Preservation of Interactive Multimedia Systems with an Ontology based Approach

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Summary

Digital preservation aims to address changes that inevitably occur in hardware or software, in the designated community, i.e. the users of the preserved information. In order preserve digital information so that they are usable and understandable in the future, digital information has to be enriched with metadata, usually referred to as Representation Information, which can be used for the interpretation of information. Representation Information needs to be connected to the Knowledge Base of the designated community with appropriate terminologies for better interpretation and representations. Ontologies offer the means for organizing and representing the semantics of this knowledge base. The paper presents the CASPAR project[1] (supported under the EC IST Framework programme) which aims to build a pioneering framework to support the end-to-end preservation lifecycle of scientific, artistic and cultural information. This paper is focused on the contemporary arts testbed with a particular attention on interactive multimedia performances (IMP)[2]. The paper describes several different IMP systems and presents an archival system, which has been designed and implemented based on the CASPAR framework and components for preserving Interactive Multimedia Performances.

Key words: digital preservation, interactive multimedia, ontology, performing arts, OAIS, gesture, motion

[1] http://www.casparpreserves.eu

[2] http://www.icsrim.org.uk/caspar/

Introduction

Interactive Multimedia Performance (IMP) preservation is part of the Contemporary Arts testbed of the CASPAR project. IMP is chosen as part of the testbeds for its challenges due to the complexity and multiple dependencies and typically involves several difference categories of digital media data. Generally, an IMP involves one or more performers who interact with a computer based multimedia system making use of multimedia contents that may be prepared as well as generated in real-time including music, audio, video, animation, graphics, and many others.[3, 4]

The interactions between the performer(s) and the multimedia system[5, 6, 7] can be done in a wide range of different approaches, such as body motions (for example, see Music via Motion (MvM)[8, 9]), movements of traditional musical instruments or other interfaces, sounds generated by these instruments, tension of body muscle using bio-feedback,[10] heart beats, sensors systems, and many others. These "signals" from performers are captured and processed by multimedia systems. Depending on specific performances, the input can be mapped onto multimedia contents and/or as control parameters to generate live contents/feedback using a mapping strategy.

Traditional music notation as an abstract representation of a performance it is not sufficient to store all the information and data required to reconstruct the performance with all the specific details. In order to keep an IMP performance

[3] Ng, Kia (ed). Proceedings of the COST287-ConGAS 2nd International Symposium on Gesture Interface for Multimedia Systems (GIMS2006), 9-10 May 2006, Leeds, UK. http://www.i-maestro.org/documenti/view_documenti.php?doc_id=1052

[4] Ng, Kia; Nasi, Paolo (eds). Interactive Multimedia Music Technologies IGI Global, Information Science Reference, Library of Congress 2007023452, 2008.

[5] Young, D.; Nunn, P.; Vassiliev, A. Composing for Hyperbow: A Collaboration between MIT and the Royal Academy of Music. in *Proc. of the New Interfaces for Musical Expression International Conference (NIME)*. Paris, France. 2006

[6] Overholt, D. The Overtone Violin. In *Proc. of the International Conference on New Interfaces for Musical Expression*. Vancouver, BC, Canada. 2005.

[7] Lévy, Benjamin; Ng, Kia. Audio-driven Augmentations for the Cello, in Ng (ed), in *Proc. of the 4th i-Maestro Workshop on Technology-Enhanced Music Education*, co-located with the 8th International Conference on New Interfaces for Musical Expression (NIME 2008), Genova, Italy, ISBN: 978 0 85316 269 8, pp. 15-20, 4 June 2008

[8] MvM. Music via Motion, http://www.kcng.org/mvm or http://www.leeds.ac.uk/icsrim/mvm [last accessed 28/9/2009]

[9] Ng, Kia. Music via Motion: Transdomain Mapping of Motion and Sound for Interactive Performances, in *Proceedings of the IEEE*, vol. 92, 2004.

[10] Nagashima, Y. Bio-Sensing Systems and Bio-Feedback Systems for Interactive Media Arts. in *Proc. of the New Interfaces for Musical Expression International Conference (NIME-03)*. Montreal, Canada. 2003.

alive through time, not only its output, but also the whole production process to create the output needs to be preserved.

Interactive Multimedia Performance (IMP) Systems

In this section we describe several different IMP systems and software with different types of interaction and different types of data while the following section explains how the CASPAR framework is used for their preservation.

