Innovative solutions for the fruition of Cultural Heritage: VALUE

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Fig.1 - Demonstrative image of a user using VALUE.

Digital evolution leads to important changes on the ways cultural services are offered and on the visitor's role who, in certain cases, has the possibility to interact firsthand with the artwork.
The VALUE solution offers an innovative method of cultural enjoyment based on Mixed Reality technologies which turn the visit into an immersive and emotional experience.

The digital revolution has contributed to radically change the supply of goods and services across all market sectors. The spread of technological innovations has also brought substantial changes within the Cultural Heritage sector, improving the experience offered to the public.
Today's new technologies allow the implementation of innovative solutions capable not only of engaging users in a direct and stimulating way, but also of offering the artistic product in a completely different mode.
Just think of the possibilities offered by the so-called eXtended Reality (XR) which allows entire environments or individual works to be recreated in their original state even in those cases where the assets are not physically observable or accessible. Innovative solutions are not only limited to improving the visit experience but are a valid tool for breaking down social barriers; in fact, thanks to these technologies, it's now possible to allow even users with disabilities to get complete tours.
Within this context, VALUE (*Visual Analysis for Localization and Understanding of Environments*) is born, an innovative project that revolutionizes the visiting experience within museum spaces using specific technologies and digital tools. The service can be used by means of wearable devices (for example Microsoft HoloLens 2). On these devices, information content is presented in Mixed Reality, multimedia elements superimposed on the surrounding reality that allow

the user to live a unique and engaging experience.

Through VALUE it's possible to imagine interaction scenarios with monuments, archaeological finds and works of art virtually reproduced and visible through augmented reality headsets.

VALUE is also configured as a valid tool for analysing the preferences and degree of satisfaction of a visitor for benefiting the museum structure. To this aim, the system is able to anonymously collect data on the visiting preferences, implicitly expressed by the visitor through his stay in some rooms or in the intensive viewing of some works. This provides the managing body with statistical analyses to improve the organization of its cultural site (use of spaces, distribution of service staff, etc.), and, at the same time, improve the experience offered to the visitor.

From the analysis of the observed works, the system will autonomously identify visitors' preferences and will be able to offer "cultural recommendations" on other works on the same site that may be of interest and will provide proposals (*commercial suggestions*) for the purchase of objects, souvenirs, books and so on, available in the museum bookshop.

The development and testing phases of VALUE were conducted by examining the painting Annunciation by Antonello da Messina. The work carried out has made it possible to offer the visitor not only the

Fig.2 - Annunciazione (by Antonello da Messina), oil on panel 180x180 cm, located at Palazzo Bellomo in Syracuse.

Fig.3 - Demonstrative image of a visitor using the VALUE solution to access detailed information regarding the capital present in the Annunciation painting by Antonello da Messina.

Fig.4 - Avatar of Antonello da Messina created for the VALUE solution. By wearing the viewers, users can interact with the hologram and listen to information and descriptions of the painting directly from the artist of the artwork.

opportunity to appreciate the peculiarities of the painting in detail, with a fine analysis of the artwork's, but also to listen to the descriptions narrated by an exceptional guide, the author himself, Antonello da Messina, reproduced in "flesh and blood" in a digital version thanks to virtual reality. Once the smart glasses are worn, the user will be able to interact with the author's avatar and with the surrounding environment and discover information and details about the painting in an innovative way. The VALUE project has been developed with funds from Regione Sicilia via the PO FESR 2014/2020 – Line 1.1.5. – initiative (Support for the technological advancement of companies through the financing of pilot lines and early product validation actions and large-scale demonstrations).

CASE STUDY

L'Annunciazione (Annunciation) by Antonello da Messina is an oil on wooden panel painting dated 1474 and exhibited in the Regional Gallery of Palazzo Bellomo in Syracuse. Commissioned by the priest Giuliano Manjuni of Palazzolo Acreide (Bove, 2018), news of the work was lost until 1897 when it was rediscovered by Enrico Mauceri.

The scene represents the moment of the annunciation inside a room full of details, some of which were lost following the traumatic transfer from the panel to the canvas, an operation necessary due to the poor conditions of the wooden support (La Mendola, s.d.). The humidity has in fact led to significant deterioration which has subjected the representation to various restorations over time, essential to prevent further damage. The protagonists of the depiction are the archangel Gabriel on the left and the virgin Mary on the right. Great attention to architectural details such as the ceiling beams and details of the false ceiling. In the background of the windows that justify the light and bright colors of the foreground of the painting, a detail of Flemish inspiration and testimony to the influence of Jan van Eyck, a Flemish artist known by Antonello da Messina in Naples during his training (Bove, 2018).

TECHNOLOGIES

VALUE's great innovation is represented by Mixed Reality (MR). Through the wearable device, the visitor can observe virtual objects superimposed on the surrounding reality and interact with them, experiencing a unique and engaging experience. MR applications integrate holograms, virtual elements extremely similar to tangible physical objects, into the real environment. Holograms can be defined as virtual objects composed of light and sound (Coulter, et al., 2023).

