COMPONENTS OF INTERACTIVE MULTIMEDIA PERFORMANCE AND PRESERVATIONS

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Abstract – This paper presents an introduction to interactive multimedia performance, discusses its various components and focuses on preservation issues. As interactive multimedia performance is becoming popular in the performing arts communities, like other types of performance, there is the need to preserve related information and components of a performance for future study, analysis and recreation. One special characteristic that distinguishes interactive multimedia performance from other types of performance is its heavy reliance on digital media. Information in digital format is compact and ubiquitous but extremely fragile. The EU collaborative project CASPAR is building a digital preservation framework and infrastructure to address such challenges.

INTRODUCTION

Interactive Multimedia Performance is the kind of music performances where one or more performers interact with a multimedia system which is often made of various electronic devices, computer software and hardware to produce/process multimedia contents. The interactions between the performances and the system can be body motions [6] [4], movements of traditional musical instruments, sounds generated by these instruments [8] [7], tension of body muscle using bio-feedback [5], heart beats, sensors systems, and many others. These input signals are translated into output multimedia contents, which are commonly music, manipulated sound, animation, videos and computer graphics, using a predefined mapping strategy.

As interactive multimedia performances getting popular in performing arts community, the need for preserving them is arising. The preservation helps to keep the content a performance a live through time for post performance analysis, for recreating a performance at a later time or for historical study of performing arts. For analysis purpose, the preservation process needs to be done in way so that different aspects of body motions and their relationships with output multimedia contents are viewable and reasonable at a later time. In addition, the whole production process also needs to be documented so that a recreation of the same performance is possible in the future. This is a challenging problem. Traditional use of photos, video and audio records are not sufficient for these purposes.

The CASPAR (Cultural, Artistic and Scientific knowledge for Preservation, Access and Retrieval) project aims to build a preservation framework to address such kind of challenges. The project is co-supported by the European Commission, under the Information Society Technologies (IST) Sixth Framework Programme [1]. The project consortium consists of 17 research institutions and laboratories from academic and industrial sectors across Europe.

The main objectives of CASPAR include:

- establishing a foundation methodology applicable to an extensive range of preservation issues;
- researching, developing and integrating advanced components to be used in preservation activities. These components will be the building blocks of the CASPAR framework;
- creating the CASPAR framework: the software platform that enables the building of services and applications that can be adapted to multiple areas.

Three testbeds are being developed within CASPAR to instantiate its generic framework functionalities into real domains:

(i) a Scientific testbed for very-high volume, complex digital data objects, oriented towards processing;
(ii) a Contemporary Arts testbed dealing with dynamic interactive digital objects, oriented towards presentation and replay of artistic contents. The preservation of interactive multimedia interactive multimedia performance is addressed in this;
(iii) a Cultural Data testbeds for virtual digital objects, spanning between processing and display.

The focus of CASPAR is specifically on preserving knowledge for future archive intelligibility and information system/services interoperability. Preserving information and knowledge – not just 'the bits' – allows the keeping of archives alive through time. Therefore, in addition to simple data syntactic of data objects, CASPAR will also capture their higher-level semantics for preservation.

This paper introduces different components of an interactive multimedia performance using the MvM (Music via Motion) system as a typical example [6] (http://www.kcng.org/mvm, http://icsrim.leeds.ac.uk/congas). These components are discussed in detailed in the next section. Requirements for preservation of interactive multimedia performances and preservation issues are presented in the sections follows. The CASPAR preservation framework and how it can help to address the issues related preservation of interactive multimedia performances is discussed afterwards.

COMPONENTS OF INTERACTIVE MULTIMEDIA PERFORMANCES

Components of an interactive multimedia performance are illustrated using the MvM system. MvM is a typical multimedia system for interactive performances. In principle, MvM system uses body motion as input and produces musical sound as multimedia output content. The motions are mapped into musical contents using a predefined mapping strategy. Two versions of the MvM have been implemented. The 2D version of MvM system, the body motions are captured in two dimension video images using a digital video camera. This is a lightweight implementation but lack of precision if precise analysis of body motion is required. The 3D version is using a 3D motion capture system, with a set of infrared cameras, to capture body motion in three dimension space. Using 3D motion data allows more accurate mapping of motion to music as well as deeper analysis of body motion. The 3D implementation of the MvM can also be used together traditional musical instruments such as violin or cello to provide augmentation to the traditional instruments. The motion of the different parts of the body and instruments as well as the relative position between them can be analysed and mapped to music separately. From a preservation point of view, preserving 3D motion data can help to recreating exact body motion in 3D space for analysis and other studies at a later time.

