MiRA: Mixed Reality as a shared experience in the museum space.

A system of immersive visualisation and content authoring

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Background: XR in the museum

This contribution reports on an ongoing project which promotes an advanced paradigm of interaction and engagement in exhibition spaces, with the aim of improving the communication of cultural heritage, starting from the observation that many museum artefacts are fragmented and hence "invisible" because they are hard to understand, as they are exhibited without contextualization and without the information needed to be fully appreciated. The contemporary design practice of experiences, among which museum experiences, is increasingly characterized by an interplay between real and virtual elements, where both the space, matter and time of the experience may be actual or imaginary, leading to a multitude of novel possibilities on the digital frontier of experiences (Pine and Korn, 2011). The effectiveness of the Augmented Reality principle that is superimposed information, or Mixed Reality which is the intersection between real and virtual objects, as well as the more conventional Virtual Reality, is already widely documented also in the museum context (Silva and Teixeira, 2022). Particularly since 2021, the largest producer of virtual reality headsets (Meta) is strongly promoting the concept of metaverse to consumers (though their devices and services, naturally), which raises awareness towards immersive technologies, but also raises the issue of enclosing people in immersive illusions that entertain individuals without necessarily stimulating connections between them. While assessing the effectiveness of XR is an important issue (Trunfio, Campana, and Magnelli, 2020), resolving the debate on the long-term effects of XR is beyond the scope of this contribution. The assumption is that immersive technologies will have an increasing role also in the museum context, where the balance between private and shared experiences is particularly delicate.

This makes it relevant to consider the device through which the "immersion" happens. Currently, immersive extended reality (XR, comprising VR, AR, MR) experiences are implemented through smartphones, tablets and, qualitatively most relevant, with head mounted displays (HMD visors) which guarantee the perspective illusion through a direct contact with the user, in the same time raising issues in the museum context with hygiene, device durability, management, as well as some cognitive difficulties that limit usability for inexperienced users.

This contribution presents an experimental system that does not require any handheld or head-mounted devices to achieve immersive visualization with perspective illusion, comprising simple interactions with various types of digital contents. Based on the already experimented core experience, the goal is to develop a software platform that allows you to create effective interactive displays even in the absence of IT experts, while enabling professionals who already work with cultural sites. "MiRA: Mixed Reality Ambiances. A CMS for museums" is a multidisciplinary research and development project, funded by the region of Lazio, Italy, within the DTC programme, and carried out in collaboration between three universities and a company in the museum sector.

Technological principle of the already tested interactive experience

The MiRA system makes it possible to visualize extended reality (VR, AR, MR) without the use of devices in physical contact with the visitor, enhancing the exhibition spaces with the interactive and immersive explanation of the exhibits. The holographic effect is obtained through screens / projections positioned behind the exhibited objects, changing the perspective of the view according to the position of a visitor, which is precisely traced thanks to infrared distance sensors (depth camera, e.g. Kinect). Fig. 1 shows possible spatial configurations.

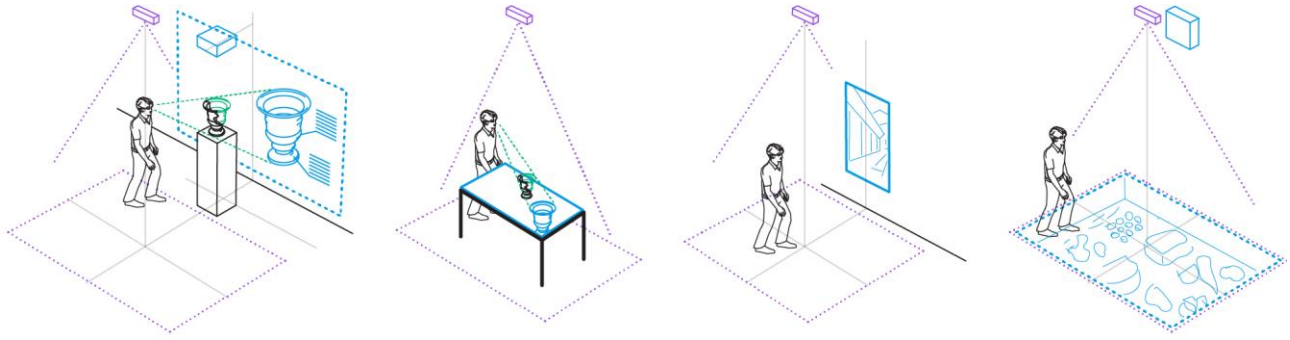

Fig. 1. Possible configurations between the depth camera and the area it observes (purple), the projection or other screen (cyan), the physically present objects (black) and the illusion of integration (green). The first two example shows the integration of a vase, placed on a pedestral and then on a table. The second two examples show the system working as a VR window or VR pavement showing archeologic reconstructions.

