtual environments and their actual ability to represent the sense of presence (Schwind et al., 2019). The Presence Questionnaire (PQ) (Witmer and

Singer, 1998) has the lowest variance, which denotes good reliability, probably due to the large number of items, but the iGroup Presence Questionnaire (IPQ) (Schubert et al., 2001) seems to be the one that best represents presence (Schwind et al., 2019).

Nonetheless, the PQ questionnaire was chosen for the present study in order to take advantage of its more articulated structure that allows for the evaluation of the effect of multiple factors and the relationships between them. In particular, a variant of this questionnaire proposed by the Laboratoire de Cyberpsychologie de l'UQO was chosen, consisting of 22 items (plus two optional items for applications that include haptic feedback), for each of which a rating is given on a scale of 1 to 7. This version of the questionnaire was further modified for the testing of the considered application by replacing the last two questions on the identification and localisation of environmental sounds with "Were you able to understand the tabacchine's stories?", given the importance of oral testimonies in the entire project. The item "How compelling was your sense of objects moving through space?" was removed because no significant object movement was implemented in the described VR application. Two further items were added to ask whether the user has already visited the castle in person, and if so, whether he or she finds the virtual reconstruction faithful to the real castle.

The test was administered to a total of 31 users aged between 17 and 60 without previous experience with Virtual Reality. Each user filled in the questionnaire after a few minutes of experience through the three eras reconstructed by the virtual application.

According to (Witmer et al., 2005), the questionnaire items can be aggregated into the following factors:

- *Involvement*, which is a psychological state triggered by how much energy and attention is focused on the activities in the VR environment. This may depend on other factors such as personal thoughts and concerns, the stability of the visor on the head or the quality of the audio that may negatively affect a proper engagement in the virtual world;
- *Interface Quality*, which includes possible distractions caused by poor video resolution or controllers during the experience;
- *Adaptation/Immersion*, which is the perception of being fully immersed in the virtual world by interacting with it. This component increases with isolation from the physical environment, with the sensation of natural movement even in the 3D environment;
- *Visual Fidelity*, which refers to the viewpoints one can assume when navigating in the three-dimensional reconstruction (e.g. the possibility of looking at objects more closely), and how closely they reflect those in reality.

In the case study of the Castle of Corsano, a fifth factor was added, called *Understanding Stories*, which corresponds to the item on the ability to understand the stories told by the tabacchine.

The mean values and the standard deviations of the scores (between 0 and 6) of the components identified above, represented in the histogram in Figure 8, showed a clear convergence of user opinions towards high levels of *Involvement* and *Visual Fidelity*. This may partly depend on the novelty effect of VR environments, which usually helps to produce a higher level of user satisfaction along with the hands-on learning strategy typical of serious games (Checa et al., 2021). Users generally spend a longer time in adapting themselves to a virtual environment, but, once they get familiar with it, they enjoy all the opportunities offered by VR (Checa et al., 2021).

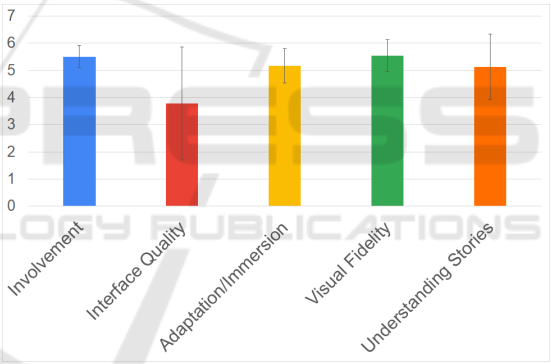

Figure 8: Histogram showing mean and standard deviation values for each PQ factor.

The lowest values are referred to the *Interface Quality*, though there is great variability in the scores for this factor, probably caused by a different predisposition of each user to the VR technologies according to their personal attitudes.

The five users who had already visited the castle in person gave an average score of 5.9 out of 6 for the fidelity of the virtual reconstruction.

The study presented in (Witmer et al., 2005) on PQ factors identified the correlations depicted in the diagram in Figure 9, where *Sensory Fidelity* represents a combination of *Visual* and *Audio Fidelity* (Witmer et al., 2005).