MvM system components

Components of 3D implementation of the MvM system are shown in Figure 1. Inputs to the system are 3D motion data captured in real-time using a motion capture system. The 3D motion data are then analysed and recognised by a software module. The recognised motions are forwarded to the mapping module for translation into music, using a mapping strategy input from user through the GUI components. The mapping table is sent to multimedia generation module to produce musical contents.

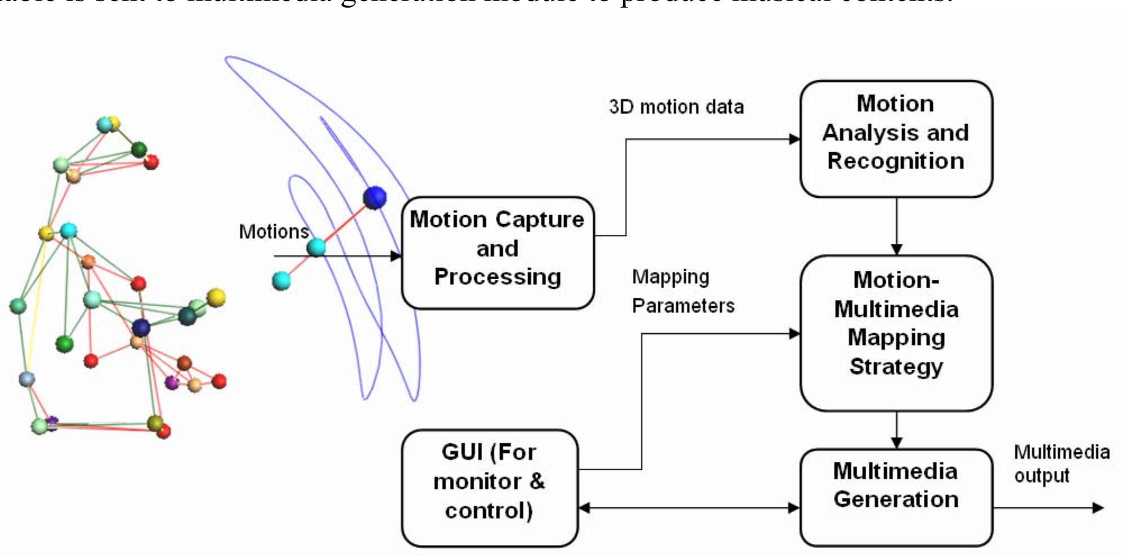

Figure 1. Preservation of multimedia performances.

In order to capture motions of a performer (e.g. dancer or instrumentalist) and/or instruments (e.g. a violin and a bow, or a conductor baton), reflective markers need be placed on the performer's body or the instruments, where the movement will be captured. A system of infrared cameras captures reflective light from the markers and calculates their positions in 3D space. For 3D motion data capture, we currently use the Vicon 8i hardware system and Vicon iQ 2.5 software.

3D motion data output from the Vicon system is visualised in real-time for analysis and recognition using a Max/MSP patch. Various types of analysis can be performed in real-time such as motion speed and acceleration, trails of markers, relative position amongst subjects, and view of subjected being captured at different angles. Selected motion is then forwarded to another module, also written in a Max/MSP patch for mapping and generating sound, video feedbacks and animations.

The mapping of selected motion into sound can be one-to-one or many-to-many. The motion selected can be in form of raw motion with 3D coordinates, processed data (e.g. the tilt angle between the bow and the violin) or the distance any two markers. Depending on the mapping rules, the captured motion data can be pre-processed accordingly. In the current implementation, the multimedia generation component is integrated within the mapping module. Motion is mapped directly into sound content.

Post-performance analysis tools

In addition to tools for performance, analysis and visualisation in real-time, a set of tools are being built for post performance analysis to provide further description and understanding to the 3D motion data for preservation. For example, the active (motion) region necessary and the space required for the performance, and considerations for the positioning and orientations of interface/interactive devices etc. Using these tools, the movement of a subject can be visualised for analysis. Relative movement between subjects can also be visualised.

