Virtual Historic Costume across Cultures and Disciplines

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Abstract— **"Material culture is the conventional name for the tangible yield of human conduct. We have things to study, and we must record them dutifully and examine them lovingly if the abstraction called culture is to be compassed."… "The design is a record of the process of design and … of the designer's mind and provides a resource for the historian and scholar created in time and shaped to cultural pattern." [1] Historic Costume Collections offer an opportunity for sociologists, anthropologists, historians and designers to study fashion design from concept to realization; the social milieu in which the garments were produced and worn; and the evolution of body type and posture. This paper discusses a project to enhance these investigations through advanced technology in virtual humans and a multicultural, multilingual development team.**

Keywords-component; virtual humans; historic costume; convergent technologies

I. Introduction

Full appreciation of an historic garment is limited by the constraint of not being able to see the garment on a live body. Conventional custodianship of historic fashion has relied on occasional exhibition on mannequins and archival storage of representative clothes. Every time the garment is displayed, even under optimum conditions, it degrades from stress and light, and is exposed to the danger of completely disappearing due to natural disasters. In storage, the garment becomes inaccessible. We are in a dire need of a means to permanently conserve these finite objects of cultural heritage that vividly conveys the subtleties associated with each era and culture. State of the art Digital Clothing software, incorporated into a comprehensive procedure and set of computational tools, will enable digital archiving of historic fashion designs. This will conserve a garment by creating a digital surrogate for it and its owner, bringing to life the garment and a full understanding of its construction; and, since the virtual human will be constructed from the data specifications of the garment, an identity to its owner, time and place.

The project also addresses an innovative model for international, interdisciplinary research and design education. Fashion Design, Computer Science, Digital Media and Computer Science students and faculty from Drexel University and Seoul National University, building on work in progress by The Digital Clothing Research Group and The Body and Motion Research Group at Seoul National University (SNU), with collaboration from clothing experts in Dongduk Women's University, are cultivating a multi-national collaborative program that marries fashion design, historic and contemporary, with cutting-edge science and engineering. The program will drive synergistic development of innovative technologies in multiple disciplines ranging from computer vision to historic fashion design study.

II. Digital Clothing Suite

SNU's physically-based simulation of clothes, which is readily adaptable to any body type and motion, can construct complex ensembles and reproduce their dynamic movements with a striking degree of realism. Reproduction of clothes in this work is based on the immediate buckling model proposed in [2]. To initiate the process, inputs to the software are (1) the cloth panels which constitute the basic shapes of the ensemble (i.e. front, back, sides, sleeves, etc.) and (2) the 3D human body along with its walking motion. Fabric details such as textures, prints, embellishments or textile structures, as well as the physical parameters (e.g., the tensile stiffness, mass density), are set up, which are important elements in making the results of the physically-based reproduction resemble real clothes. Then, the software automatically generates the movements of the ensemble through the numerical integration of the differential equations that model the physical flow of the fabrics. The above functions are integrated into a software system called the Digital Clothing Suite.

The first introduction of the technology was made at SIGGRAPH 2002 [2]. While previous techniques for clothing simulation had to trade-off between stability and realism, the immediate buckling model demonstrated at SIGGRAPH [2] achieved stability and realism at the same time, which brought significant acceleration to the simulation of clothes. Although the immediate buckling model solved the post-buckling instability problem, there was still room for improvements, including (1) extending the physical model to simulate thick, heavy fabrics, and (2) improving collision handling so that the simulator could handle tricky collision/contact situations (e.g., at the armpit). In 2004, SNU succeeded in extending the immediate buckling model for simulating thick/heavy fabrics and in refining the collision handling capability.

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Figure 1.Examples of early work at SNU

Figure 2. Left: ensemble donated by Sejong University, Korea; Right: its digital reproduction.

The image on the left was produced with the new physical model which can simulate the wrinkles in the jeans which last throughout the walking motion. The image on the right was produced with the new collision handling technology, in which the complex collisions occurring for a long-sleeve blouse and a coat at the armpit are successfully handled.

