Animating Non-Human Characters using Human Motion Capture Data

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ABSTRACT

This paper presents a large problem in 3D animation, which is animating non-human characters with human motion capture data. Many techniques of altering motion capture data are discussed and explored, and many new research problems are defined, which build upon existing techniques of modifying motion capture data.

KEYWORDS

Non-human characters, motion capture

1. INTRODUCTION

The main goal of this research project is to provide a way to animate a nonhuman character using an actor's performance during a motion capture session. Using Autodesk's Maya [1] as a starting ground, different techniques of manipulating motion capture data were explored. The sub goals of this project are 1.) Use different data manipulation techniques to animate different categories of objects and characters. 2.) Differentiate what techniques would work best on different types of objects. 3.) Understand previously implemented techniques of animating non-human characters and building upon them.

This paper will present previously published and related work, what has been achieved, and what still needs to be achieved to accomplish our above goal.

2. MOTIVATION AND BACKGROUND

In the history of animation, the animated character has been a wide variety of shapes, sizes, and personified objects. For example, Disney's *Beauty and the Beast* [2] or Pixar's *Toy Story* [3] are two very popular animations which revolve around personified non-human objects. While one part of the challenge is to map the human motion capture data onto the non-humanoid character, the other more difficult part of the challenge is to preserve the essence of the actor's performance in the motion capture lab, while using the correct physics for the newly mapped character. For example, if a humanoid character had extremely long legs, it would be easy to map the correctly proportioned motion capture data to the new skeleton, but the longlegged character would walk like he had normally proportioned legs, because that was the data that was mapped to the skeleton. The data would have to go through multiple alterations to have the character look like he is walking correctly.

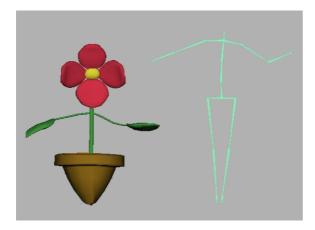


Figure 1: A 3D model of a flower in Autodesk's Maya with a human motion capture skeleton on the right.

Figure 1 is another example of an animated character that needed motion capture data alteration to look "physically correct" while moving. While Figure 1 could have easily defined arms and head, once the human motion capture data is mapped to the flower skeleton, it is easy to see that instead of looking like an animated flower, the models looks like a human stuck in a flower suit. Previous solutions to the above mentioned problems include uses of optimization [4] and have only been solved for characters that are very proportionately similar to humans [5] or even humanoid robots [6].

3. TECHNIQUES FOR ANIMATION

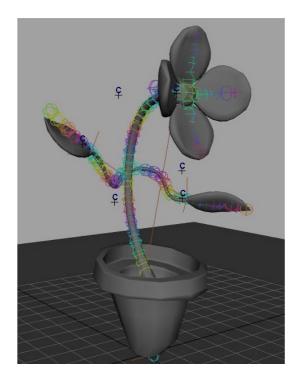


Figure 2: Same 3D model showing the joints of the skeleton (which are very numerous, compared to the human skeleton.)

3.1 Retargeting

Mapping human motion capture data from one skeleton to another, different skeleton (retargeting) is an extremely important process to know and understand. Working within Maya 2008, it was easy to see that the process of retargeting worked very well when mapping to a similar skeleton with the same degrees of freedom. But, when retargeting from a human skeleton (obtained during the motion capture session) to a skeleton that is shown in Figure 2, the retargeting capabilities of Maya are not sophisticated enough to interpolate the motion through the extra joints presented.

3.2 Free Form Deformations and Inverse Kinematics Splines

One of the solutions to the abovementioned restrictions of Maya's retargeting was to use free form deformations and inverse kinematics splines with the human motion capture data to enhance and improve the degrees of freedom that are possible. The goal of this part of the research was to use advanced "rigging" of a non-human character and provide these characters with their unique degrees of freedom that are not driven by the human skeleton joints or the human's degrees of freedom. In an optimal situation, an animator could "set-up" or rig a character with as many degrees of freedom as he or she imagined, then, take this skeleton and animate it with a permutation of motion capture data. Inverse kinematics splines or IK Splines is one method of altering the motion capture data to fit a specific non-human character. Once applied to the character correctly the IK spline will interpolate through the joints, creating a smooth and sinuous motion, instead of a sharp angle (which is present in human skeletons.) Now, instead of a sharp elbow joint, the spline interpolated between the end effectors of the hand and the shoulder, producing a smooth motion. Thus, fixing the aforementioned problem of human motion capture data looking like a human stuck in a flower suit.

