PERFORMING ARTS OF INTANGIBLE CULTURAL HERITAGE IN SECOND LIFE

Woong Choi[*1], Drew Baker[*2], Martin Blazeby[*2],
Kohei Furukawa[*3], Kozaburo Hachimura[*4] and Richard Beacham[*2]

[1*]Global Innovation Research Organization, Ritsumeikan University, Japan
[2*]King's Visualisation Lab (KVL), King's College London, UK
[3*]College of Image Art and Science, Ritsumeikan University, Japan
[4*]College of Information Science and Engineering, Ritsumeikan University, Japan

In this research, we set ourselves the task to record and collate Japanese Traditional Performing Arts, motion data and audio recordings and develop a method to create a real-time animation combining these within their context in Second Life™ (SL). For this we specifically focused on assets of *Noh* in Japanese Traditional Performing Arts. We propose a method that synchronously controls motion, sound and subtitle of a performance and transmits this information to avatar of audience in SL. In our research, we successfully collated intangible cultural material through digital capture methods and migrated them through the proposed method into the SL environment to produce an integrated real-time version of *Utaura* within the context of the *Noh* theatre.

1. INTRODUCTION

Recently, extensive research has been undertaken on digital archiving of cultural properties. These investigations have examined the processes of recording and preserving both tangible and intangible materials through the use of digital technologies. While digital records of material culture are becoming commonplace in archives, the intangible material of human body motions can be recorded using the motion capture technique and the data archived for preservation. Visualization through computer graphics (CG) and virtual reality (VR) are promising areas for researchers in access to virtual archives and resources. The present problems are how such assets can be captured, archived, restored and interpreted.

Although, for decades, tangible, physical, cultural heritage has been digitally recorded from archeological remains, historical, cultural buildings and monuments etc, the intangible cultural heritage such as performing arts, traditional music, theatre, social practices, and events, has been rarely regenerated in the virtual world. Intangible cultural heritage has a number of challenges to the process of digital preservation as follows.

a) Intangible cultural material is intrinsically tied to the human action within a place and time. No two performances are exactly the same and traditional forms of knowledge transfer from master to student subtly changes with the passage of time.

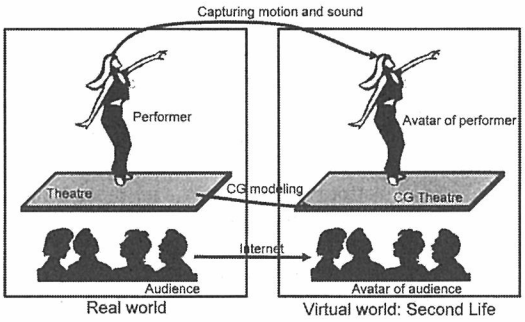

Figure 1. System overview.

b) The traditionally detailed recording of the performing arts has been captured using the 2D media of films and videos which, by its nature, presents only one of multiple possible views of the performance.

c) The performing arts comprise both the intangible, the performance, and the tangible, location, stage equipment etc and ephemera lighting, effects etc and without the combination of all of these components the understanding of the performance is degraded.

To resolve these challenges, we propose a method that combines the motion data of the performing arts with visualizations of physical space within the virtual world platform of Linden Lab's Second Life™ (SL) [1].

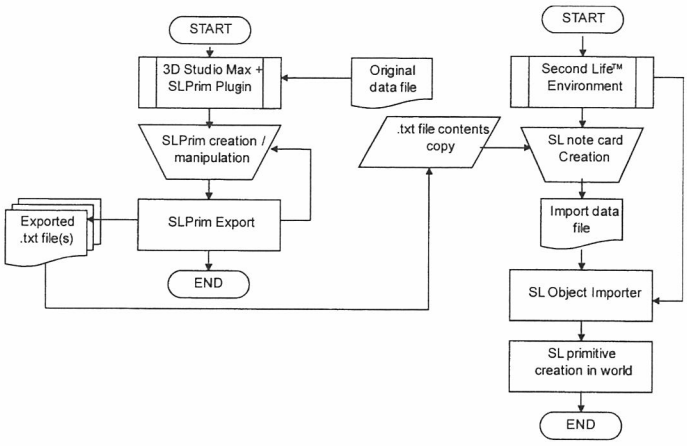

Figure 2. Pipeline of modeling *Noh* theatre.

