REVITALIZING MULTIMEDIA ART: RESTORATION AND RE-ACTIVATION OF AN AUDIOVISUAL INSTALLATION IN VIRTUAL REALITY

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ABSTRACT

In this paper we describe the re-activation of the multimedia artwork "La(M)pelle di Ahmad" (1979) by Italian artist Roberto Taroni, an installation that combines visual and sonic arts, using Super 8 films and magnetic audio tapes. After the digitization and the digital restoration of both film and audio components, we re-activated the artwork in a Virtual Reality (VR) environment. This technology provides a unique opportunity to recreate the immersive experience, and to preserve the original concept of the artwork, enabling the audience to experience it in a digital context. We recreated the physical features of the original installation in the virtual environment, as well as the interplay between the multiple audio and film sources, aiming for a faithful recreation of the original installation that also incorporates considerations from the artist. Maximizing access to the installation was one of the main objectives during the design of the digital experience, therefore we took care to balance the needs for faithful preservation and for usability on older, more widely available hardware. This project revitalized the historical artwork, underscoring VR's efficacy in preserving cultural heritage in resource-constrained settings by exploring the possibilities offered by virtual reality in preserving and re-activating multimedia art installations.

1. INTRODUCTION

In contemporary arts, the coalescence of diverse media, aided by advances in interactive technologies, has become a defining characteristic of modern artistic expression. Art forms can be characterized by the technologies employed (e.g., artificial intelligence, virtual reality), multimedia (e.g., film, video, sound), or the modes of engagement (e.g., installation, performance, interaction). In addition, the temporal and spatial context assumes a central importance in the creation of the artwork, alongside the dynamic nature it may assume due to internal or external influences (e.g., audience interaction). New multimedia artworks diverge significantly from traditional fixed forms such as paintings, sculptures, and architecture, because they lack permanence. Multimedia artworks, whether film, video, sound, or computer-based, need innovative preservation methodologies and new access-oriented approaches tailored to the unique characteristics of contemporary art.

Roberto Taroni emerges as a vibrant presence within the artistic scenario. Born in 1957, since the inception of his career, he has embarked on an ambitious and intricate endeavor, crafting a holistic artistic vision that traverses various disciplines, combining sound (especially electronic music) and visual arts. Taroni's artistic journey is distinctive in its exploration of diverse modes of expression, intricately weaving together a tapestry of influences and stylistic approaches. Over time, he has established himself as a fixture in the art world, evolving as a visual artist and a distinctive designer. His artistic pursuits encompass a broad spectrum of forms, including multimedia installations, films, performances, and *expanded cinema* [1], adding layers of complexity to his work. The exploration of expanded cinema holds particular significance within Taroni's body of work, as it not only pushes the boundaries of traditional filmmaking but also creates immersive and multisensory (visual and aural) experiences for audiences within his installations.

Taroni's artistic collection includes a vast array of cinematographic works and a rich archive of sound materials, often used by the artist in his installations and performances. The Centro di Sonologia Computazionale (CSC) [2, 3] of the University of Padova worked on the digitization and restoration of the whole corpus of sound materials, including 1/4" open-reel tapes (stereo, quadriphonic, and 8 channels), traditional audiocassettes, as well as the less common "Endless" type, used for creating small loops (usually between 3 and 5 minutes, and up to 12 minutes long), examples of which are shown in figure 1.

This digitization intervention followed a previous digitization of film materials by Taroni-Cividin, conducted by La Camera Ottica Film and Video Restoration Lab of the University of Udine in 2022-2023, when the first author of this paper was part of the preservation team. This standalone preservation project was carried out in relation to *Taroni-Cividin. Performance, Video, Expanded Cinema (1977-1984)* [4], supported by the Directorate-General for Contemporary Creativity - Italian Ministry of Culture under the Italian Council program (2021).

Starting from 2023, the research team of the CSC

Figure 1. Original audio recordings on 1/4" open reel tapes and audiocassette used in the installations.

worked with the artist in exploring new possibilities for re-activating his artworks and digitally restoring the digitized materials, focusing on a particular case study: the 1979 installation *La(m)pelle di Ahmad*.