In 2005, SNU started working with fashion experts to experiment with the reproduction of more complex clothes. For this experiment, Sejong University and Ewha Women's University donated the two ensembles shown below which had appeared in a fashion show. The ensembles were reconstructed via the Digital Clothing software and their dynamic movements were simulated. Then each frame of the animation was rendered so that the images resembled the texture and textile of the real ensembles. The computer generated results did not exactly match the real ensembles due to the imperfection of the technology but due also to the variations the (digital) fashion designers intentionally introduced. Although the technology could not produce exact duplications of the original ensembles, the experiment demonstrated that the technology can reproduce fairly complex clothes.

Figure 3. Right: Ensemble donated from Ewha Women's University, Korea; Left: its digital reproduction

In 2006, SNU performed more challenging experiments with the fashion experts in Dongduk Women's University in Korea. The next ensemble, produced with Dongduk Women's University, beautifully illustrates the drape of a diaphanous fabric and its movement as effected by gravity and the air drags created when the model turns and walks.

Figure 4. Ensemble created with Dongduk Women's University using Digital Clothing software.

III. VIRTUAL HUMANS AND HISTORIC COSTUME

The world class Drexel Historic Costume Collection is comprised of 7000+garments and accessories from the early 1800's through the current time. The Collection also includes the appropriate undergarments to support the gowns. The Museum of the First Regiment, the nation's oldest, continuous regiment, is comprised of examples of military uniforms and regalia from the Revolutionary War to current time. The Collections, both including excellent examples of garments of the Civil War era and both residing in Philadelphia, PA, share the wish to create greater access to their collections and to demonstrate a full understanding of how these garments functioned on a body. In addition to the uniforms and gowns, both Collections feature the complex undergarments worn with these ensembles. From pattern specifications taken from selected holdings from these Collections we will be able to create virtual humans with bodies custom fit to the garments, dress them from the inside out in complete ensembles of the period and demonstrate how the bodies moved in this dress during a dance of the Civil War era. Expert programs in Fashion Design, Computer Science, Information Science, and Digital Media disciplines from Drexel University and Seoul National University are converging to provide the design and technological advances needed to bring the vision to realization, through the perspective of a multicultural, multilingual team, bridging design in general and STEM, (Science, Technology, Education and Math), objectives.

Working with historic costume presents several problems. Current simulated cloth representations are not specifically detailed. Although the drape and flow of some fabrics have been beautifully and successfully mimicked in the work at SNU, detailed movements, resulting from the dynamic complex mechanical structure of and constraints imposed upon the cloth, are noticeably different from those of real clothes. Additional deforming characteristics, created by layers of garments and underlying support garments, such as the corset and crinolines worn under the 1870's era illustrated below, have not been addressed.

Figure 5. Left: Virtual garment produced with Dongduk Women's University; Right: Multi-layered, complex surfaced ensemble, 1870, Drexel Historic Costume Collection

Figure 6. Beading detail, evening gown, Callot Soeurs, 1930. Drexel Historic Costume Collection

Moreover, the way complex embellished surfaces, such as the beading or intricate weave structure involved in historic costume, (illustrated above) react to light and shadow are not precisely portrayed. We will acquire and integrate these complex cloth structures in the virtual representations by investigating the derivation of compact representations for encoding the spatially heterogeneous and view-dependent local light reflection induced by real-world fabrics and devise newly derived rendering algorithms to efficiently synthesize the surface appearances on the clothes of the virtual humans.

Additionally, the motion of existing virtual humans lacks the nuanced movements needed to reenact the dancing couples and sometimes multiple couples interacting. To facilitate the creation of additional simulation character assets, we will integrate state-of-the-art motion capture of regional Civil War dance re-enactors during the production cycle. Multiple cameras and markers will capture the movements of the dancers and two MX Giganets will provide power and data communication and manage the data flow to the host computer running the host software which will analyze the data. The Giganet provides synchronization of the captured images through timecode and generator lock, preventing changes in color hue and saturation and image flicker, not only to the connected cameras and analog acquisition, but also to reference video and other measurement equipment that can receive synchronized pulses.