For the considered case study, a cluster analysis was conducted through *ICLUST*, a package for the *R* environment based on a hierarchical algorithm (Revelle, 1978) that tries to maximize internal consistency

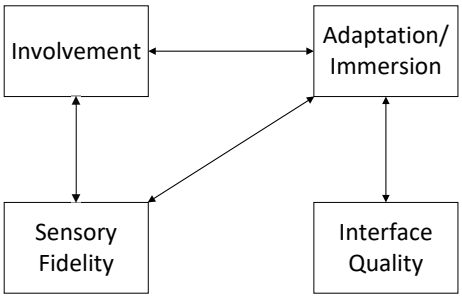

Figure 9: Correlations between PQ factors according to (Witmer et al., 2005).

and homogeneity. A model based on two clusters was chosen, as it maximizes cluster fit and pattern fit and minimizes the root-mean square radius (RMSR). The result is depicted in the diagram of Figure 10, where ovals represent clusters between items. Cronbach's *alpha* (Cronbach, 1951) and Revelle's *beta* (Revelle, 1979) inside each oval represent internal consistency and scale homogeneity respectively: as these values tend to coincide in the considered scenario, the clusters can be considered reliable.

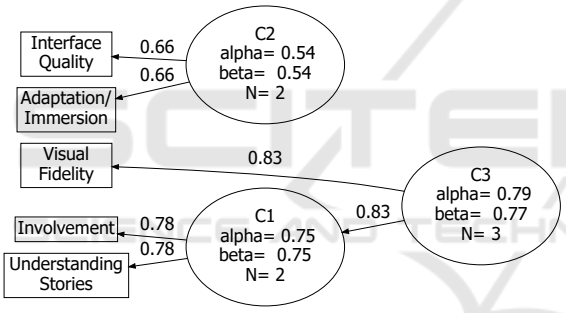

Figure 10: Cluster fit = 0.72, Pattern fit = 0.99, RMSR = 0.06.

While *Sensory Fidelity* is correlated with *Involvement* and *Adaptation/Immersion* in (Witmer et al., 2005), in the considered scenario *Visual Fidelity* is correlated with *Involvement* and *Understanding Stories*. *Involvement* is more strictly correlated with the ability to understand stories, with which it forms a cluster, than with *Visual Fidelity*: this highlights the greater importance of the audio component for understanding the context, which in turn is crucial for keeping the user's attention.

Neither *Visual Fidelity* nor the ability to understand stories, which could be considered as an audio component of *Sensory Fidelity*, is correlated with *Adaptation/Immersion*, which in turn is only weakly correlated with *Interface Quality* and not with *Involvement*.

6 CONCLUSIONS

The goal of the project is to raise awareness among the citizens, especially the inhabitants of Corsano and its surroundings, towards the enhancement of the territory and the local artistic heritage not included in the mainstream visit circuit, because of their peripheral geographical location or because of bad management upstream.

VR could be the most congenial tool to reach a wide range of target users. Therefore, the strategy is to exploit Virtual Reality as a tool for accessibility to cultural heritage, in its dual meaning. Traditionally, the term "Cultural Heritage" has referred only to tangible heritage, such as monuments, buildings, and objects. Later, the definition of the term was expanded to also include intangible cultural heritage, which involves the traditions and oral expressions of a community passed down from generation to generation (UNESCO-ICH, 2003). The evolution of the Castle of Corsano over the centuries has been available thanks to the information received from several sources in order to produce a hybrid combination of historical research and technology. This dichotomy between real and virtual, between history and memory is the fil rouge of the entire project, which becomes its strong point.

This paper encourages future more analytical research on the building, although the hope remains to make the castle physically accessible again.

REFERENCES

Banfi, F. and Bolognesi, C. (2021). Virtual Reality for Cultural Heritage: New Levels of Computer-Generated Simulation of a Unesco World Heritage Site. *Springer Tracts in Civil Engineering*, pages 47–64.

Bekele, M., Pierdicca, R., Frontoni, E., Malinverni, E., and Gain, J. (2018). A survey of augmented, virtual, and mixed reality for cultural heritage. *Journal on Computing and Cultural Heritage*, 11(2).

Cannarozzo, R., Cucchiarini, L., and Meschieri, W. (2012). *Principi e strumenti della fotogrammetria Definizione e classificazione*. Zanichelli editore S.p.A., Bologna, Italy.

Checa, D., Gatto, C., Cisternino, D., De Paolis, L. T., and Bustillo, A. (2020). A Framework for Educational and Training Immersive Virtual Reality Experiences. In *7th International Conference on Augmented and Virtual Reality and Computer Graphics (Salento AVR 2020), September 7-10, 2020, Lecture Notes in Computer Science*, volume 12243, pages 220–228. Springer.

