Preserving today for tomorrow: a case study of an archive of Interactive Music Installations

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***Abstract*—This work presents the problems addressed and the first results obtained by a project aimed at the preservation of Interactive Music Installations (IMI). Preservation requires that besides all the necessary components for the (re)production of a performance, also the knowledge about these components is kept, so that the original process can be repeated at any given time. This work proposes a multilevel approach for the preservation of IMI. As case studies, the *Pinocchio Square* (installed in EXPO 2002) and the *Il Caos delle Sfere* are considered.**

I. Introduction

Since the 1970s, computers have become the main tools to explore the acoustic world by deconstructing the sound matter at the level of elementary attributes of signals relying on different analysis techniques, while programming languages and synthesis techniques have allowed a nearly total control over the sonic material.

During the 1990s physical and spectral modeling was enhanced and various interfaces for musical creativity were developed and widely spread. The exploration of different levels of complexity, from physics to phenomenology and semantics, was made possible by improved tools that balanced cost and efficiency.

The musical works created with the above-mentioned technologies are represented in a *fixed* form (i.e. recorded music). In this sense, the preservation problem has reference to the preservation of the audio documents (i.e. audio signal, metadata and contextual information[1]).

[1]In this context, as it is common practice in the audio processing community, we use the term metadata to indicate content-dependent information that can be automatically extracted by the audio signal; we indicate as contextual information the additional content-independent information

More recently, the role played by multimediality within the performing arts has become more and more important, most notably in the music field, where the opening to interaction between images and sounds fostered the experimentation of new expressive solutions by the artists. Along with the evolution of the creative processes, the development of increasingly more sophisticated audiovisual technologies affected the ways in which the public acknowledges the artistic event, its habits and aesthetics. With innovative solutions for mutual interaction, music, dancing and video turned into "expanded disciplines", thus giving birth to "Interactive Music Installations" (IMI). At present, the spotlight is on physically-based sounding objects that can be manipulated and embodied into tangible artifacts that support continuous interaction. Technology offers the tools to detect and control sets of variables which modify specific elements within a system (sensors), it relies on an enhanced computational power and it pays special attention to design strategies.

Generally IMIs are able to detect and analyze motion, speech, sounds produced by one or more users, in order to control sound synthesis, music and visual media (laser effects, video, virtual avatar) in real-time, and to modify the environment (setting and mobile robots). IMIs observe and act within a certain environment, modifying their own structure and responses in a dynamic way according to the users' behavior (same gestures have different effects in different settings). Basically IMIs are able to retrieve general features in a Gestalt-like approach to the detection of sound and motion.

Unlike virtual reality and multimediality, IMIs are not aimed at deceiving the human sensory system, but to extend reality, allowing the user to interact with an expanded world by means of technology, mainly for artistic

and esthetic purposes. Particularly important in this sense is the SAME project (http://www.sameproject.eu/) that aims at creating a new end-to-end networked platform for active, experience-centric, and context-aware active music listening/making.

Besides providing scientific and technological requirements for the creation of new forms of musical dramaturgy, the playback and recording devices for audio/visual reproduction is the one to suit best the preservation and the spreading of the moment of the performance. Collecting several recordings of an art work, shot under different circumstances, allows a thorough documentation of the history of the work itself. Furthermore, recordings are the only means to keep memory and to increase the value of those works which were performed only once.

Digital tools makes it possible to (i) watch over and over again an event after it was performed and to (ii) reorganize its elements with hyper-textual and interactive processes, for example by enriching the video-recording with interviews and backstage footage. Besides, shooting an event with several cameras introduces a multiple point of view which is impossible to have in a regular theater set, where the experience is usually static and tied to the features of the venue. Such possibilities clearly point out that recordings are artificial reconstructions that by no means can take the place of the original performance.

In the field of audio documents preservation some relevant guidelines have been sketches along the years, but most questions regarding the safeguard and the preservation of IMIs remain unanswered, as the (European) regulations in force do not provide for specific care or legislative obligations. One of the few work related to the IMI preservation is the ontology approach used in [1], [2] to describe an IMI and its internal relationships to support the preservation process. The proposed ontology is an extension of the CIDOC Conceptual Reference Model (CIDOC-CRM), which is an ISO standard for describing cultural heritage [3]–[5].