Creative use of metadata tags which "travel" with the models throughout the rendering pipe have shown to be an effective way of integrating material and other complex properties which will be needed for these simulations. Because of the multi-cultural, multi-lingual nature of the project computer and information scientists from the two Universities will define a structure to store and retrieve the objects efficiently by defining an appropriate meta-data schema, facilitating cross-cultural resource description and discovery.

The characteristics of non-textual multimedia resources, such as fashion design, bring forth special hindrances in content representation and metadata generation of multimedia objects. In order to fully and accurately describe and process historic, present, and virtual fashion, we will investigate various content analytic modules (e.g., audiovisual analysis, textile analysis) and (semi)automatic metadata generation techniques. The textile analysis module which features basic, intermediate and advanced characteristics of textiles, is used to classify an object according to pre-generated taxonomy and classification schemes in the fashion domain. Considerable work on a classification schema for historic costume category has been accomplished in the Drexel Digital Museum Project. [5] We will capture metadata value through exploiting sources not only from the multimedia object itself but also from its context including object usage, user profile and metadata repositories.

To leverage the speed of metadata generation and facilitate more consistent metadata application, we will devise software for automatic production of technical metadata (e.g., data format, size). By adopting the concept of application profiles, given metadata schemas suitable for capturing multimedia objects are customized; and data elements geared toward cultural and fashion domains are further extended. Metadata can be generated in multiple languages depending on the sources of the multimedia objects. We shall also investigate how to manage multi-lingual metadata by utilizing an automatic multilingual thesaurus. The automatic multilingual thesaurus is constructed by statistical analysis and machine learning techniques. Such techniques have been tested in cross-lingual information retrieval and multilingual document management tasks and have achieved promising results. We shall develop techniques for multi-lingual metadata management based on the foundation of our previous developed techniques.

IV. SUMMARY

Advanced technologies are being used to illustrate cultural heritage and deliver a captivating "museum" experience. Virtual humans will play an important role in these new experiences. This project will allow display of selected objects from our Collection to many venues outside of the physical Collection. In the classroom the study of historic garment design via virtual humans and the Digital Clothing software will allow students and scholars to examine explicit details of construction and textiles without stressing the physical garment. Displayed on touch screen monitors inside and outside of the Collection, the virtual humans will bring the garment to life and demonstrate how the body moved in historic dress to an audience that may not otherwise realize the role of historic costume in cultural heritage. Showing the full dress, from undergarments to outer garments, will illustrate the changes in body image and the practical and aesthetic function of clothes from the mid 1800's to the current time. Accompanying audio will provide additional historic context.

Creation of virtual humans has progressed considerably in the past few years but there is still much to be done. Technology alone, particularly when developed in segregated arenas, does not deliver the most promising virtual tools of the future. The diverse perspectives of the participants in this project will create an innovative model for international, interdisciplinary development, storage and retrieval of virtual humans for multiple end uses, including conservation and display of cultural heritage. The imaginative experience of the virtual display will serve to attract students of all ages to the career potential of the pursuit of any of the disciplines involved in the project.

REFERENCES

[1] Glassie, Henry, Material Culture, Indiana University Press, 1999, p.41.

[2] Kwang-Jin Choi and Hyeong-Seok Ko. Stable but Responsive Cloth. ACM Transactions on Graphics (Proceedings of SIGGRAPH 2002), Volume 21, No. 3 (July 2002), pp. 604-610.

[3] Kwang-Jin Choi and Hyeong-Seok Ko. Extending the Immediate Buckling Model to Triangular Meshes for Simulating Complex Clothes. Short Presentations in EUROGRAPHICS 2003, pp.187-191, Granada Spain. September 2003.

[4] Kwang-Jin Choi and Hyeong-Seok Ko. Research Problems in Clothing Simulation. Computer Aided Design, Volume 37, Issue 6 (May 2005), p. 585-592.

[5] Martin, Kathi. Standards in the Visual and Linguistic Language of a Historic Costume Collection. The Research Journal of Textile and Apparel (RJTA), special issue devoted to Design, Material and technology Interface, vol.10, no. 3, (2006) http://mc.manuscriptcentral.com/rjta