2. SECOND LIFE

As shown in Figure 1, the environment of SL enables the researchers to digitally construct the physical environment, character animation using the motion of the performer, sound and other relevant considerations in real-time. Further virtual worlds such as SL allows the researchers to decouple the tangible and intangible and "re-master" performances without the restriction of time and space and to provide and archive accessible on demand for the research community.

The SL platform has many advantages of preservation of the performing arts within the virtual world:

a) Distribution: SL is distributed via the internet using a client server paradigm. The client side "viewer" is free at point of use (with a subscription option available) and support for multi platform hardware/operating systems.
b) Accessibility: The SL client system requirements are moderate and can be run on an entry level computer.
c) Multi-participations: SL is a massively multi user system allowing the users virtual presence, the "avatar" to participate in various roles, audience member, performer etc.
d) Multi-view: The SL environment allows the user the full six degrees of freedom permitting the observation of the performing arts from any direction/orientation.
e) Contextualization: The SL rich media environment supports not only 3D building of structures but also audio, visual and motion assets.
f) Recreation: The flexibility of the SL platform allows the researchers to easily re-interpret, re-engineer and re-purpose different assets to explore and present different hypotheses from a common data pool.

While the SL has its strengths it has some limitations. Some of them are out of the control of the end user, avatar faces and hand gestures for example cannot meaningfully be manipulated in real time, while others place severe limitations on what is permitted, both motion data and audio files are restricted in size and length (30 seconds and 10 seconds, respectively) and require creative programming to resolve.

In our research, we set ourselves the task to record and collate Japanese Traditional Performing Arts, motion data and audio recordings and develop a method to create a real-time animation combining these within their context in SL. For this we specifically focused on assets of *Noh* in Japanese Traditional Performing Arts.

3. PREVIOUS WORK

There are several researches on character animation of intangible cultural properties in virtual heritage. CG restoration of a historical *Noh* stage [2] is a content of non real-time that allows the users to only watch the movies. This content was modeled and rendered by using the software LightWave™. Real-Time Recreated Ceremonies in VR Restituted Cultural Heritage [3] is a real-time interactive content that implemented by the VHD++ real-time frame work. However, this system does not allow multi participant the virtual presence because of without internet. Virtual Hagia Sophia [4] is a content with high-quality byzantine edifice that modeled by 3D CG tool. It has also not full real-time visualization and Internet. Mobile augmented heritage [5] indicated a methodology for real-time mobile mixed reality

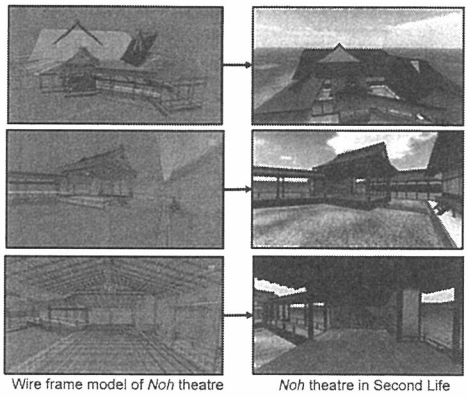

Figure 3. *Noh* theatre in Second Life.

systems that feature realistic simulations of animated virtual human actors (clothes, body, skin, face) who augment real environments and re-enact staged storytelling dramas in Cultural Heritage Sites. Benini. etc [6] used portable devices in managing interaction in (semi) Immersive Virtual Reality (IVR) systems reconstructing cultural heritage objects and environments. Ulicny. Etc [7] generated a virtual population of worshippers performing morning Namaz prayer inside a virtual mosque.