To guarantee a 360° immersive experience, therefore, the positioning of these virtual objects must be carried out with great precision and verisimilitude. The mechanism that allows you to draw a hologram and position it in a specific area with respect to the environment is called holographic rendering .

The technologies developed in VALUE, the studies of the painting and the historical period of its creation, made it possible to conduct a peculiar analysis which led to the creation of a hologram of the artist Antonello da Messina. Once the smart glasses are worn, the avatar guides the visitor to discover the painting, the details, the curiosities and the history that has brought the painting up to the present day.

The device adopted for the development of the solution was Microsoft HoloLens 2, a viewer that can be considered a holographic computer capable of integrating the virtual world with the real world.

One of the characteristics of the device is precisely the ability to start spatial mapping processes that allow you to obtain an analysis of real surfaces and thus position holograms and contextualized virtual objects within the identified areas.

Key principles for hologram control include Position, Occlusion and Physics.

Position - By applying the principle of position it becomes possible to delineate suitable and unsuitable areas for the positioning of holograms.

Occlusion – Occlusion is the aspect that profoundly affects the user's perception, convincing him of the effective integration of holograms into the real world.

Physics – Applying this principle makes the user experience even more realistic. For example, by applying the laws of gravity to a falling hologram, the sensation perceived by the user will be even more integrated and harmonious compared to the real environment.

The VALUE solution is the result of the implementation of multiple technologies which combined, offer a product of cultural enjoyment with a great emotional impact. The technologies contained in the solution can be summarized as follows:

▸ Computer Vision: Recognition of observed environments and objects.
▸ Machine Learning: Data

Fig. 5 - Demonstration event open to the public of the VALUE solution, Wednesday 31 May 2023 at Palazzo di Bellomo in Syracuse.

analysis for improving recognition algorithms.
▸ Behavioral Analysis: Identification of user paths and preferences.
▸ Eye Tracking: Use of eye tracking to identify the details of a work observed by the user.
▸ Speech Recognition: Interaction with a conversational agent using natural language.

DEVELOPMENTS AND APPLICATIONS

In a context in which the visitor is the main actor of the visit experience, technology becomes the fundamental means through which to optimize the use of a service.

Even though visitors show more and more consensus regarding the possibility of enjoying a cultural asset through innovative systems, in Italy the entities that adopt new technologies are not only still few, but in most cases,

they marginally integrate new technologies into their offer, not adopting complete solutions like those described above.

Computer Vision is in fact one of the most promising technologies, especially within market sectors that offer services with a high emotional impact (Redazione Osservatori Digital Innovation, 2023). Thanks to technology, the museum structure improves the quality of what is offered to the public, providing more dynamic and complete information, capable of bringing the public closer to the artwork and providing information that will be remembered more over time.

In its testing phases with the public, the VALUE solution aroused strong interest among the majority of visitors sample. In particular, the public was more attracted to the solution and the possibility of being able to access historical-cultural contents

through a different methodology. Following the visit experience, almost all of the sample was fully satisfied and declared that they had learned more information than they would have done with traditional audio guides.

The solution developed to date is scalable, customizable, usable both from wearable devices and from Smartphones and Tablets and considering the cultural heritage sector, the application possibilities are numerous. Regardless of the nature of the cultural asset considered, in fact, the technology developed in VALUE finds great application in this sector. Interactive tours, characters that come to life, time travel, instant sharing and personalized experiences are just a few examples of how the solution can be implemented in different scenarios.

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ABSTRACT
The digital revolution has helped to radically change perspective in the provisioning of goods and services in all market sectors. In the CH business, people visit's approach has substantially changed, with the introduction of new enabling technology, i.e., Artificial Intelligence and related technologies like Computer Vision, Machine Learning, eXstended Reality, etc. The digital evolution, by modifying the process of providing the cultural services, determines important changes both in the ways of using the asset and in the role of the visitor, who more often has the possibility of interacting firsthand with the cultural artworks.
The VALUE project provides a different cultural fruition method, based on the use of mixed reality technologies capable of making the visit a unique emotional experience.

KEYWORDS
MIXED REALITY; MACHINE LEARNING; AUGMENTED REALITY; CULTURAL HERITAGE; COMPUTER VISION.

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Cultural Heritage as a Resource
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The association **CHNT-ICOMOS Austria** was founded in early 2021 to organise the annual Conference on Cultural Heritage and New Technologies. It is a sister association of the Austrian National Committee of the International Council on Monuments and Sites (ICOMOS). The association has around 20 members who contribute to the continuous development of the conference and participate intensively in the preparations.

The **City of Vienna** (Department 7 – Cultural Affairs) is the association's cooperation partner and is hosting the event in the Vienna City Hall.

CHNT provides a platform for exchanging views on the Cultural Heritage protection agenda and enables discussions among colleagues from a wide range of disciplines. During the conference the latest approaches to the research, management and monitoring of world heritage sites, cultural assets and archaeological monuments will be presented. The focus is primarily on interdisciplinary cooperation between experts with a strong interest in the application of new technologies in the field of cultural heritage.

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„We believe that technology can make a difference and help to protect, research and valorize Cultural Heritage in a sustainable way and to thereby preserve it for the next generation."