The study of several projects related to the preservation of virtual artworks gave rise to some interesting considerations: the Database of Virtual Art in Germany [6] is aimed at archiving expanded documentation about virtual artworks; the Variable Media Network [7] encourages artists, in the field of conceptual, minimalist and video art, to define their artworks medium-independently so that the artworks can be recreated at another time, when the medium becomes obsolete; the Variable Media Network also aims at developing the tools, methods and standards required to implement this strategy. Altogether, research in preservation of artworks has investigated different preservation methods. However, there has been no definitive answer on which one is the best approach for preservation of artworks in general and IMI in particular. In our field, the preservation of various recordings (such as still images, audio and video) remains necessary, but not sufficient. Motions of performers as well as the setting of performance space also need to be captured and preserved. Our differentiation is that we strongly believe that not only an exact experience of a performance must be recreated, but also the interactions must be archived for future analyses, studies and fruition.

In this sense, this work presents the problems addressed and the first results obtained by one of the first projects completely dedicated to the preservation of Interactive Music Installations. After an overview of the problems related to the IMI preservation (Sec. II), Sec. III, considering [2], presents a multilevel approach for the creation of an IMI archive. Finally, it describes some experimental results obtained in the preservation of two installations, the first produced for EXPO 2002 and the second presented in a number of Italian venues (Sec. IV).

II. Interactive Music Installation: preserving the *experience*

The meaning of an IMI inextricably lies in the interaction among people, objects, and environment [8], in this sense IMIs must have (at least) three characteristics: (i) a phenomenological essence, that is meanings and structures emerge as experienced phenomena; (ii) an embodiment ; (iii) the human interaction .

As mentioned above, music works that were written or recorded in a fixed form mainly refer to problems that lie within the scope of the audio documents preservation. IMIs demand a different challenge, that is to *preserve the interaction*. This involves the preservation of: audio signal, metadata, contextual information and *experience*.

In the IMI context, audio (non-speech) signal contributes to the multimodal/multisensory interaction, which can have several meanings. It represents the main goal of the IMI in itself when it is the vehicle for the music performance, but the audio channel can also be used to communicate events and processes, to provide the user with information through sonification, or to give auditory warning. This communication is related to the physical world where the IMI is immersed. Depending on the environment where the IMI is set, the same sound can elicit different levels of representation. In visual perception, space can be considered an indispensable

attribute [9], i.e. a prerequisite for perceptual numerosity. The Time-Frequency plane (with spectra, envelopes, etc.) is the principal dimension of auditory perception, where auditory spatial perception is in the service of visual perception: *Ears lead Eyes*.

All this considered, it should be now clear that it is not possible to use the protocols and instruments defined in the field of multimedia documents preservation: in fact what we preserve are not (only) audio and video documents. So what do we preserve? *Useful information* [10] is the answer to the question. In this sense, we must preserve at least two sound attributes: source localization and the sensation of *ambience*. This is not necessarily realism, but rather *Fidelity in Interaction*.

III. Preserving (faithfully) the interaction: a multilevel approach

As expressed in [11], "preservation is the sum total of the steps necessary to ensure the permanent accessibility – forever – of documentary heritage". In most forms of traditional artistic expressions, the artifact coincides with the work of art. In Interactive Music Installations, however, it is less clear where the art lies, as it usually "happens" during the process of interaction. Preserving the installation as it was presented to the public falls within the scope of current approaches to preservation, yet the creative process is something impossible to freeze. Therefore, in this sense, the preservation is an ongoing process: nothing has ever been preserved: it is being preserved. In our opinion, in order to grant a permanent access, which is the ultimate objective of preservation, a combination of approaches is desirable. The *model* that underlies the interaction process is essential. This leads to different levels of preservation, with different purposes and ways to be performed. Moreover, we must consider that two forms of preservation exist: static where records are created once and not altered and dynamic where records keep changing. The next paragraphs describe a multilevel preservation approach, which is summarized in Tab. I.

Preserve the bits – Each part of the original installation that can be directly preserved. All the data are kept in the original format (the problem of their interpretation is a matter aside), and the risk of introducing alterations must be avoided. It is a physic and static form of preservation, and it works in the original contexts. It still requires metadata preservation and refreshing. There can be physical and digital objects. Preserving the digital objects will follow the general conceptual model defined in the OAIS Reference Model [12]. This means that each digital object will be accompanied by its representation information, preservation description information (i.e. reference, context, provenance and fixity) and descriptive information. The *performance* objects also need another layer of information about itself as a whole, including information about: i) various activities necessary for the performance and their temporal relationships; ii) necessary components of the performance and how these components can possibly be linked together to create the performance. The most challenging problem is to preserve the knowledge about the logical and temporal relationships among individual components so that they can be properly assembled into a performance during the reconstruction process.