Using a common video game engine (Unity), the user's head position is used to set not only the position of the virtual camera, but also its custom calculated asymmetric frustum (viewing cone), in order to achieve the correct anamorphic illusion (Fig. 2). The system is suitable to various types of experiences, from the integration of physically present artefacts, to the opening of "virtual windows" for intuitive navigation of any three-dimensional content, on screens or projections that can be both vertical and horizontal (table, floor). Beyond the simple visualization of 3d scenes, the system is capable of simple interactions. Albeit full gesture control was excluded in order to minimize the visitor's burden of "learning" to enjoy the installation, it is still possible to use the head position (projected perpendicularly to the screen) as a pointer device providing x-y coordinates as a mouse would, albeit without any button-like interaction, if not through stopping for a few seconds to confirm choice. Using this parameter, the system will offer various interactive scenarios, ranging from the activation of additional info layers to showing the chronological evolution of an archeological site, as well as more playful scenarios such as a treasure hunt or a puzzle game.

Fig. 2. The already existing experimental setup at the Metateca of Terme di Aquinum, showing the illusion of integrating virtually the exhibited fragments of a vase and a sculpture.

The main advantage of this system lies in that, unlike HMD visors, the user's gaze remains free, allowing direct visual contact not only with the artifact on display, but also with other visitors, thus maintaining a sense of community. At the same time, other visitors are encouraged by the preview they have, even if distorted, after which they can enter in the immersive experience without any learning or calibration phase. The technological principle has already been tested and demonstrated in a relevant environment (TRL 6) with a previous funding. The present project is driving technology forward towards a more effective usability, for visitors and for cultural sites, crucial stakeholders with special needs.

Research and development in progress

The goal of the current project is to transform the existing ad hoc solution into a system that can be replicated in different contexts through a flexible, open authoring tool, usable without IT experts. The aim of this new tool is to provide a management experience comparable with common CMS platforms such as Wordpress, which allow the rapid editing of textual and visual content on the web. While there are already XR authoring tools in commerce, these are optimized for HMDs or handheld devices, and not for the special, "deviceless" setup experimented by this project.

The challenge of interaction design for the back-end software is twofold: on the one hand, interfaces are needed through which museum sector professionals (curators, archivists, archaeologists, installation designers) can calibrate the hardware components (projector, sensor) with respect to the museum space and exhibited objects. On the other hand, the system must make it possible to effectively set up the information displayed, be it three-dimensional integrations or environments, either static and animated. An abacus of pre-programmed interactive experiences is therefore established, which can be quickly customized with the appropriate cultural, narrative and visual contents.

For the back-end interface design, a multi-column layout has been adopted (Fig. 3), following the natural reading order of left-right & top-bottom. The first column is dedicated to high-level choices about the kind of immersive experience; the second column shows the scenario outline with its components (e.g. 3d models, animations, texts); while the third column shows the details of the selected

component. The two vertically stacked panels occupying the rightmost double column are dedicated to a preview of the screen and the active area where users are traced.

The resulting system has been ideated originally for the Italian context, in order to promote the effective presentation of archaeological relics that often need integration and/or contextualization to be fully appreciated. However, the same principles could be applied worldwide to a variety of museum types, form natural history museums which have a similar issue of partial preservation, to art museums where the immersive and playful communication of the historic context can help to explain the artworks.

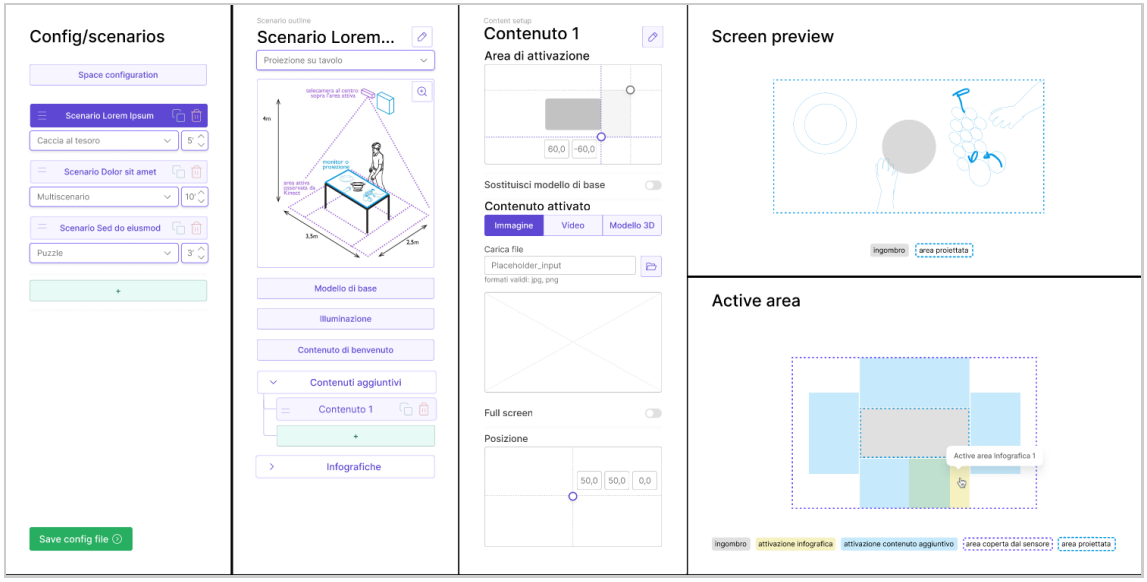

Fig. 3. A mockup of the back-end interface for content configuration, in development.

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