The 3D Augmented Mirror (AMIR) System

The 3D Augmented Mirror (AMIR)[11, 12] is an example IMP system which has been developed in the context of the i-Maestro project (http://www.i-maestro.org), [13] for the analysis of gesture and posture in string practice training. Similar to many other performing arts, string players (e.g. violinist, cellists) often use mirrors to observe themselves practicing to understand and improve awareness of their playing gesture and posture. More recently, video has also been used. However, this is generally not effective due to the inherent limitations of 2D perspective views of the media.

The i-Maestro 3D Augmented Mirror is designed to support the teaching and learning of bowing technique, by providing multimodal feedback based on real-time analysis of 3D motion capture data. Figure 1 shows a screenshot of the i-Maestro 3D Augmented Mirror interface which explore visualization and sonification (e.g. 3D bow motion pathway trajectories and patterns) to provide gesture and posture support. It uses many different types of data including 3D motion data (from a 12-camera motion capture system), pressure sensor, audio, video and balance.

The i-Maestro AMIR multimodal recording, which includes 3D motion data, audio, video and other optional sensor data (e.g. balance, etc) can be very useful to provide in-depth information beyond the classical audio visual recording many different purposes including technology-enhanced learning, and in this

[11] Ng, Kia; Weyde, Tillman; Larkin, Oliver ; Neubarth, Kerstin; Koerselman, Thijs; Ong, Bee. 3D Augmented Mirror: A Multimodal Interface for String Instrument Learning and Teaching with Gesture Support, in *Proc. of the 9th International Conference on Multimodal Interfaces*, Nagoya, Japan, pp. 339-345, ISBN: 978-1-59593-817-6, ACM, SIGCHI, DOI: http://doi.acm.org/10.1145/1322192.1322252, 2007

[12] Ng, Kia; Ong, Bee; Weyde, Tillman; Neubarth, Kerstin. Interactive Multimedia Technology-Enhanced Learning for Music with i-Maestro, in *Proc. of ED-MEDIA 2008 World Conference on Education Multimedia, Hypermedia & Telecommunications*, Vienna, Austria, 30 June – 4 July 2008.

[13] Ng, Kia (ed). Proceedings of the 4th i-Maestro Workshop on Technology-Enhanced Music Education, co-located with the 8th International Conference on New Interfaces for Musical Expression (NIME 2008), Genova, Italy, ISBN: 978 0 85316 269 8, 4 June 2008. http://www.i-maestro.org/workshop/

context for the preservation of playing gesture and style for detailed musicological analysis (now and in the future).

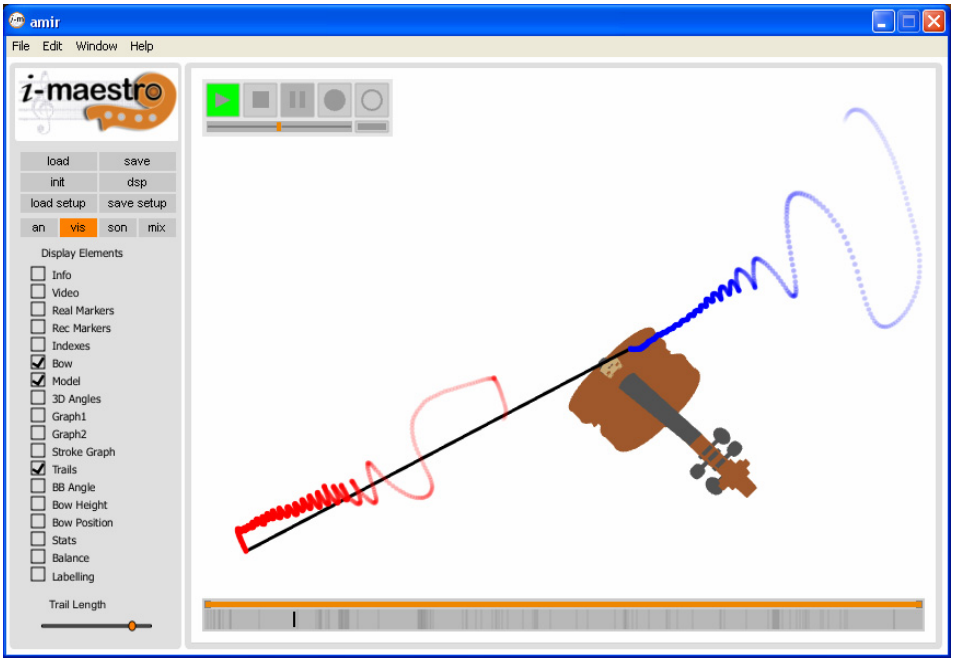

Figure 1: The i-Maestro 3D Augmented Mirror System

ICSRiM Conducting Interface

The ICSRiM Conducting System is another IMP system example. It has been developed for the tracking and analysis of a conductor’s hand movements.[14, 15] The system is aiming at supporting students learning and practicing conducting, and also provides a multimodal recording (and playback) interface to capture/measure detailed conducting gesture in 3D for the preservation of the performance.