Preserve the data – Technical notes, comments and useful information about the realization of the installation. Includes a high level descriptions of algorithms and models. No special attention is paid to presentation and context. It is a physic and dynamic form of preservation, as it could be necessary to use new design languages, possibly developed on purpose.

Preserve the record – Any element that was modified or updated in respect of original installation. Includes reinterpretation of the patches and information about the context. Costs are balanced against utility, and appearance is not necessarily preserved. It is a logic and static form of preservation. Some risks are tolerated, if not necessary (e.g. migration to new informatics environments). The results of each intervention should be checked using philological instruments. This level needs another layer of information about activities *actually* performed in the performance (the actual activities performed during a performance can be different from the necessary activities mentioned at the *bit* level).

Preserve the experience – Any document that bears witness to some aspect of the installation. Includes hardware, software, interviews, audio/video recordings, usability tests of the original system, as well as information about people (composers, directors, performers, technicians) involved in the original performance and their roles. Resembles a museum-like approach, that aims at keeping track of the history of the installation. It may require emulators or old computers (emulators reproduce a whole system, or a program; system emulators require us to use old interfaces; program emulators may use current interfaces) and/or migration in new systems (*reinterpretation*). Although emulation has been known as a method that could create the original look and feel of the work [13], [7] showed that this was not easily

achievable, owing to many differences between the original hardware platforms and their emulated counterparts, such as CPU speeds, as well as looks and feels of the new hardware platforms. Reinterpretation seems to be a preferred approach, where the artworks could be entirely encoded using a symbolic notation [14]. It is a logical and dynamic form of preservation, necessary for a long term action ($>$ 30 years). Its existence may be more important than the content, although it does not help reuse, it is expensive and not oriented to fruition.

The rapid obsolescence of the new technologies employed in Interactive Music Installations complicates the maintenance of hardware/software (bits and data). Besides, some installations base their interaction on objects that are meant to be used or consumed by the users (food, perishable material, etc.). This implies that parts of the installation may literally not exist anymore after the interactive process is over (no bits to preserve). The approaches described above do not require sequentiality, as they basically pursue different goals. Quite the contrary, they may occasionally show overlapping contents.

IV. Cases study

A. Pinocchio Square in EXPO 2002

The multimedia exhibition *Pinocchio Square* has been presented at the EXPO 2002, at Neuchatel (CH) in the period May-October 2002. Scientific partners were Sergio Canazza and Antonio Rodà, at that time, members of Computational Sonology Centre of the University of Padova, while involved artists were Carlo De Pirro (1956-2008: music composer, professor at the Conservatory of Music "Venezze" in Rovigo, from 1982 to 2008) and Roberto Masiero (artistic director, Professor in History of Architecture at the University of Venice). This IMI was motivated also by scientific aims, which were to test some movement analysis patches, for the measurement of high level features and to investigate some kinds of mapping between movements and music and its effect on a children audience. Moreover, an additional goal was to test the reliability of the Eyesweb environment (www.infomus.org/EywMain.html) during a long time performance (18 hours/day; 6 months).

1) Concept: In the contest of EXPO 2002, Switzerland built some wood platforms in its four major lakes. Each platform (80 x 30 meters) was dedicated to an artistic topic or to a scientific discipline. Our exhibition was installed in the platform dedicated to Artificial Intelligent and Robotics. The system was made by a room for children, like a magic room, in which each gesture becames sound, image, color. In this system the visitors are been involved in a communication of expressive and emotional content in non-verbal interaction by multisensory interfaces in a shared and interactive mixed reality environment. From the gestures of the visitors (captured by two video-cameras) are extracted the expressive content conveyed through full body movement. Mapping strategies will convey the expressive content onto a multimedia output (audio and video). The system focused on full-body movements as primary conveyors of expressive and emotional content. This approach implies a new and original consideration of the role that the physical body plays with respect to interaction. During the 6 months, the exhibition was visited by a large audience: the Swiss organization reckons about 4 millions of visitors. The exhibition was very appreciated in its artistic content.

2) Technical description: The setup was based on two video-cameras to capture full-body movements inside the room and two video-projectors to render the real-time video-processing in the room. Computation was carried out with a computer cluster (using Pentium III 800MHz, 128 MB Ram, HDD 16GB, Windows 2000) composed by: two PC to process the video captured information, called V1 and V2, and one PC to render audio content, called A. Sound was amplified by five loud-speakers (4 independent channel + 1 subwoofer). All the three PCs has installed and running Eyesweb 2.4.1 for both audio and video processing.

Description of the employed patches.

