Virtual Marionette

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ABSTRACT
Virtual Marionette is a research on digital puppetry, an interdisciplinary approach that brings the art of puppetry into the world of digital animation. Inspired in the traditional marionette technology our intention is to study novel interfaces as an interaction platform for creating artistic contents based on computer animated puppets. The overall goal of this thesis is to research and deploy techniques and methods for the manipulation of articulated puppets in real-time with low-cost interfaces to establish an interaction model for digital puppetry.

Author Keywords
Digital Puppetry; Virtual Marionette; Real-time animation; Computer Kinematics; Interactive Animation; Performance Animation; Human Computer Interaction.

ACM Classification Keywords
H.5.2 [Information Interfaces And Presentation]: User Interfaces - Interaction styles.

CONTEXT AND MOTIVATION

Sometimes we just want to tell a story with simple character animation, but then, we take so much time producing the animation that we forgot the story line.

Digital character animation based on key-frame techniques is laborious and time consuming, especially for non-expert animators that have to lead with complex concepts like time and space in animation for building motion. In other hand, traditional puppetry techniques presents a natural and intuitive interaction between the manipulator and the puppet. With digital puppetry the animation is produced in real-time focusing the performer improvisation, which is great for live shows and storytelling. An interactive way for working with narratives turning story time into life.

Some digital puppetry techniques like motion capture are a common practice for character animation in high-end industry, like film productions that spend a high budget in technology. With today low-cost technologies, like Microsoft Kinect, Nintendo WII, Sony Playstation Move, or multi-touch surfaces, digital puppetry became a hot topic opening new targets like the home entertainment industry. As a result, a new research domain related to the interaction methods opens the door for different ways of interacting with puppets using low-cost devices, which must be explored.

With these novel interfaces the human to computer interaction (HCI) paradigm is changing raising new questions, like multi-user interaction or gesture recognition.

We intend to study the interaction possibilities with puppets using digital interfaces with different users like, animators, puppeteers and non-export artists.

Our main focus is the pedagogical environment, developing a prototype to be used as a learning tool for children. An application for story telling that let children explore the magical and fascinating world of puppets in a simpler manner and easy to control system. A learning tool, that brings the creative and inventive world of puppets into the computer animation.

In this way, we can measure and evaluate how children respond to the interaction with the puppets and the success of these applications as learning tool.

Another contribution will be for the entertainment industry, building a model for a virtual live TV puppet show, making use of the cinematic language, using lights and cameras. The evaluation of this model with animators and puppeteers will show the potential of digital puppetry in television.

Artistic performances using digital puppetry are also part of this research; understating how live performers can interact with digital puppetry. We will work with performers to explore the relation between analog and digital interaction.

Our final contribution is to disseminate digital puppetry through different areas as an interaction platform for puppet animation.

RELATED WORK

Digital puppetry experiments started in early 1960s, using analog circuits to animate figures in real-time conducted by Lee Harrison III [16]. The interaction with the character was made with analog sliders and knobs. In 1967 he presented the first approach to mechanical motion capture using a rig of potentiometers inside an armature that was

IUI'12, February 14–17, 2011, Lisbon, Portugal.

used by a performer to control a video character in real-time. But it was only in 1988 that arrived the live animated computer graphics characters rendered in real-time. Thanks to the combination of the Silicon Graphics 4D workstation with real-time computer graphics (CG) and Waldos, mechanical controllers made by deGraf/Wharman and Pacific Data Images (PDI), digital puppetry was born. Mike the Talking Head was the result of this combination, a real-time animated head controlled by a puppeteer. In the same year, PDI brought the first successful real-time digital animated figure for television. Waldo C. Graphic was built for Jim Henson productions [5]. Performed and rendered in real-time with a low-resolution model for "The Jim Henson Hour" TV series for later post-production; Waldo was manipulated trough a mechanical arm controlled by a puppeteer. In 1991, Medialab presents Mat the Ghost, a fully real-time CG animated puppet for a television production. A multimodal system, using data-gloves, joysticks, motion capture and midi devices used by puppeteers to control Mat [14]. A very interesting solution for mapping performer movements to animated characters is presented by Kyun et al. [9]. They describe a method for transferring motion capture data to animated characters whose size and proportion may differ from the performer. Using the notion of dynamic importance of an end-effector applied to the inverse kinematic solver preserving the main motion aspects of the performance. Since then, many researches and developments have been made on digital puppetry, from motion capture technologies to film production companies [11]. Henson Digital Puppetry Studio is an example of this evolution, a system that provides performance animation with CG characters using a mechanical hand controls that can be broadcast for television. Sid the Science Kid is an example of the recent Jim Henson production for television that combines motion capture with hand controls.