From the variety of projects and researches, virtual cultural heritage is a fast growing area of virtual reality applications. Using all the existing technologies in 3D modeling and reconstruction a large number of monuments, edifices, and sites are represented through virtual replicates over internet, on media, and trough immersive device. However, virtual cultural heritage of intangible cultural properties are still not widely simulated in their integrality due to their complexity, lack of historical references, and character animation.

4. MODELING *NOH* THEATRE IN SECOND LIFE

The realization of cultural heritage artifacts within Linden Labs Second Life™ (SL) platform presents the developer some unique challenges.

4.1. Pipeline of modeling *Noh* theatre in SL

The SL platform uses primitive objects (or 'prims' in SL parlance) as the basic building block for construction. Unlike more traditional 3D building environments these primitives have strict limitations on their size and availability for modification, this requires the careful and considered planning of the 'build', a degree of lateral thinking about how primitives can be modified in order to get a desired shape or effect and an acceptance that some artifacts created for SL will lack a high degree of fidelity with the original.

As a development platform SL is relatively crude and its lack of sophistication has prompted many developers to create their own toolsets to allow more sophisticated manipulation of primitives. Further SL is a de facto closed environment and provides no native import or export methods for models requiring all creation to be conducted 'in world' raising issues of data security, version control, and skill training. In response to this omission a number of utilities have been developed by the community to facilitate the off line creation of builds in more familiar 3D modeling environments, while these are not perfect solutions to the problem such utilities provide a degree of security and significant savings in development time.

As shown in Figure 2, in order to construct the *Noh* theatre as part of the offline build and import pipeline was used. Data of *Noh* theatre (*Nishi-Honganji* Temple located in *Kyoto*) provided by one of the authors, Furukawa, was imported into Autodesk 3D Studio Max 2009, positioned at the origin point and the scene rescaled to meters.

4.2. Modeling *Noh* theatre with SLPrim

A community created plug-in Second Life Max Offline Builder (aka SLPrim) [8] was installed and the code slightly modified to ensure metric units were used across the creation process. The SLPrim plug in gives the 3D Studio Max a set of new objects that replicate the primitives of SL which while still retaining the prohibitions of the SL environment allows the developer to take advantage of 3D Studio Max functions such as nested grouping, precision transformations, array creation etc.

Using these primitive objects the polygonal geometry of the *Noh* theatre was analyzed to find the optimal fit both in terms of dimensions (SL primitives must fall within the range of 0.01m – 10.0m in any axis) and in quantity (each area of land, or 'SIM' within SL is restricted to a maximum 256m² footprint with an allocation of 15,000 prims. Once the strategy for implementing the primitive was decided upon the scene was replicated using SLPrim objects, effectively tracing over the original polygonal forms. Each SLPrim object was given a unique identifier based on the given name of the original object and where multiple primitives were needed to realize a version of the original, instantiated numerically, this was done so that elements across platforms could be readily identified by a common name. This is essential both for London Charter compliancy and for remedial identification and correction with in SL.

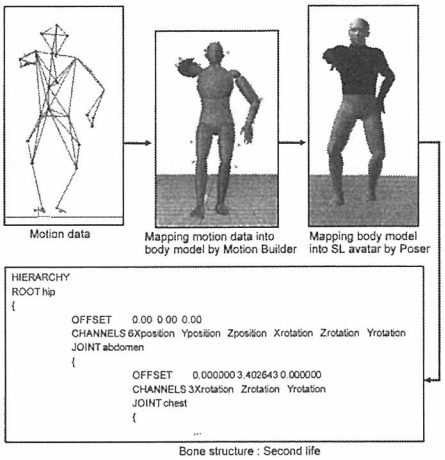

Figure 4. Generating of animation data.

Once a logical group had thus been replicated using SLPrim objects export of the group took place. It is strongly recommended that if using this method the option to export only the selected objects and the description over ride options be used, as this will facilitate smoother integration of the import into the SL scene.