Patch 1. This patch is installed on PC V1 and is dedicated to the processing of the video, captured by the first video-camera. The patch is divided in two parts: the first, analyzes the video streaming, in order to calculate some high level features; the second, implements several algorithm for the real time processing of the video-streaming . The patch is connected via MIDI to PCs V2 and A.

3) Preservation Process: During the first 2 months of the preservation project carried out in CSC (University of Padova), the *bits preservation* task has been carried out: we created the conservative copies of all the documents related to the installation (software, textual, audio and video documents, etc.). In addition we described algorithms and models used by the installation (*preserving the data*). Finally, we migrated the patches in new Eyesweb environment in order to run the installation using new hardware with the Windows XP and Vista O.S. (preserving the record): figure 1 shows a frame of a running patch. We are carrying out the *experience preservation* step: we collected the original hardware and

Preservation approach	Static/Dynamic	Physic/Logic	Life expectancy (Years)
Preserve the Bits	Static	Physic	$5-10$
Preserve the Data	Static	Logic	>30
Preserve the Record	Dynamic	Physic	$10-20$
Preserve the Experience	Dynamic	Logic	>30

TABLE I
CHARACTERISTICS OF THE MULTILEVEL PRESERVATION APPROACH IN THE IMI FIELD

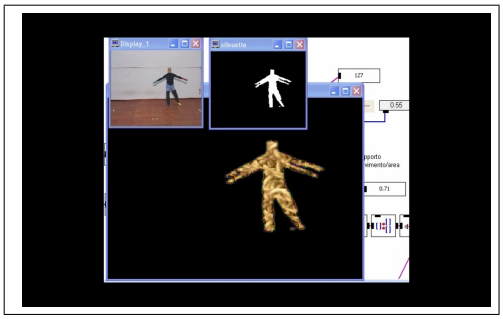

Fig. 1. The *vermi* (worms) patch migrated in new environment, with new release of Eyesweb and Windows XP.

software, and some interviews to the authors. The more difficult task is probably the re-creation of the original space: the magic room (with the same material). We have the original plan: up to now, lack of an adapted museum space and financial funds.

B. Il Caos delle Sfere: Be a Pianist with 500 Italian Lire

The interactive music installation *Il Caos delle Sfere: Become a Pianist with 500 Italian Lire* has been presented for the first time at the "Biennal of the Young Artists of Europe and Mediterraneo" Giovani Artisti di Europa e del Mediterraneo" in Rome, 1999; afterwards the exhibition toured in other artistic manifestations until year 2004. Scientific and technical partners were Nicola Orio and Paolo Cogo, at that time, members of Computational Sonology Centre of the University of Padova, while Carlo De Pirro was the involved artist. Although this IMI did not have scientific aims, it has been based on the results of a joint research work on music interaction called "Controlled Refractions" [15], on the interaction between a pianist and a computer through a music performance.

1) Concept: The basic idea was to use a common gaming machine, such as a electronic pinball, to control an automatic performance played on a Disklavier. The kind of interaction introduces a large amount of unpredictability on the obtained sound, because normal users have only a loose control on the "silver ball". Given that normally all the electronic pinballs give auditory feedback to the user, the basic idea of the composer was to avoid a one-to-one mapping between the objects hit by the ball and the generated sound. Moreover, the composer decided that a good player should be rewarded with a more interesting and complex performance than a naïve player. To this end, the amount of interaction varied according to the evolution of the game. The more levels were reached, the more complex and virtuosistic was the generated performance on the Disklavier. The game starts with some pre-written sequences; when the user changes to a new level, some automatically generated sequences start to play while the user partially controlled depending on the kind of targets he is hitting. At new level the style of automatic sequences changes, so it does the way the user can control them.

2) Technical Description: The installation was based on a popular electronic pinball "The Creature from the Black Lagoon". The choice of this particular pinball, which is one of the first to introduce the concept of different levels of a match where the player has to achive a number of goals that correspond to levels in the game, partially influenced the technical and artistic choice as explained in the previous section. The first technical goal was to monitor the game (levels and targets) minimizing the need to interface with the preexisting electronic. To this end, it has been chosen to split the signal coming from the pinball switches to track the targets hit by the ball. The level of the game was monitored by splitting the signal going to the pinball lights. It can be noted that the in this way it is only possible to estimate the level of the game and that some of the features (i.e. the actual number of points) have been neglected. The acquisition was made through an electronic circuit that has been designed ad hoc, which sends to the PC the information about switches and lights through the parallel port. A PC running Windows acquires the data through the parallel port, processes the information through a software developed in C by the technical team. The software is able to play, generate, and modify melodic sequences according to the indication provided by the composer. The result is sent to the Disklavier through the

MIDI port, using the environment Midishare developed by Grame (http://www.grame.fr/) and now available open source. The Disklavier, which could be either a grand or a upright piano depending on the place of the installation, was the only sound source. The goal was to minimize the presence of digital media, for instance, the PC has almost no graphical user interface.

