Shape Your Body: Control a Virtual Silhouette Using Body Motion

Luís Leite
IT, FEUP -
Instituto de Telecomunicações
Porto, 4200-465 Portugal
luis.grifu@gmail.com

Veronica Orvalho
IT, DCC/FCUP -
Instituto de Telecomunicações
Porto,
veronica.orvalho@fcc.fc.up.pt

CHI'12, May 5–10, 2012, Austin, Texas, USA.
ACM 978-1-4503-1016-1/12/05.

Abstract

In this paper we propose to use our body as a puppetry controller, giving life to a virtual silhouette through acting. A framework was deployed based on Microsoft Kinect using OpenNI and Unity to animate in real-time a silhouette. This was used to perform a set of experiments related to the user's interaction with human and non-human like puppets. We believe that a performance-driven silhouette can be just as expressive as a traditional shadow puppet with a high degree of freedom, making use of our entire body as an input. We describe our solution that allows real-time interactive control of virtual shadow puppets for performance animation based on body motion. We show through our experiment, performed by non-expert artists, that using our body to control puppets is like mixing the performance of an actor with the manipulation of a puppeteer.

Keywords

Real-time animation; digital puppetry; performance animation, HCI

ACM Classification Keywords

H.5.2 [Information Interfaces And Presentation]: User Interfaces - Interaction styles;

General Terms

Human Factors

Introduction

Shadow theatre is an ancient art form that brings life to inanimate figures. Shadow puppets are effective as educational tools and as a great platform for storytelling. Thus, our objective was to build a digital puppetry tool to be used with non expert-artists to create expressive virtual shadow plays using body motion. Shadows have a symbolic meaning in a figurative way because they are representations of their original form. However, when moved in a dramatic manner by the shadow-player they produce the illusion of life [2]. These traditional two-dimensional flat cutout figures are held by a rod or wire behind a translucent screen. The shadow-player can model and transform the figure, which will be interpreted by the imagination of the spectator [1]. In order to achieve the dramatic motion the shadow-player has to describe subtle gestures with the rods.

Shadow puppets are also used to produce animated films. The Adventures of Prince Achmed is an example of a feature film from 1962 built with thousands of cutout paper puppets, but producing an animated film with shadow puppets, frame by frame, is laborious and time-consuming. With digital animation the process can take less time. However we still lack of continuous motion behavior when using the key-frame method, which characterizes puppet performance. When performing with shadow puppets, the puppeteer works with improvisation in order to get a more spontaneous movement. We propose to use a real-time human body controller to bring the improvisation to the animation. Thus, mixing the art of puppetry with acting inanimate figures becomes alive in a spontaneous manner. The body becomes the interface interaction model. The correspondence between the body and the object is defined by mapping the human joints to the object's control structure; this is not a trivial task. We implemented a solution that lets the user explore its body expression to find the best correspondence to different silhouettes, to interactively animate and trigger procedural animations. This solution was tested in a pilot experiment comparing and evaluating human and non-human like silhouettes. In the study we gave special attention to the expressiveness in the animation. We also tested using our hands to interact with the interface to extend the user capabilities of control. In such way, the performer could interact with props or trigger other animations. This study contributed to a better understanding of user interaction with shadow puppets by using direct and indirect body mapping correspondence.

Background

Digital puppetry experiments started in early 1960s, using analog circuits to animate figures in real-time, conducted by Lee Harrison III [9]. But it was only in 1988 that the live animated computer graphics (CG) characters arrived. With Mike the Talking Head project, controlled by a puppeteer using Waldos, mechanical controllers made by deGraf/Wharman and Pacific Data Images (PDI), digital puppetry was born. In the same year, PDI brought the first successful real-time digital animated figure for television. Waldo C. Graphic for Jim Henson productions [3] 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. To control Mat, puppeteers used a multimodal system, using data-

Figure 1. Dragon silhouette fully rigged, made with 9 rigid slices of planner geometry.