The SLPrim export function creates a number of plain text files (.txt) depending on the complexity of the scene exported. Each of these text files will be a maximum of 64kb in size (Each primitive object is approximately 907 bytes in size) this is a restriction placed on the file size by SL. If more primitives exist in the export that can be recorded in on text file then the export will continue to create files numerically.

The export process as described above may be done incrementally and the import process is not dependant on the whole scene being exported at one single point.

4.3. Importing *Noh* theatre in SL

The importing of the exported SLPrim objects into the SL environment is a simple process and requires another community developed utility SL Object Importer [9] by Thraxis Epsilon. The importer object must be placed within the sim in which the import is to take place. Further the importer object will be origin point of the exported world, i.e. for 3D Studio Max coordinates 0, 0, 0. As SL does not use negative coordinates x and y being 0 – 256m and z 0 – 4096m (768m recommended) the positioning of the import object must be considered carefully ensuring that all of the import elements will fall within the limits of the land area available. If using a full SIM and a build not exceeding elements in 128m in any direction it is recommended that the importer box is placed at the centre of the sim and at an appropriate height

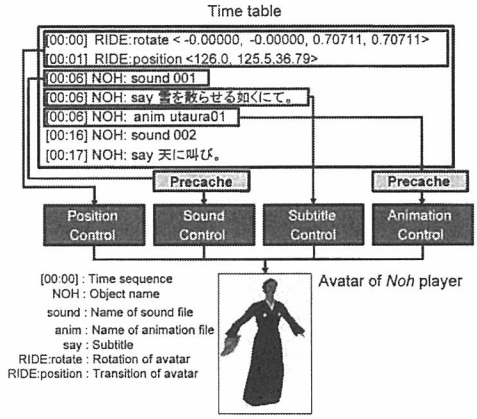

Figure 5. Implement of character animation.

Once the import object is placed the import process is ready to begin. For each of the text files created during the export process, the contents must be copied and pasted into a new note card within SL. It is recommended that the note card and text file are named the same so that files can be easily tracked should changes be necessary.

Having completed the production of the note cards each note card in turn is dragged from the inventory and dropped on to the import object. This will start the import process which reads the information in the note card and adjusts the parameters of a new SL primitive to match. Once the import process has concluded the import object will alert the user and another note card may be dropped on to it.

The resulting objects created by the import process are identical reproductions of those created in 3D studio Max using SLPrim plug-in, but untutored or tinted using the default plywood texture.

As the result of modeling, Figure 3 shows the wire frame model and the modeled *Noh* theatre with texture in Second Life. An avatar of *Noh* player will use this *Noh* theatre to play *Utaura* of *Noh*.

5. CHARACTER ANIMATION IN SECOND LIFE

In this section, we will carry out implementing of character animation in Second Life.

5.1. Capturing motion data of *Noh* player

In order to realize our SL *Noh* performance the assets were collected and prepared for the specific requirements of the platform. We employed the motion capture data of a *Noh* play called *Utaura* played by a leading professional *Noh* player, Mr. Toyohiko Sugiura who has forty four careers.

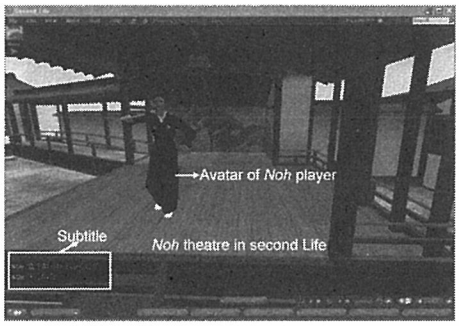

Figure 6. Character animation in Second Life.

We used optical motion capture system to record the accuracy 3D motion data. Thirty-two markers were attached on the body of each subject in order to capture motion data using an Eagle-Hawk system (Motion Analysis Corp.). This system incorporates 17 cameras detecting the 19mm markers attached to a subject who moves in a 4m × 4m area. We captured data with a sampling rate of 60Hz and recorded *Utaura* of *Noh* in Japanese Traditional Performing Arts.