3) Preservation Process: The *bits preservation* task has been partially carried out by creating conservative copies of all the software, the music sequences to be played at different levels. The electric scheme of the acquisition board has been digitized as well, while the notes of the composer about the installation are still in the process of been gathered. As regards the *data preservation*, a small team has been created for the definition of the used algorithms that, being developed in direct collaboration with the composer with a try-and-error approach, have been left mostly undocumented. Due to technical choices made about ten years ago, in particular the use of the parallel port and of a proprietary compiler which is no more supported, the *record preservation* is still an open issue. The *experience preservation* has to deal with the fact this IMI was not conceived for a particular space, and in fact it has been presented at different occasions from small indoor to large outdoor places. On the other hand, the experience preservation is directly related to the correct functioning of the electronic pinball, which has been completely restored.

V. Conclusion

Museums are experienced in describing and preserving things and events from the past. As for IMIs, out goal should be to maintain usable documents and events for the future. This work proposes a multilevel approach for the creation of an IMI archive. Some experimental results obtained in the preservation of the Installations *Pinocchio Square* and *Il Caos delle Sfere* created by Carlo De Pirro are described.

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This paper is affectionately dedicated to the memory of the composer Carlo De Pirro (1956-2008), a leading researcher in Computer Music and an outstanding teacher whose brightness and kindness we will always remember.

References

[1] K. N. ng, T. Vu Pham, B. Ong, A. Mikroyannidis, and D. Giaretta, "Preservation of interactive multimedia performances," *International Journal of Metadata, Semantics and Ontologies*, vol. 3, no. 3, pp. 183–196, 2008.

[2] ——, *Metadata and Semantics*. Springer US, 2009, ch. Ontology for Preservation of Interactive Multimedia Performances.

[3] M. Doerr, "The cidoc crm – an ontological approach to semantic interoperability of metadata," *AI Magazine*, vol. 24, no. 3, pp. 75–92, July 2003.

[4] ——, "Increasing the power of semantic interoperability for the european library," *ERCIM News*, vol. 26, pp. 26–27, July 2006.

[5] T. Gill, "Building semantic bridges between museums, libraries and archives: the cidoc conceptual reference model," *First Monday*, vol. 9, no. 5, 2004. [Online]. Available: http://firstmonday.org/issues/issue9_5/gill/index.html

[6] H. Grau, "The database of virtual art: for an expanded concept of documentation," in *International Cultural Heritage Informatics Meeting: Proceedings from ICHIM03*. Paris, France: Ecole du Louvre, 2003. [Online]. Available: http://www.archimuse.com/publishing/ichim03/016C.pdf

[7] A. Depocas, J. Ippolito, and C. Jones, Eds., *Permanence Through Change: The Variable Media Approach*. Guggenheim Museum, 2003. [Online]. Available: http://www.variablemedia.net/pdf/Permanence.pdf

[8] P. Dourish, *Where The Action Is: The Foundations of Embodied Interaction*. MIT Press, 2001.

[9] M. Kubovy and D. V. Valkenburg, "Auditory and visual objects," *Cognition*, vol. 80, no. 1-2, pp. 97–126, 2001.

[10] S. Barrass, "Auditory information design," Ph.D. dissertation, The Australian National University, 1998.

[11] R. Edmonson, *Memory of the World: general guidelines to safeguard documentary heritage*. UNESCO, 2002.

[12] *Reference Model for an Open Archival Information System (OAIS)*. Consultative Committee for Space Data Systems, 2002. [Online]. Available: http://public.ccsds.org/publications/archive/650x0b1.pdf

[13] J. Rothenberg, *Avoiding Technological Quicksand: Finding a Viable Technical Foundation for Digital Preservation. Council on Library and Information Resources*. Council on Library and Information Resources, 1998. [Online]. Available: http://www.clir.org/pubs/reports/rothenberg/contents.html

[14] R. Rinehart, "A system of formal notation for scoring works of digital and variable media art," in *Annual Meeting of the American Institute for Conservation of Historic and Artistic WorkMustica Technical Documentation Server for Ircam Musical Works*, 2004.

[15] N. Orio and C. De Pirro, "Controlled refractions: A two-level coding of musical gestures for interactive live performance," in *Proceedings of the International Computer Music Conference*. Ann Arbor, MI: ICMC, 1998, pp. 88–91.