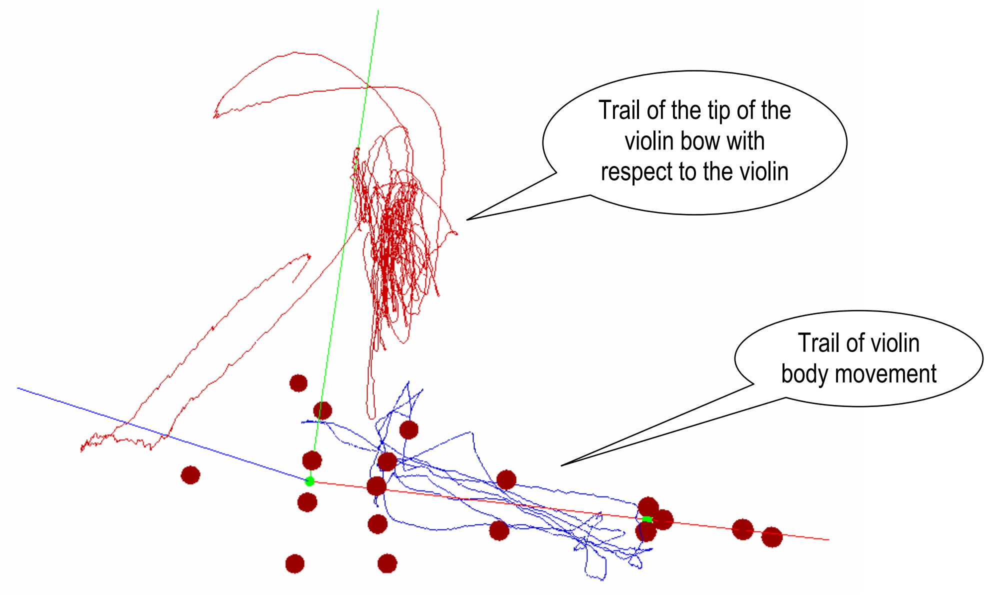

Figure 2. Trails of violin movement in a performance.

Figure 2 shows an example of such an analysis. The markers in the figure form the shape of the violin in its initial position. Two types of trails are shown in the figure. The lower trail shows the movement of the violin body in a global coordinate system during the play. This trail is useful for analysis of overall movement of the violinist. The upper one is the relative movement of the tip of the violin bow with respect to the violin body. In this case the movement of the violin in the global coordinate was eliminated for analysis. This kind of analysis demand 3D motion data as it is not possible with images and videos captured in 2D

PRESERVATION REQUIREMENTS

The goal of preservation of an interactive multimedia performance is to keep it alive through time for recreation or analysis at a later time. In order to achieve this goal, it is necessary to preserve the multimedia system (the core engine of a performance), input and output multimedia content together with the knowledge of how to assemble different components involved into a proper order to recreate the performance. It is also necessary to preserve tools for performing analyses on performance data. Preservation of the results of analyses performed on the data using these tools is also required, as they are critical criteria to guarantee the authenticity of the recreated performances.

The main inputs to an interactive multimedia performance are motion and mapping strategy. While the mapping strategy can be used in form of a digital document, which is ready for preservation, the creation of motion is involved with human being and physic instruments. It is unlikely that the same performer will be able to participate in a future performance recreated from preserved data. This is completely not possible in long term preservation. The only viable way to preserve motion is to keep motion data together with documentation on its creation process so that the preserved performance can be recreated without the presence of the original performer.

Multimedia systems, like the typical MvM, are commonly computer based. Except the hardware involved, digital components (e.g. software modules, configuration files, etc.) of such a system can be archived directly into a digital repository. In order to properly reconstruct the system from its preserved components, logical relationships amongst them and their relationships with required hardware also need to be documented and preserved.

As a preserved performance, in an ideal case, can be recreated at a later time, the output of the performance can then be reproduced. Therefore, preserving output multimedia contents seems not to be a primary preservation target. However, it is important to keep the original output. If the original output is not available for comparison, there is no way to assess the authenticity and overall quality of the whole preservation process.