A portable motion capture system composed by multiple Nintendo Wiimotes is used to capture the conductor’s gesture. The Nintendo Wiimote has several ad-

[14] Bradshaw, David; Ng, Kia. Tracking Conductors Hand Movements Using Multiple Wiimotes, in *Proc. of the International Conference on Automated Solutions for Cross Media Content and Multi-channel Distribution (AXMEDIS 2008)*, Florence, Italy, pp. 93-99, Digital Object Identifier 10.1109/AXMEDIS.2008.40, IEEE Computer Society Press, ISBN: 978-0-7695-3406-0. 4. 17-19 Nov. 2008.

[15] Bradshaw, David; Ng, Kia. Analyzing a Conductor’s Gestures with the Wiimote, in *Proc. of EVA London 2008: the International Conference of Electronic Visualisation and the Arts*, British Computer Society, 5 Southampton Street, London WC2E 7HA, UK, 22-24 July 2008.

vantages as it combines both optical and sensor based motion tracking capabilities, it is portable, affordable and easily attainable. The captured data are analyzed and presented to the user highlighting important factors and offer helpful and informative monitoring for raising self-awareness that can be used during a lesson or for self-practice. Figure 2 shows a screenshot of the Conducting System Interface with one of the four main visualization mode.

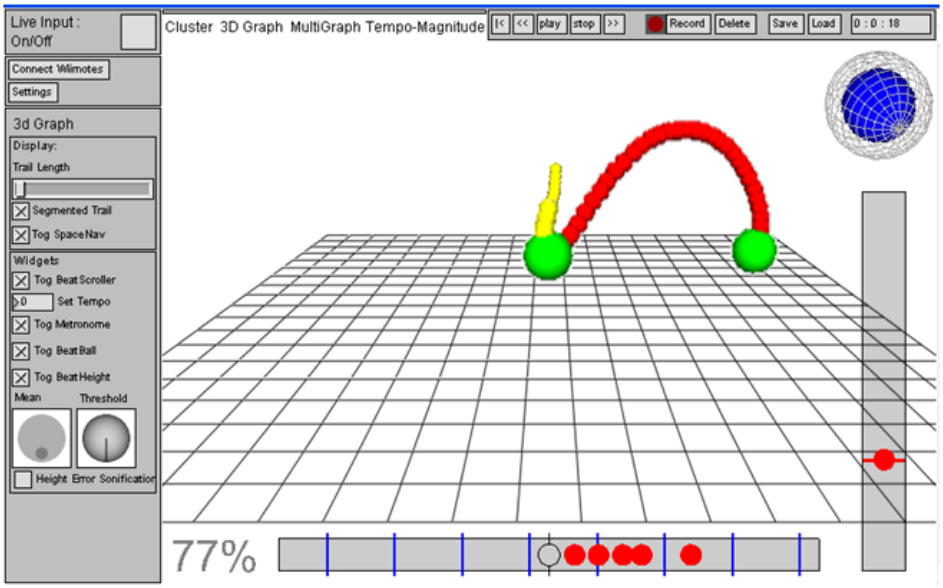

Figure 2: The ICSRiM Conducting interface showing a conducting gesture with 3D visualisation

Preservation with Ontology models

The preservation of these IMP systems is of great importance in order to allow future re-performance, understanding and analysis. The multimodal recordings of these systems offer an additional level of detail for the preservation of musical gesture and performance (style, interpretation issues and others) that may be vital for the musicologist of the future.