2. MOTIVATION AND RELATED WORKS

Traditional methodologies employed by archives and museums, while effective for many forms of art, often prove insufficient for preserving and re-activating multimedia art installations. In fact, multimedia art installations present unique challenges in terms of preservation and accessibility, often related to their complex nature (i), the short-life expectancy and obsolescence of digital and analog components (ii), and their time and process-based nature (iii). Nevertheless, the tendency of traditional paradigms is to preserve installations as fixed objects, rather than dynamic ones. Experimental preservation strategies have been applied to revive numerous multimedia pieces. Since the 2000s, several European initiatives, such as those undertaken by ZKM in Karlsruhe and the Archive of Digital Art (ADA), and projects such as the Horizon's *Dynamic Preservation of Interactive Art: The next frontier of Multimedia Cultural Heritage* and *New Approaches in the Conservation of Contemporary Art* (NACCA) have focused on preserving new multimedia art, but there is still the need of a shared preservation methodology.

Another open issue concerns not only the technical and material aspects of the artwork but also the *user experience* and the *interaction* within the surrounding space, since multimedia installations often engage viewers in an interactive experience with the environment.

To overcome these challenges, the CSC started to work on this topic in 2014 [5], and this effort led to the definition of the Multi-Dynamic Preservation Model (MDP) described in [6]. To refine and expand the MDP model, the CSC research team is currently exploring new re-activation strategies and considering new case studies. The advent of modern technologies, such as Virtual and Augmented Reality, offers a promising solution to this challenge. Virtual Reality enables the virtualization of real environments [7] and creates interesting possibilities for re-activating obsolete multimedia installations in an immersive and interactive manner, allowing users to fully experience the artwork. The recent progress in VR technology expanded its applicability across various domains. The emergence of relatively affordable hardware from corporations like HTC and Oculus has made VR more accessible, alongside software platforms often coming from the video game industry, which underscores the continued influence of the gaming sector on VR development [8].

In recent years, the possibilities offered by VR technologies in the field of preservation started to be explored by some international projects, for example *Obsolete Equipment*, a collaboration of the Netherlands Media Art Institute (NIMk) and PACKED, Platform for the Archiving and Preservation of Audiovisual Arts, together with MHKA Museum van Hedendaagse Kunst Antwerpen (Museum for Contemporary Art Antwerp), and S.M.A.K. Stedelijk Museum voor Actuele Kunsten Ghent (Municipal Museum of Contemporary Art in Ghent), SMA Stedelijk Museum Amsterdam, Museum Kröller-Müller en Instituut Collectie Nederland [9].

In this scenario, the possibilities offered by VR may also be explored in the field of digital restoration and its related documentation. The use of this technology may in fact allow the users to visualize the installation before and after the restoration intervention. This can be particularly interesting when dealing with multimedia installations that use analog *time-based media* [10] such as videos, open-reel magnetic tapes, films, and audiocassettes as fundamental components of the artwork. These materials face several problems related to obsolescence and physical/chemical degradation of the carriers, which significantly lower their life expectancy and the quality of content. Before restoration, VR enables the visualization of the artwork in its original state, allowing the users to experience its original preservation conditions. After restoration, VR allows the direct comparison of the previous state with the current one, highlighting the transformations and improvements introduced by the intervention.

3. CASE STUDY: LA(M)PELLE DI AHMAD

Among Taroni's works, the 1979 installation *La(m)pelle di Ahmad* stands out as a significant case study for its use of space, multi-projection, and audio/video looping as a means to explore new artistic possibilities. This installation is an emblematic example of multisensory and conceptual exploration that gives the users an immersive experience. Comprising three films projected onto as many walls, *La(m)pelle di Ahmad* immediately captures the viewer's attention. The first projection, taken from the film *Umwelt* (1978), strikes with its simplicity and evocative power: a light bulb suspended in darkness, the thin filament disappearing into the void, evokes a sense of mystery and contemplation. The second film, extracted from *La bocca di Ahmad* (1978) focuses on the mouth itself, a symbol of communication and introspection, opening and closing in a hypnotic rhythm, inviting the viewer to reflect on the meaning of language and human expression. Lastly, the third fragment unveils an additional layer of complexity, depicting the skin on the back of a knee where the

schematic for the installation is drawn. This metaphorical representation of the structure of the artwork questions the relationship between the artist, the artwork, and the users, opening spaces for an interpretation that extends far beyond the visible surface of the installation.

The film components are accompanied by three different audio loops that create a surreal dimension of interaction between sound and visual components. The loops were recorded on a tape used by the artist during the performances. In fact, in the whole of Taroni's artistic production, the sound element plays a very central role, almost as much as the visual content.

4. DIGITIZATION AND DIGITAL RESTORATION

4.1 Film materials

In 2022, the research and technical team of the Camera Ottica Lab, University of Udine, carried out a first digitization of the films belonging to the artist's collection. The materials comprised different films shot in 16 mm, 8 mm, and Super8 formats. The digitization ensured the creation of 2K digital preservation copies, as well as the inspection and reparation of the original materials. Materials filmed in 8 mm and Super8 were digitized using an MWA Choice film scanner, while the 16 mm films were digitized using the Blackmagic Design Cintel film scanner; the files were encoded with Apple ProRes 422.