PRESERVATION ISSUES

There are a number of issues that need to be dealt with in preservation of interactive multimedia performances. Firstly, it is the use of 3D motion data for preservation of motion, which is the only viable way to encode precise motion of performers or instruments in 3D space. The difficulty posed by using 3D motion data is enabling the interoperability amongst different data formats and applications. There are currently many different systems using different technologies for capturing and processing 3D data, such as the Polhemus magnetic systems which use magnetic sensors positioned in a magnetic field for tracking movement or the Vicon optical systems using a set of infrared cameras for tracking reflective markers which are attached to the captured subjects. Each of these systems may support a number of different data formats.

The common 3D formats existing in the community are usually marker-based, e.g. Coordinate 3D (C3D) and Tracked Row Character (TRC), and skeleton-based, e.g. BioVision Hierarchical Data (BVH) and Hierarchical Translations and Rotations (HTR). Some application specific formats, such as the Vicon V-file and Trial file, contain both marker and skeleton data in one file. The conversion of data from one format to another may result in loss of some essential data (e.g. converting data from a skeleton-based format to a purely marker-based format usually results in a loss of segment orientation data). The Gesture Description Interchange Format (GDIF) has been proposed as an attempt to provide a common interoperable format for describing music related gesture [3] to encapsulate motion data and analysis. Whether or not this new format can influence the community to resolve the interoperability problem is still to be seen.

Secondly, it is the issue related to digital preservation in general. Through time, computer hardware and software will be changed. Keeping a software system through time is difficult, but making it work with unexpected new software platform (e.g. operating systems), hardware and standards for data formats in the future is much more challenging. Although the preserved system is kept in its archive, it has to be constantly kept up to date with changes in its operating environment. It may have to be reprogrammed or extended to adapt to changes in its environment. This is a never ending task.

The last issue involved with the designated community, who will eventually use the preserved system. They may not have the necessary knowledge to recreate a performance from its preserved components. It may be the case that the designated users have completely different background knowledge from the archiver's expectation. Hence, the necessary documentation required for recreation of the preservation may not be available in the origin archive. As one never knows who may be the eventual use of the preserved system, the possible solution to this issue is to document as much information related to the preserved contents as possible.

CASPAR PRESERVATION FRAMEWORK

CASPAR framework is based on OAIS, which is an ISO standard for archival information systems [2]. OAIS defines a consistent set of terminologies, conceptual and functional models for the development of archival information systems. The adoption of OAIS in CAPSAR will enable its interoperability with other OAIS based digital archives. CASPAR adds to OAIS a number of high-level components to deal with a range of issues involved in the digital preservation process, such as knowledge preservation, virtualisation of multidisciplinary contents, preservation registry and storage virtualisation. The framework covers the whole preservation process from the point of ingestion, where data packages enters the archive, to access, where the designated user communities can get access to archived data packages, including the management of data packages in the archive (know as preservation orchestration as shown in Figure 3).

With respect to preservation of interactive multimedia performances, the CASPAR framework addresses the major issues in the following ways:

- Dealing with various formats for 3D motion data, instead of trying to provide a standardised format, CASPAR requires that any data package to be ingested into the preservation storage needs to be associated with documentation about the data format used to encoding the data. This type of documentation is defined as Representation Information by OAIS reference model. In CASPAR framework, representation information is also considered as an information package and managed through the preservation registry. Using representation information archived together with the data packages, the data contained within a package can be interpreted and converted to a usable format a later time.

- In order to adapt with changes of related software and hardware in the environment, the representation information associated with a data package in the preservation storage needs to be constantly updated. As representation information itself is a data object, it also needs other representation information. This is a recursive process. Changes happen in the environment may turn a representation information object into obsolete. Therefore, continuous updates of representation information associated to a representation information data object are also necessary. In CASPAR framework, this process is known as preservation orchestration.