Preserving an interactive multimedia performance is not easy. Preserving the single digital media object for a longer term is already a challenging issue. However, putting all the necessary digital objects together does not reconstruct the full system to allow a re-performance. For the preservation of IMP, we proposed to preserve the whole production process with all the digital objects involved together with their inter-relationships and additional information considering the reconstruction issues. It is a challenging issue since it is difficult to preserve the knowledge about the logical and temporal components, and all the

objects such as the captured 3D motion data, Max/MSP patches, configuration files, etc, in order to be properly connected for the reproduction of a performance.[16]

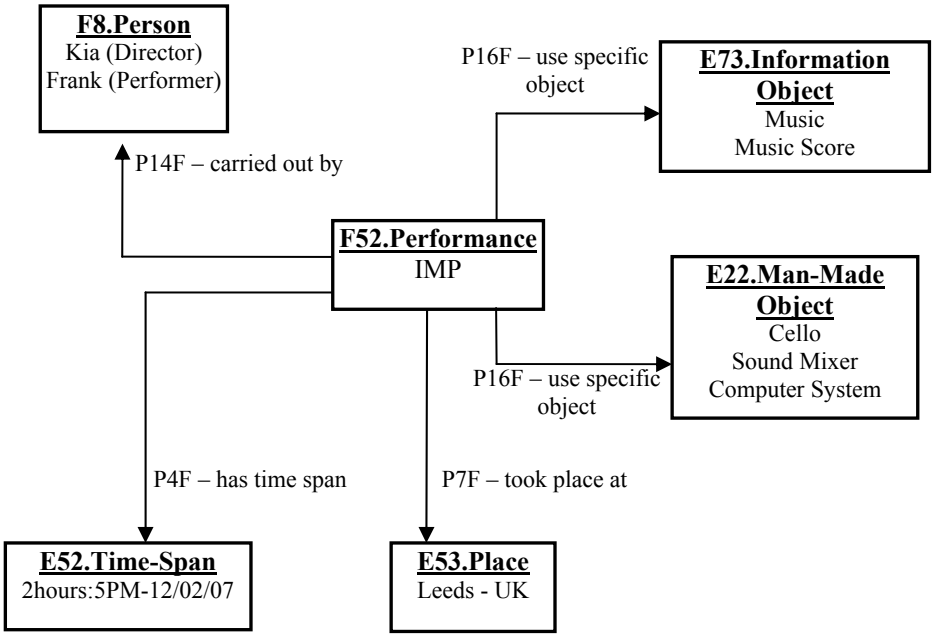

Figure 3: Modeling an IMP with the use of the CIDOC-CRM and FRBR ontologies

Due to these multiple dependencies, the preservation of an IMP requires robust representation and association of the digital resources. This can be performed using entities and properties defined for CIDOC-CRM and FRBRoo. The CIDOC Conceptual Reference Model (CRM) is being proposed as a standard ontology for enabling interoperability amongst digital archives. [17]

[16] Ng, Kia; Pham, Tran Vu; Ong, Bee; Mikroyannidis, Alexander; Giaretta, David. *Preservation of interactive multimedia performances*, International Journal of Metadata, Semantics and Ontologies 2008 - Vol. 3, No.3 pp. 183 – 196, DOI: 10.1504/IJMSO.2008.023567. 2009.

[17] Ng, Kia; Mikroyannidis, Alexander; Ong, Bee; Bonardi, Alain; Barthélemy, Jérôme; Ciavarella, Raffaele; Boutard, Guillaume. Ontology Management for Preservation of Interactive Multimedia Performances, in *Proc. of the International Computer Music Conference (ICMC)*, Belfast, 24-29 August 2008.

CIDOC-CRM defines a core set concepts for physical as well as temporal entities.[18, 19] CIDOC-CRM was originally designed for describing cultural heritage collections in museum archives. A harmonisation effort has also been carried out to align the Functional Requirements for Bibliographic Records (FRBR)[20] to CIDOC-CRM for describing artistic contents. The result is an object oriented version of FRBR, called FRBRoo.[21] The concepts and relations of the FRBRoo are directly mapped to CIDOC-CRM.
Figure 3 shows how the CIDOC-CRM and FRBR ontologies are used for the modelling of an IMP.