Figure 2. Digitized Super8 films used in the installation before color correction intervention (a) and after (b).

The original Super8 films used for *La(m)pelle di Ahmad* were contained in special cassettes that allowed the artist to play their content in an endless loop. Therefore, before proceeding with the inspection and reparation of the material, it was necessary to extract the film from the cassette box. Some of the digitized films exhibited severe color fading, typically in magenta tones, which required correction. This was carried out by the research team of CSC using the software DaVinci Resolve 18 [11], a standard in the film restoration and video editing industry. The color correction intervention aimed at reestablishing the original tones of the films that were lost in the originals (Fig.2).

4.2 Sound materials

The sound materials were digitized by the CSC in 2024, following the methodology developed at the centre described in [12, 13], and refined in numerous digitization and restoration projects since [14].

The digitization process of the sound collection encountered several challenges due to the preservation conditions of the analog materials and, in some cases, poor sound quality, likely resulting from multiple transfers of the content over the years. In fact, on many occasions, Taroni used to work on open-reel tapes that were then copied on audiocassettes to take advantage of the possibilities offered by smaller portable formats and devices. For digitizing 1/4" open-reel tapes, three different open-reel recorders were used: the Studer A810 (up to 2-channel tapes), the Otari MX5050 (4-channel tapes) and the Fostex A-8 LR (8-channel tapes). Audiocassettes were digitized with a TEAC W-1200 double cassette deck. The A/D conversion was performed at 24 bit/96 kHz using Prism Sound Converters (*Lyra* and *Orpheus*). The digitization of the sound materials allowed us to identify the audiocassette containing the original audio loops used in the installation. For this installation, the artist created two electronic music compositions through the creative use of a phase modifier that intervened with the sound of a windshield wiper of a car, along with sounds produced by a sound effects generator and a Casio synthesizer. This combination of elements created two unique works, where the noise of the windshield wiper blends with synthesized melodies and sound effects. In the third composition, Taroni adopted a different approach, overlaying different contents on the two separate channels: the first channel features an excerpt from Orson Welles' famous radio broadcast *The War of the Worlds* (1938), while the second channel includes three swing-jazz songs (*Thinking of you* by Key Kayser, *When the moon comes over the mountain* by Kate Smith, and *Goodnight Sweetheart* by Bing Crosby). This overlay creates a fascinating contrast between the rhythm and the melody of the songs and the dramatic and eerie atmosphere of the radio excerpt, offering an engaging and multi-layered sound experience.

The audio tracks of *La(m)pelle di Ahmad* presented various issues, such as harmonic saturation, hum, and a high level of background noise. To address these issues and restore the audio to its original quality, the software iZotope RX 10 [15] was used for its advanced capabilities in noise reduction, spectral editing, and audio enhancement. Audio tracks were processed with De-Click and De-Crackle algorithms to remove impulsive noises, and then they were processed with a De-Hum filter to attenuate the low-frequency Hum. The background noise presented various profiles and intensities due to the fact that some of the noise was intro-

duced by the audiocassette carrier, while another component had been introduced by the original analog devices (open-reel tapes and phonographic discs) used for the first recording. Therefore, it was necessary to process the files acquiring multiple noise profiles while applying the DeNoise algorithm. The third composition was recorded on two separate channels of the audiocassette (Fig. 3), but during the live performances, the artist played it through a single speaker. Therefore, during the digital restoration process, the audio track was converted into mono. The whole restoration process took into consideration the interaction between the sound sources in the VR environment, especially in the final mixing and equalization process, in order to allow the user a better experience by removing resonances and unwanted energy on some frequencies.

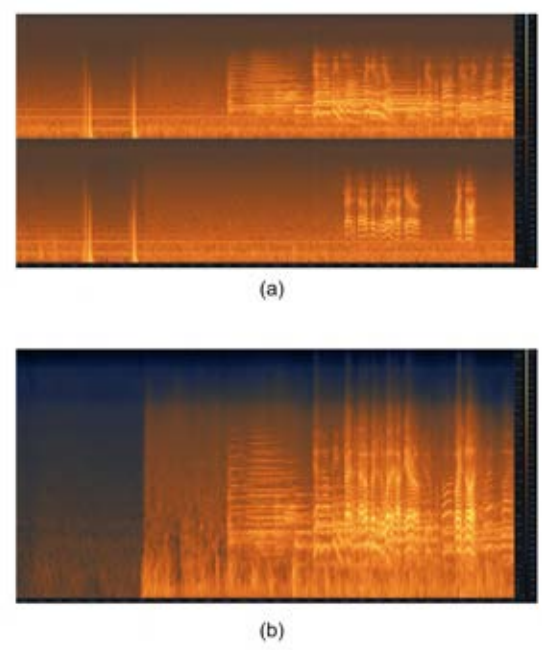

Figure 3. Original audio track before restoration (A) and after (B)