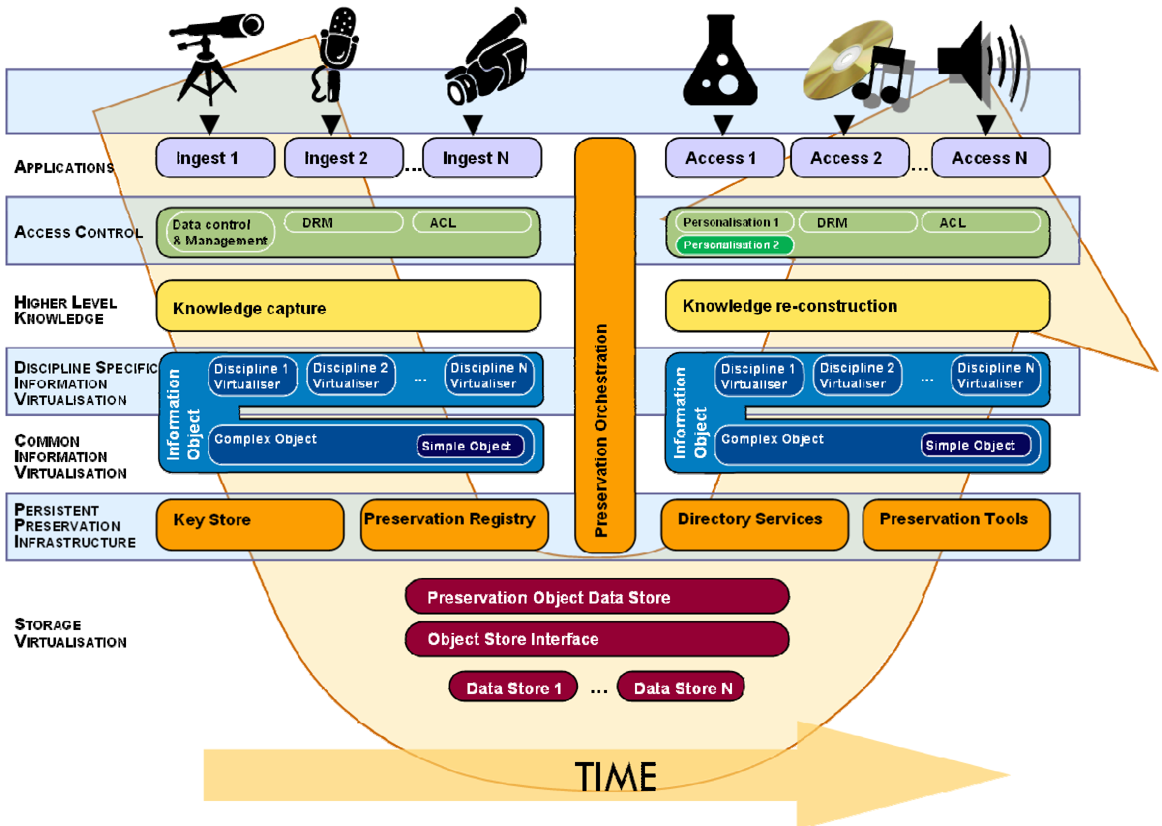

Figure 3. CASPAR preservation framework.

- The relationships amongst components of a performance and with their external context are dealt with in CASPAR framework through Knowledge Management together with Information Virtualisation. Central to knowledge management is the use of Ontologies, enabling relationships amongst components of a performance to be described in a formal way, which can then be interpreted and reasoned by human beings or machines using the vocabulary provided. Information virtualisation allows viewing a data object from different perspectives. An interactive multimedia performance is complex. It is composed of a number of different components. Some of its components can only be managed by people within its domain. Through the information virtualisation during the archival process, a performance object can be seen as the whole as a single object having common attributes as other types of objects. Its internal components are encapsulated. This mechanism will help to protect the consistency and integrity of internal components of a performance and their relationships during the preservation process.

CONCLUSION

This paper has presented different components of a typical interactive multimedia performances using 3D motion based MvM system as an example. For the purpose of analysis, using 3D motion data is preferred as it can provide precisely different views on motion of a performer in 3D space. From the preservation perspective, 3D motion data can help to preserve exact motion of the performance 3D space, so that a re-performance is possible without the need for the presence of the original performer. However, the use of 3D motion data as well as the complex reliance on digital media of different interrelated components of an interactive multimedia performance makes the preservation process a challenging problem. It needs to deal with various standards and formats 3D motion in order to enable interoperability amongst them. The complex relationships amongst different components also need to be preserved in order to properly and authentically recreate a performance at a later time.

The CASPAR project is developing a framework and infrastructure to deal with digital preservation issues, including the typical issues related to preserving interactive multimedia performances. The framework is based on the OAIS conceptual model and stresses the importance of knowledge preservation and information virtualisation. Not only do the bits need to preserved, but also the knowledge required for meaningful interpretation of the bits.

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