The most common approaches to create animations using digital puppetry include: digital strings to control the puppets using a digital glove [2]; computer vision for tracking color marks in a object that controls the marionette movements [10]; using a multi-touch surface for direct manipulation of bi-dimensional shape puppets [13]; hand gesture recognition to use fingers to move the marionette simulating a string controller [7] a multi-modal interface to simulate different marionette techniques in a virtual puppet show [6]; a motion capture system for performance-driven with gesture recognition to trigger behavior animation for virtual theater, using an extra joystick for expanding the movement area [12].

These researches contributed to a greater knowledge on character animation using digital puppetry, but some are complex to use or to implement, and others use expensive equipment. We propose easy to use affordable systems to be used in different environments and different users.

STATEMENT OF THESIS

Digital Character animation is complex and time consuming. Based on this question we propose using puppetry as an interaction and rigging model to simplify character animation using affordable interfaces as controllers, which could be used for content generation as a story telling technique in educational and entertainment.

Our main goal is to build an interaction model for digital puppetry using traditional marionette methods as a starting point. Seeking new ways for a user to interact with performing objects in real-time.

A model that can be abstract from the interaction interface, which simply map different inputs into a single or multiple outputs converting and scaling the input data to the desire animation values. In this way, a multi-model interaction solution could contribute to a more expressive result in performance animation.

It is important to establish digital puppetry taxonomy. Looking at traditional puppetry taxonomy approaches we found that Alexandre Passos [8] presented a simple classification based on the available manipulations systems. Upper, medium and lower manipulation level are the divisions to classify from were the puppets are manipulated. But this classification doesn't fit completely in the digital medium, which presents other methods of interaction. A different approach is presented by Stephen Kaplin [3], based on distance and objects/performers ratio. Kaplin describes "distance" as the contact and separation level between the performer and the manipulated object. Starting with absolute contact, were the performer and the object are just one, to the opposite scale based on physical and psychological body factors, and temporal contact levels. With objects/performers ratio, Stephen Kalplin refers to the number of performing objects compared to the number of performers. We can build a digital puppetry taxonomy based on this two classification systems assuming the performer as the main interaction platform. To describe a methodology for digital puppetry performance animation we propose three parts:

1. Performing objects structure, describing the rigging system, shape and materials, like if they are rigid or deformable.

2. User interaction methods, which defines the way users interacts with the puppet, describing the performer expressions, interaction interfaces and joint mapping.

3. Animation, which defines the motion of the puppets using performance, pre-recorded, procedural or physics based animation.

Rigging the puppet defines his behavior with bones connecting joints; the mapping is the correspondence of the performer joints to the puppet, which can be direct or indirect mapping, like the hand of the performer to control the head of a monster; the input interface establish the controlling method, using a perceptual input which doesn't require any physical contact with the device or a non-perceptual input which requires physical contact like a mouse; in animation, puppet responds to the performing animation, use pre-recorded animation to produce actions, physics to create enhanced and natural motion, and procedural that can be trigger by the performer.

To understand how this model works in a pedagogical, artistic and entertainment environment we intend to develop three proofing tools. Each approach will be focus on the particularities of each environment. For the pedagogical approach the intention is to work with groups of children creating a virtual marionette play for storytelling. A complete virtual play, with performing puppets, animated scenery and props. For the artistic environment the main objective is to create a live performance in which the puppet interacts with the performer. The entertainment approach is for live television or film productions in which the performer controls mainly characters that interact with images from other sources.

By the end of this research we expect to achieve the following results:

- An Interaction Model to be used in digital puppetry.
- Prototype of a Virtual Puppet Show as a learning tool.
- Evaluation and validation of the interaction model.
- Classification of digital puppetry.
- Dissemination of results in scientific journal and conferences of high impact.
- Digital puppetry demonstrations in different fields.

The Prototype of the Virtual Puppet Show will be evaluated with a pilot experiments. Using a focus group of children in a school environment for a live story telling experiment. This experiment needs to be validated with a survey and statistical analysis of puppet interactions.

Beyond the study of marionette mechanics we will also seek the cultural and artistic aspects related to the marionette, like the puppet theatre. Search for similarities and differences between marionette motion and digital character animation; for instance, an important difference between frame-by-frame animation and real-time animation is the improvisation of the puppeteer.

We will explore the various expressions of the marionettes, in particular their different ways of handling and its particular language, studying the anthropological and cultural side. Two examples of this study are "Os bonecos de Santo Aleixo" from the Portuguese *Bonecreiros* [12] and the silhouette puppets (shadow theatre) *Wayang Golek* [4] of Java in Indonesia. Ancient puppetry presenting different ways of handling, which we will explore and compare with digital interfaces:

- Multi-touch interfaces for multiple control points manipulation;
- Computer Vision methods for the use of body language;
- The use of sensors like accelerometer to simulate rod or string controllers;
- Computer Sound Analysis for generating facial expressions;
- Networks for multiuser manipulation

DISSERTATION STATUS

It is intended to follow up the previous studies, published in the Master's thesis "Marionetas Virtuais" [10] with the prototype "ANIMATIC" [1] and thus further research in the areas of interaction and in the real-time animation.