ICSRiM IMP Archival System

The CASPAR project evaluated a set of preservation scenarios and strategies in order to validate its conceptual model and architectural solutions within the different testbed domains. In this case, our scenarios are related with the ingestion, retrieval and preservation of IMPs.
The ICSRiM IMP Archival System has been designed and developed with the CASPAR framework integrating a number of selected CASPAR components via web services. The system has been used to implement and validate the preservation scenarios.
The archival system is a web interface, which communicates with a Repository containing the IMPs and the necessary metadata for preserving the IMPs. The first step for preserving an IMP is to create its description based on the CIDOC-CRM and FRBRoo ontology. This information is generated in RDF/XML format with the use of the CASPAR Cyclops tool. The Cyclops tool[22] is used to capture appropriate Representation Information to enhance virtualisation and future re-use of the IMP. In particular, this web tool is integrated into the Archival System and it used in order to model various IMPs.
During ingestion, the IMP files and the metadata are uploaded and stored in the Repository with the use of the web-based IMP Archival System. For the retrieval of an IMP, queries are performed on the metadata and the related objects are returned to the user. Figure 4 shows the web interface of the ICSRiM IMP Archival system.

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[18] Gill, T. Building semantic bridges between museums, libraries and archives: The CIDOC Conceptual Reference Model. First Monday, 9. 2004.

[19] Doerr, M. The CIDOC CRM - an Ontological Approach to Semantic Interoperability of Metadata. AI Magazine, 24, 2003.

[20] FRBR. Functional Requirements for Bibliographic Records - Final Report. Frankfurt am Main, Germany, International Federation of Library Associations and Institutions (IFLA). 1997.

[21] Doerr, M.; Leboeuf, P. FRBRoo Introduction. http://cidoc.ics.forth.gr/frbr_inro.html (last accessed: 1/10/2009). 2006

[22] http://www.utc.fr/caspar/wiki/pmwiki.php?n=Main.Proto

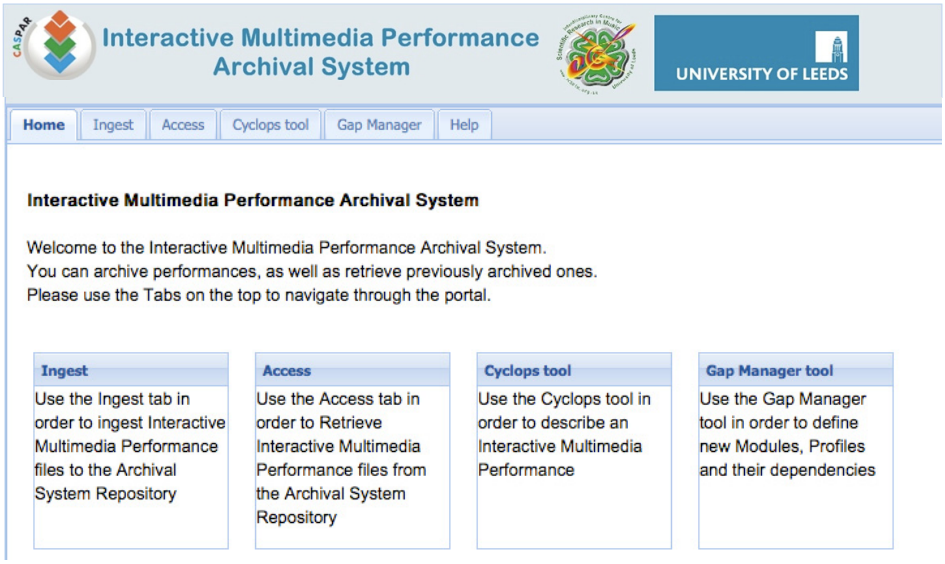

Figure 4: The Interface of the Web Archival System.

In case a change occurs in the dataset of an IMP, such as the release of a new version of the software, the user has the ability to update the Representation Information and the dataset of the IMP with the new modules (e.g. the version of new software). A future user will be able to understand which one is the latest version of a component and how these components can be reassembled for the reproduction of the Performance by retrieving the Representation Information of the IMP.

Conclusion

This paper briefly introduces the usages and applications of interactive multimedia for contemporary performing arts as well as its usefulness for capturing/measuring multimedia and multimodal data that are able to better represent the playing gesture and/or interactions. With two example IMP systems, it discusses key requirements and complexities of the preservation considerations and presents a digital preservation framework based on ontologies for Interactive Multimedia Performances.

With the CASPAR framework, standard ontology models were adopted in order to define the relations between the individual components that are used for the re-performance. The paper also described the development and implementation of a web-based archival system using the CASPAR framework and components.

The ICSRiM IMP Archival System has been successfully validated by users who have created their own IMP systems using their own work for ingestion

and using ingested works from others (without any prior knowledge) to reconstruct a performance with only the instruction and information provided by the archival system.

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