5.2. Generation of data of animation and sound

As shown in Figure 4, the captured motion data was transformed from the TRC format into BVH format by using Autodesk's Motion Builder. This data was then used to animate custom characters within e-Frontier's Poser that compiled to the structure of SL avatar to ensure that the data would conform to SL specifications. The BVH data of *Utaura* is consisted of approximately 2,580 frames, too large for the 30 second limit on animations within SL, and subsequently were broken up into 5 separate files. These files are set in 30 fps because of the speed of animation in SL. Similarly the sound recording of *Utaura* was split up into 10 second segments and saved into the .WAV format at 44.1KHz in 16-bit mono.

5.3. Implementation of character animation in SL

These assets were uploaded successfully to the SL server. The native programming language of SL, Linden Scripting Language (LSL) was used to create a method to enable the sequencing of the assets without noticeable pauses between files.

The solution derived from the problem domain separates the avatar and the resources and utilizes a time schedule script to synchronize avatar movement, audio and other actions (such as subtitles), allowing avatar/object/event control and interaction across the virtual performance area (see Figure 5). Further, the solution provides a degree of security for the digital asset, access to non scheduled interactions and the ability to make the audience track the performance in a "directors-cut" format in real-time.

6. RESULT AND CONSIDERATION

Figure 6 - Figure 8 illustrate the results of the character animation of *Noh* player in Second Life. Our system synchronously controls the motion, sound and subtitle of the performance and transmits this information to avatar of audience. The character animation of intangible cultural heritage in SL was executed in a PC system, while running on a Win XP, 3GB RAM, Core2 Quad 2.83GHz, with NVIDIA GeForce 9800 GTX+ graphics card, yielding approximately 85fps performance in SL.

Figure 6 indicates the environment of character animation which is consisted of the *Noh* theatre of *Nishi-Honganji* Temple, the avatar of *Noh* player, the subtitle of sound in SL. All of controls are processed by time table of Figure 5 in real-time. It is able to confirm the character animation of *Utaura* as showed in Figure 7 through the image 1 to the image 9. Also, audience can see *Noh* performance by using avatar of audience in SL (see Figure 8).

Further, evaluation comments from the *Noh* player, a pupil of Mr. Toyohiko Sugiura, from whom the motion data was recorded for the creation of the content noted.

a) The quality of the SL content, both the Noh theatre and the *Noh* play, were of high quality.
b) The combination of the SL environment and the *Noh* created a place which would increase interest in the *Noh* tradition, not only those familiar with *Noh* but also those unfamiliar with the art form.

However, it was also noted that the *Noh* theatre in SL is required an entrance (*Kiridoguchi*) of *Noh* player for more improving interactive Noh play.

7. CONCLUSION

In our research, we successfully collated intangible cultural material through digital capture methods and migrated assets through the proposed method into the SL environment to produce an integrated real-time version of *Utaura* within the context of the *Noh* theatre. While we can conclude that SL has some restrictions at the present time, we have demonstrated that it is possible to overcome many of these issues and present unified assets of the performing arts in a meaningful and accessible way. Future development of the advanced method will optimize the method,

Figure 7. *Utaura* in Second Life.

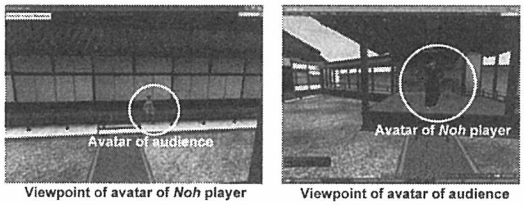

Figure 8. Viewpoint of each avatar in Second Life.

refine inter avatar (multi actor) interaction and explore the cross cultural aspects of performance traditions across different virtual performance spaces.

8. ACKNOWLEDGEMENTS

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