5. RE-ACTIVATION IN VIRTUAL REALITY

In re-activating the artwork, we considered the following requirements:

1. Accurate recreation of the physical features of the installation in the virtual environment;

2. Possibility to experience the artwork before and after the digital restoration process;

3. Accessibility of the artwork.

Given the relevance of the artwork's spatial aspect, we decided to recreate its typical real-life implementation in a 3D virtual environment, according to the artist's notes, instead of simply restoring and preserving the audio and films in digital form. Maximizing access to the artwork (requirement 3) meant having to work with dated technology so that the resulting application would be accessible to the widest range of VR headsets. We chose to work with two modern consumer VR headsets that are at the opposite ends of the technological state of the art: the Oculus Quest (2019), and the Meta Quest 3 (2023).

To meet these requirements, we needed a way to develop a VR application that was (i) flexible, to allow fast prototyping and iteration, and (ii) easily available, well documented, implementing open standards, and ideally (iii) open source, to ensure ease of future maintenance. We chose the open-source video game engine Godot [16]. First appearing in 2013, Godot is relatively new compared to the most popular engines commonly used for VR applications, such as Unity (2005) and Unreal Engine (1998). Despite this, Godot supports OpenXR, the open-source standard for virtual and augmented reality applications, and the documentation is of consistently good quality and frequently updated, making Godot a good choice for this project.

The virtual installation has been re-activated in two different versions: the first one includes the original digitized materials before any restoration intervention – i.e., faded film materials with magenta tones and noisy soundtracks – while the second one displays color-corrected films, accompanied by restored audio tracks. Pressing a controller's trigger allows the user to switch between the pre- and post-restoration versions.

La(m)pelle di Ahmad was typically implemented in a square or rectangular room, approximately 6×6 meters wide, and consists of three films projected on three of the four walls of the room, with three sound sources placed underneath the projection surfaces. All three projectors were Technicolor Instant Filmloop and were placed in the middle of the room, each facing its own wall. The projectors would be placed on a stand or, more frequently, hanging from the ceiling with wires.

5.1 Visual elements

We modeled the environment from scratch using Blender [17], based on the artist's instructions. We placed the projectors on a surface hanging from the ceiling using a rigid pole. This allowed us to limit the visual impact of the stand while at the same time avoiding issues with oscillating projectors, as they would be if hanging with wires. To not interfere with the artwork, we sought a balance between accuracy and clutter by only including the minimum visual elements to recreate the experience and excluding tangible items such as power cords, audio cables, unnecessary mounting parts, and so on. We did however include intangible analog elements such as the projectors' light flickering, because the artist felt it was an important part of the experience (Fig. 4). A 6-DoF visor enables the user to move inside the virtual environment to get around the projectors and closer to the projection screens. If the visor used does not support movement, we place the point of view near the empty wall, where the user can have a clear view of all the three projections.

Global Illumination (GI) was critical to achieve a minimum level of realism. Godot 4 does support several real-

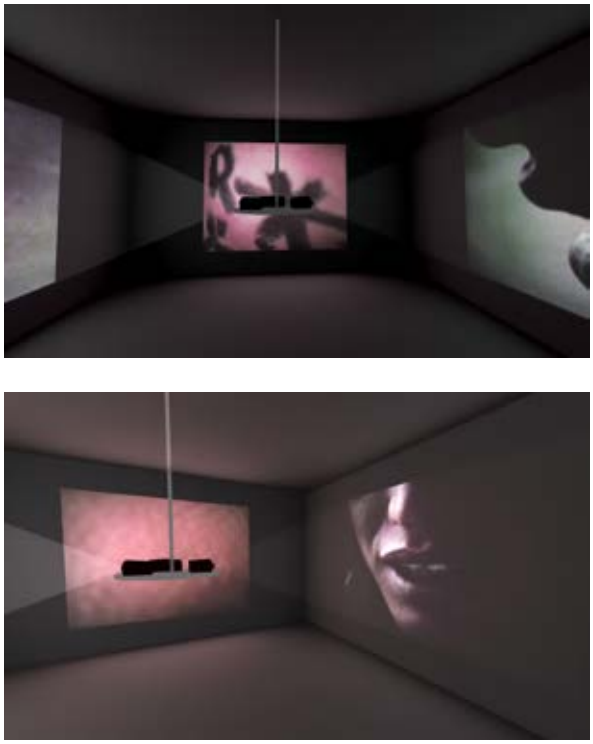

Figure 4. Vignettes from the re-activated VR installation.