Checa, D., Miguel-Alonso, I., and Bustillo, A. (2021). Immersive virtual-reality computer-assembly serious

game to enhance autonomous learning. *Virtual Reality*.

Ciardo, G. (2014). *Il Palazzo Baronale di Corsano: tra storia e architettura. Tesi di Laurea*. Department of Cultural Heritage, University of Salento, Lecce, Italy.

Cronbach, L. (1951). Coefficient alpha and the internal structure of tests. *Psychometrika*, 16(3):297–334.

De Paolis, L. T., Chiarello, S., D'Errico, G., Gatto, C., Nuzzo, B. L., and Sumerano, G. (2021). Mobile Extended Reality for the Enhancement of an Underground Oil Mill: A Preliminary Discussion. In *8th International Conference Augmented and Virtual Reality, and Computer Graphics (Salento AVR 2021), September 7-10, 2021, Lecture Notes in Computer Science (LNCS 12980)*, pages 326–335. Springer.

De Paolis, L. T. and De Luca, V. (2022). The effects of touchless interaction on usability and sense of presence in a virtual environment. *Virtual Reality*, 26(4):1551–1571.

De Paolis, L. T., Aloisio, G., Celentano, M. G., Oliva, L., and Vecchio, P. (2011a). Experiencing a town of the Middle Ages: An application for the edutainment in cultural heritage. In *IEEE 3rd International Conference on Communication Software and Networks*, pages 169–174.

De Paolis, L. T., Aloisio, G., Celentano, M. G., Oliva, L., and Vecchio, P. (2011b). MediaEvo project: A serious game for the edutainment. In *3rd International Conference on Computer Research and Development*, volume 4, pages 524–529.

De Paolis, L. T. and De Luca, V. (2020). The impact of the input interface in a virtual environment: the Vive controller and the Myo armband. *Virtual Reality*, 24(3):483–502.

Gatto, C., D'Errico, G., Paladini, G., and De Paolis, L. T. (2021). Virtual Reality in Italian Museums: A Brief Discussion. In *8th International Conference on Augmented and Virtual Reality and Computer Graphics (Salento AVR 2021), September 7-10, 2021, Lecture Notes in Computer Science*, volume 12980, pages 306–314. Springer.

Germak, C., Di Salvo, A., and Abbate, L. (2021). Augmented Reality Experience for Inaccessible Areas in Museums. In *Proceedings of EVA London 2021*, pages 39–45.

Messemer, H. (2016). *The beginnings of Digital Visualization of Historical Architecture in the Academic Field*. Palatium e-Publications, Monaco.

Revelle, W. (1978). ICLUST: A cluster analytic approach to exploratory and confirmatory scale construction. *Behavior Research Methods & Instrumentation*, 10(5):739–742.

Revelle, W. (1979). Hierarchical cluster analysis and the internal structure of tests. *Multivariate Behavioral Research*, 14(1):57–74.

Robin, B. (2006). The educational uses of digital storytelling. In Crawford, C., Carlsen, R., McFerrin, K., Price, J., Weber, R., and Willis, D., editors, *Proceedings of SITE 2006 - Society for Information Technology & Teacher Education International Conference*, pages 709–716. Orlando, Florida, USA: Association for the Advancement of Computing in Education (AACE).

Schubert, T., Friedmann, F., and Regenbrecht, H. (2001). The experience of presence: Factor analytic insights. *Presence: Teleoperators and Virtual Environments*, 10(3):266–281.

Schwind, V., Knierim, P., Haas, N., and Henze, N. (2019). Using Presence Questionnaires in Virtual Reality. Association for Computing Machinery.

Sànchez Mateos, D. (2018). *El nuevos museos y los nuevos públicos. El videojuego como un nuevo recurso de comunicación*, volume 3. Economia della Cultura.

UNESCO-ICH (2003). Text of the Convention for the Safeguarding of the Intangible Cultural Heritage. https://ich.unesco.org/en/convention.

Witmer, B. G., Jerome, C. J., and Singer, M. J. (2005). The factor structure of the Presence Questionnaire.

Witmer, B. G. and Singer, M. J. (1998). Measuring presence in virtual environments: A presence questionnaire. *Presence: Teleoperators and Virtual Environments*, 7(3):225–240.