gloves, joysticks, motion capture, and midi devices [11]. An interesting solution for mapping performer movements to animated characters is presented by Kyun et al. [7]. They described a method for transferring motion capture data to animated characters whose size and proportion may differ from performer to performer. Using the notion of dynamic importance of an end-effector applied to the inverse kinematics (IK) solver preserving the main motion aspects of the performance. Since then, many researches and developments have been carried out on digital puppetry, from motion capture technologies to film production companies [8]. Henson Digital Puppetry Studio is an example of this evolution, a system that provides performance animation with CG characters using a mechanical hand control that can be broadcasted for television. Sid the Science Kid is an example of the recent Jim Henson production for television that combines motion capture with hand controls. *However, all of these solutions are based on 3D characters, how about bi-dimensional puppet performance animation?*

Hsu et al. [4] presented a motion planning technique based on procedural character animation that can generate automatically the animation of the 2D puppet for shadow plays. Tan et al. [10] describe a method for real-time visual simulations and interactive animation of 2D shadow play puppets with OpenGL. They try to reproduce the visual environment of a real shadow play by modeling the shadow using texture mapping, blending techniques, lighting and blurring effects. ShadowStory [5] is a project created by Fei et al. for digital storytelling inspired by traditional Chinese shadow puppetry. The system allows children to design with a tablet PC their own puppets and animate them using orientation sensors. Pan and Zhang presented a sketch-based skeleton-driven 2D animation technique applied to a bi-dimensional shape deformation with squash-and-stretch cartoon effect. The animation can be produced based on 2D motion capture, retargeting the joints to the shape [6]. We found interesting performance puppet manipulation methods in some digital puppet artwork, like Puppet Parade, an interactive puppetry installation that animates puppets by tracking the arms of the puppeteers, or We Be Monsters, a collaborative puppet art installation that tracks multiple skeletons to animate a puppet. Although they do not focus the shadow puppetry, they use the body motion to control the puppets. An extensive research has been carried out in digital puppetry, presenting new methods and technologies for performance animation. Existing researches on shadow puppets do not focus on the user´s full body interaction capabilities for controlling the puppets. Our study goes towards improving the use of body expression capabilities to produce rich interaction experience, like in hand shadows performance.

System description

We started by searching interaction techniques for the development of a consumer level puppeteering tool designed for the average consumer. Our framework is based on depth cameras for capturing the performers body expression, OpenNI and NITE for skeleton model and gesture recognition and Unity for rendering and animation. We use a Microsoft Kinect device, based on PrimeSense technology that computes a skeletal model. This is an affordable mark less interface that dose not need rigorous conditions to work. We tried different software approaches searching for a suitable framework. The implementation of all of the

Figure 2. The biped silhouette matches the pose of the performer.

Figure 3. Performer interacting with the dragon silhouette launching flames with procedural animation.

Figure 4. Birds pose driven by the performers body expression.

experiments were based on the OpenNI framework and NITE middleware. The OpenNI provides an application-programming interface designed for natural interactions. NITE is a middleware for OpenNI that handles the user's identification, features detection and gestures recognition. Our first approach was based on OSCeleton and Synapse for skeleton tracking, sending the joint data via OSC (open sound control) protocol to other applications. MaxMSP was used to tweak and map the joints and Animata for real-time animation. This was a flexible solution because of the use of OSC but complex and limited, as it brings some latency performance. Then, we experiment using Unity with OpenNI wrapper achieving a better performance as it increased the interaction possibilities, like gesture recognition. We started with one-to-one mapping correspondence between the motion of the performer and a 2D biped character constraining XY axis rotations considering Y-axis as world up (see figure 2). Then, we implemented the indirect mapping using human motion to animate a non-human like silhouettes. In this case it was necessary to retarget the captured joints. Instead of using the world or screen joint coordinates, which might lead to the deformation of the shape trying to assume the human pose, we used the joint orientation for body motion (figure 5) and the root joint position for global movement. We made a 2D shadow style biped puppet and two animal silhouettes representing a bird and a dragon. The human like puppet was made with a piece of geometry that deforms according to the influence of the bones, rigged with 21 joints, 13 of them were mapped to the correspondent captured joints. The animal figures represents the indirect mapping. The bird was produced with the same method as the biped silhouette using a deformable geometry. The bird was rigged with 16 joints, where 4 joints were connected to the head and neck assigned to the performers arm and 2 joints connected to the wing that were assigned to the other arm. The legs with 4 joints were mapped directly to the legs of the performer. The Dragon figure was made with rigid geometries similar to traditional silhouettes, which were connected to the bone structure with 14 joints (see figure 1). The head and neck were mapped to one arm, the tail to the other arm and the legs to the legs of the performer. In this particular figure the user could trigger the action of flame launching (see figure 3) from the mouth of the dragon to increase the expressiveness, which could be done by activating a button using gesture recognition. The final prototype gathers all of the silhouettes in one application, making it possible to change the puppets when performing.