For the PhD we have built new prototypes, created a poster for I Interactive Multimedia Group Symposium, and conducted an experiment with a survey, which was published in ACE 2011 with the name "Anim-Actor".

Research prototypes:

"Virtual Silhuette" and "reActor" are two examples of 2D and 3D real-time rigid puppet animation using low-cost motion capture systems published in the online support site [15].

"Kine-Puppet Show" a 3D virtual puppet shows with deformable puppets, using Microsoft Kinect as a motion capture system.

"IPADATA" is an experiment of digital puppetry simulating a direct puppet manipulation. A multi-touch interaction method using the Apple Ipad as interface. The system can work with several devices at the same time and compromise three parts: Input, mapping and animation. The input device sends the finger coordinates via wireless network through the Tangible User Interface (TUIO) framework. Then, a middleware software, OSCulator, acts like a bridge between the input and output mapping the messages to be interpreted by the animation package sending them via network. Finally the animation software, which defines the shape and the bone structure, animates the joints.

"WIIDATA" is a similar experiment as "IPADATA" but works with the Nintendo *WIImotes* that are used to simulate the rod puppet manipulation.

For future work we intend to build and evaluate the three puppet tools that were mentioned, based on digital puppetry techniques with different puppets and performing objects.

As a result of the experiments we intend to build a classification map to identify different interaction methods.

OPEN QUESTIONS

Digital puppetry is subject of debate within the puppetry and animation communities since a long time and differs from conventional puppetry techniques, because there is no tangible puppet and from conventional computer animation because it involves performing characters, rather than frame by frame animation.

This undefined border of digital puppetry being integrated in puppetry or in animation raises some questions that we will explore through this research.

The main Question:

- Virtual Marionette can be considered a Marionette in terms of behaviors and characteristics and in terms of its proximity with the puppeteer/user?

Secondary Question:

- Can performance animation achieve the same or better results as traditional puppetry in storytelling?

REFERENCES

1. ANIMATIC Prototype. http://www.grifu.com/animatic/.
2. Bar-Lev, A., Bruckstein, A., Elber, G.: Virtual marionettes: A System and Paradigm for Real-time 3D Animation. *The Visual Computer, Vol. 21*, (2005), (pp. 488-501).
3. Bell, J.: Puppets, Masks and Performing Objects, Londres, Mit Press, (2001).
4. Currell, D.: The Complete Book of Puppet Theatre, A & C Black, London, (1985).
5. Graham, W.: The Story of Waldo C. Graphic. *Course Notes: 3D Character Animation by Computer*. ACM SIGGRAPH, Boston, (1989), (pp. 6-79).
6. Leite, L.: Marionetas Virtuais – Animação interactiva em tempo real, Master Thesis in Multimedia Communication Technologies, Engineering Faculty of the University of Porto (FEUP), Porto, (2006).
7. Ninomiya, D., Miyazaki, K., Nakatsu, R.: Networked Virtual Marionette Theater. In *Proceedings of the 3rd international conference on Technologies for E-Learning and Digital Entertainment (Edutainment '08)*. Springer-Verlag, Berlin, Heidelberg (2008), (pp. 619-627).
8. Passos, A.: Bonecos de Santo Aleixo, Adágio, Évora (1999).
9. Shin, H., Lee, J., Shin, S., Gleicher, M.: Computer puppetry: An importance-based approach. In *ACM Trans. Graph. 20, 2* (2001), 67-94.
10. Sirota, A., Sheinker, D., Yossef, O.: Controlling a Virtual Marionette using a Web Camera, Technion - Israel Institute of Technology, Israel (2003).
11. Sturman, D.J.: Computer puppetry. In *Computer Graphics and Applications, IEEE, vol.18, no.1*, (1998), (pp. 38-45).
12. Sturman, D.: The State of Computer Animation. In *ACM SIGGRAPH Comput. Graph.* ACM Press, New York. (1998), (pp. 57-61).
13. Takeo, I., Yuki, I.: Implementing As-Rigid-As-Possible Shape Manipulation and Surface Flattening. In *Journal of Graphics, GPU, and Game Tools*, A.K.Peters, Volume 14, Number 1, (2009), (pp. 17-30).
14. Tardif, H.: Character animation in real time. In *Panel Proceedings: Applications of Virtual Reality I*, ACM SIGGRAPH, 1991.
15. Virtual Marionette http://www.grifu.com/vm/.
16. Wu, Q.,Boulanger, P, Kazakevich, M., Taylor, R.: A Real-time Performance System for Virtual Theater. In *Proceedings of the 2010 ACM workshop on Surreal media and virtual cloning (SMVC '10)*. ACM, New York, USA. (2010), (pp. 3-8).