time GI approximation techniques, such as Screen-Space Indirect Lighting (SSIL) and Signed Distance Field Global Illumination (SDFGI), but these are not available when deploying to stand-alone VR headsets, especially of the older generations. We resolved to fake GI by using regular lights, but found that the implementation was too computational demanding for the older headsets. The solution was to use Blender to bake the GI to a texture, and use it as an emissive texture in the scene, thus avoiding the expensive lighting implementation. By baking each light separately, we achieved the double objective of having high quality global illumination in the scene, and of being able to fake each projection's dynamic contribution by modulating each texture's colour and intensity, all for a very limited computational cost. While not entirely accurate, the result is convincing.

5.2 Aural elements

We placed positional audio sources in correspondence with the speakers. While Godot does not currently support binaural rendering, the illusion of spatialization is created through a combination of filters, effects, and panning, based on the relative positions of the sound sources, the listener, and the surrounding geometry. The audio sources in the original installation "interacted" with each other by raising and lowering their volume. Typically, when one source became louder, the other two became quieter. This behaviour was replicated in the VR implementation, introducing an additional level of uniqueness to each performance. Together with the 3 audio tracks, we included the motor noise of Super 8 projectors, which the artists indicated to be an important element of the original installation.

5.3 Evaluation

We performed a lightweight evaluation with a limited number of users during the iterative development process, looking at issues such as general discomfort, motion sickness [18, 19], and acceptability of the virtual audio-visual environment. During the time spent in the virtual environment, none of the testers reported any significant discomfort or motion sickness symptoms. Given the concept behind the original installation, the time spent by the user in the virtual environment was expected to last from 1 to 5 minutes. For such short sessions, the obtained results are then largely expected, and further formal testing will be performed once the re-activation is finalized and deployable on a larger scale.

In the near future, we intend to further evaluate the VR re-activation on more areas. The first one addresses usability, including issues of VR sickness and acceptance of the virtual environment, evaluating the re-activation with a larger number of users within a longer persistence period. The second is an evaluation of the installation's experience before and after digital restoration while also analyzing how user experience changes by including or removing analog elements such as projector noise and flickering. The whole evaluation will be accomplished by also providing users with archive documentation about the installation.

6. CONCLUSIONS

Virtual Reality has proven to be an interesting technology for re-activating and revitalizing multimedia art installations, especially for similar case studies. Through immersion in three-dimensional virtual environments, viewers can experience *La(m)pelle di Ahmad* in a completely new and engaging way, while still exploring the environment as it was conceived and created by the artist. Thanks to these technologies, the preservation intervention transforms into an immersive experience that helps in facing obsolescence-related problems typical of analog *Time-based media*. The use of VR improves access to artworks, allowing people with disabilities and users from distant locations to participate in the artistic experience without physically visiting the installation site. In fact, we plan to deploy the virtual experience on the artist's website where it will be freely accessible both as a traditional desktop-based 3D experience, and as a VR experience when using supported hardware. Furthermore, the virtualization of multimedia artworks such as *La(m)pelle di Ahmad* provides an innovative opportunity for users to experience the artwork before and after the digital restoration, both for audio and film components. Viewers can directly compare the differences and transformations brought about by the restoration process, enabling them to appreciate the technical aspects of the digital intervention and its impact on the artwork. This opportunity for direct comparison not only enhances the user experience but also contributes to critical understanding and artistic education, fostering greater awareness and appreciation for this particular art form.

During the entire lifespan of the project, from the digitization of the original materials through to the re-activation in a virtual environment, it has been of crucial importance working closely with the artist, and therefore having access to their knowledge of the artwork and the documentation collected during the artwork's original development and implementation. Without either of these, we would have found it much more difficult to make certain restoration and re-activation choices – e.g., selecting the correct audio tapes, and finalizing details in the virtual environment, such as the location and appearance of the original projectors, sound sources, and so on. If direct access to artists may become a challenge in time, we hope that this shows the importance of documenting the development of similar artworks, and the importance of preserving the related documentation as much as the artworks themselves. In the next future, we plan to further study the virtualization approach by applying it to other case studies of multimedia art installations, with the aim of defining guidelines within the MDP model, enabling more effective and targeted future virtualization interventions.

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