Experiment

We started evaluating this tool as a trial of feasibility, testing the interaction techniques, measuring the manipulation level and the result expressiveness of each puppet. We conducted a pilot experiment choosing a sample frame representing the average user with a focus group of 11 volunteers (6 female and 5 male) with an average age of 22, ranging from 20 to 36. All of the participants were students and non-expert artists. We used a non-probability method with a convenience sampling. We developed a survey with three questions rating 1 (worst) to 5 (best): expressiveness of the performed puppet in terms of dramatic character representation; level of manipulation, the way users control the puppet; evaluation of the hand navigation using gesture recognition and hand tracking. Each user performed with the puppets in random order (biped silhouette, bird and dragon). Finally, the participants answered a survey. They also had the opportunity to

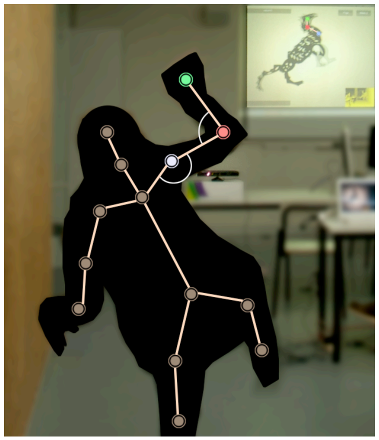

Figure 5. User performing with the dragon figure with indirect mapping.

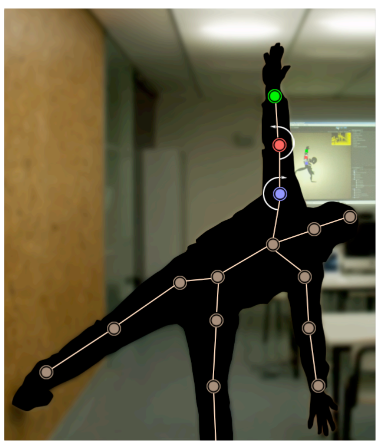

Figure 6. User searching for an expressive pose.

experiment and improvise with the puppets for 10 minutes. Some of the participants tried to accomplish objective actions like sitting or walking, others tried acting, searching expressive positions.

Results

While acting, we noticed that the participants searched the best position to interpret and besides being at linear poses facing the camera, some of them found ways of being more expressive in the interaction with the puppet, opening and closing their arms and legs (see figure 6) increasing the puppet expressiveness.

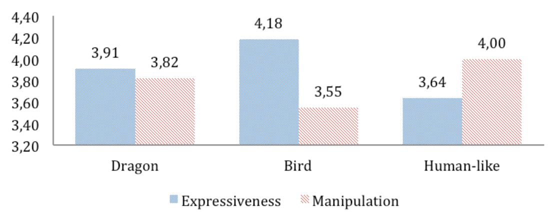

Figure 7. Expressiveness and manipulation levels from 0 to 5.

The overall results obtained from the experience were positive, showing that the users did not find major problems in handling the puppets. They rated the animated puppets as highly expressive, with values above 3.64 in a 0 to 5 scale. When comparing each puppet, the results were not conclusive; there were small differences in the expressiveness and manipulation between each puppet, as we can see in figure 7. The human like puppet obtained the best result from the participants in the manipulation, with a value of 4, because it mirrors the movement of the performer. However the bird silhouette was considered more expressive then the human like puppet, with 4.18 followed by the dragon with 3.91. A possible explanation for these results drifts from the pose of the animals that leads to a more objective action. When performing with the bird silhouette, many users searched for a clear action like feeding from the ground using the bird's beak (see figure 4). When performing with the biped silhouette the action was not so clear and the users moved the arms and legs randomly. We can find this concept in traditional animation in the staging principle. Staging is the presentation of an idea so it is completely and unmistakably clear. An action is staged so it can be clearly understood. Also, in puppetry, puppets are made to accomplish a certain action, the rigging and expression reflects this principle. Finally the participants responded positively to the hand navigation interface with 4.10, which makes us believe that this is an intuitive way to interact with our hands.

Conclusion

Interacting with puppets with the body motion relies on the acting. Unless the system offers methods for simplifying the animation, the performer must try to interpret the character. To simplify the user interaction experience we can implement methods like gesture recognition, constraints, procedural and pre-made animation triggered by the performer. But, if we turn this experience in something completely automatic, we loose the control of the puppet; therefore the freedom of movement and improvisation is limited. Like in puppetry, the puppets should be made and rigged to respond to a clearly purpose or action, helping the puppeteer to achieve a better performance. This is a principle shared by puppetry and animation. We presented a new interaction model for animating shadow puppets: using body motion in order for the user to control the virtual silhouette instead of pulling strings or handling rods.

We conclude that the expressiveness of a performed silhouette relies on the staging of the shape and on the acting of the performer. Also, retargeting or mapping human body to shapes can be fun and can help us to move our body with the art of a performer. The interaction with the virtual silhouette using the body as a controller is somehow similar to the hand shadow performance, where the performer models his hands to create the illusion of a shape. After the experiment we believe that a Virtual Silhouette can be an intuitive interactive platform to work with narratives, bringing stories into real life.

Our solution is a proof of concept that presents several limitations that should be overcome, like facial expressions or multiuser interaction. For future work, the application should allow the user to control the rigging and mapping process, therefore we could evaluate this tool with puppeteers and animators with more advanced interactions. Also, it is important to research and develop other methods and techniques to enhance the interaction experience and the animation results. Some key points for future work are: the development of a 2d puppet flipping method; include some animation principles: like squash and stretch; explore the NITE's gesture recognition; implement a multi-modal solution expanding the interaction possibilities, like voice control. This study opens some questions about how to interact with 2D puppets using body motion based on digital puppetry that must be deeply researched, like puppet rigging or using IK´s.

Acknowledgements

This work is partially funded by Instituto de Telecomunicações and the projects LIFEisGAME (Funded by FCT) and VERE (funded by EU). Thanks to Luís Silva, Marcelo Redondo, Jacqueline Fernandes and all the student volunteers.

References

[1] Currell, D. Shadow Puppets & Shadow Play, Crowood Press (2008).

[2] Currell, D. The Complete Book of Puppet Theatre, A & C Black, London, UK (1985).

[3] Graham, W. The Story of Waldo C. Graphic. In Course Notes: 3D Character Animation by Computer, ACM SIGGRAPH (1989), 6-79.

[4] Hsu W. S., Ye T. Planning Character Motions for Shadow Play Animations. In Proc. CASA'05 (2005), 184-190.

[5] Lu, F., Tian, F., Jiang, Y., Cao, X., Luo, W., Li, G., Zhang, X., Dai, G., Wang, H. ShadowStory: creative and collaborative digital storytelling inspired by cultural heritage. In Proc. of CHI 2011 (2011), 1919-1928.

[6] Pan, J., Zhang, J. Sketch-based Skeleton-driven 2D Animation and Motion Capture. In Transaction of Entertainment, LNCS, Springer (2011).

[7] Shin, H., Lee, J., Shin, S., Gleicher, M. Computer puppetry: An importance-based approach. In ACM Trans. Graph. (2001), 67-94.

[8] Sturman, D. Computer puppetry. In Computer Graphics and Applications, IEEE, vol.18, no.1 (1998), 38-45.

[9] Sturman, D. The State of Computer Animation. In ACM SIGGRAPH Comput. Graph. ACM Press (1998), 57-61.

[10] Tan K. L., Talib A. Z., Osman M. A. Real-Time Simulation and Interactive Animation of Shadow Play Puppets Using OpenGL. In International Journal of IJCIE Vol. 4 (2010), 1-8.

[11] Tardif, H. Character animation in real time. In Panel Proceedings: Applications of Virtual Reality I, ACM SIGGRAPH (1991).