Free form deformations, more specifically, lattice deformations were also researched as a possible solution to alter motion capture data. Once applied to the character, the motion became smoother. In the case of the flower model, once a lattice was applied to the arm, the elbow joint was "smoothed" out, and also helped with the problem of having specifically defined elbow joints, when it did not make sense for a stem to have an elbow.

The research also shows that IK splines are best used with characters that would produce a smooth, curving motion- thus it would make sense to use this technique on long, skinny objects or limbs (i.e. flowers, rope.) On the other hand, lattice deformations produce a more dull and subtle animation- which would make sense to use on bulkier, rectangular objects (i.e. mountains, clouds.)

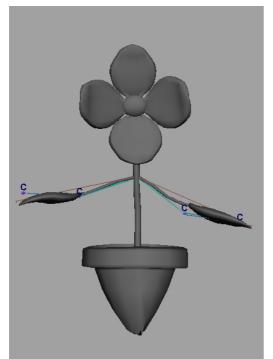


Figure 3: The flower model with IK Splines on arms (stems) and a puppet skeleton.

3.3 Combination of IK Splines and Retargeting

The most success was made when combining the above two techniques. Figure 3 illustrates the technique that was used to combine both retargeting and IK splines to produce an animation on the flower model. The motion capture data is retargeted to a "puppet" skeleton, which has the same proportions of the flower model. The flower's skeleton with the desired amount of degrees of freedom is then constrained to the puppet skeleton in the proper places. For example, the shoulder and the hand effectors are oriented to the puppet skeleton, thus letting the IK spline interpolate between the two joints. This technique produces a very different

animation than just retargeting or just using IK splines. Also, it gives the animator more options to decide what degrees of freedom he or she would like to constrain to the puppet skeleton (which uses the motion capture data.)

4. FUTURE WORK

4.1 Deciding what objects to animate

As the project progressed, it is easy to imagine what could be animated using the techniques that had been developed. But, the challenge was thinking of objects that have not been previously animated or that could not be easily animated with the above specific techniques. A future project would entail have an outdoor mountain range scene "come alive." Objects that are man-made usually have specific joints and degrees of freedom that are previously defined during the manufacturing process. The natural and organic nature of a mountain range makes the animation process a little more difficult to imagine.

4.2 Deciding what Degrees of Freedom to Map from Human to Non-Human Character

Letting the actors decide during their performance what degrees of freedom are mapped to the different parts of the objects they are portraying is a unique result of this process. Figure 4 (different mapping of actors) shows how different actors could use different parts of their bodies to portray a mountain.

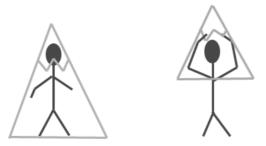


Figure 4: Two different actors portraying a mountain and using different parts of the bodies to map different parts of a mountain.

Another option available is to let the user or animator decide what mapping is most reasonable for each object. An interface could be made that enumerates the degrees of freedomgenerating all reasonable options and then lets the user choose.

4.3 Other Research Problems and Collisions

Other challenges that arose during the research process include collisions. Collisions are more frequent when retargeting to a non-human character, because the proportions are extremely different than the original human skeleton. In the case of the flower model (Figure 5) the head (or bloom) is much larger than the human head, thus causing many collisions with the hands (or leaves) get close to the head.

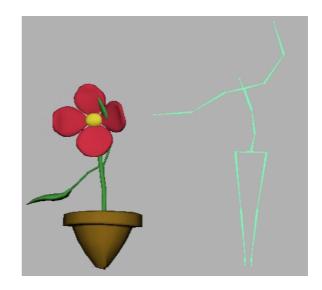


Figure 5: A collision through the abnormally large "head" of the flower, and its human motion capture skeleton on the right.

Other problems that have not been addressed include time scaling (for example, a mountain would move a lot slower than a human would.) Also, the question has not been fully addressed on what free form deformations would be best for different models. The 3D models, the collected motion capture data, and the animator all provide input into what would be best for the specific model. There could possible be a way to analyze the motion capture data to decide what options would be best, but that does not use the 3D model or the animator as an input.

5. ACKNOWLEDGEMENTS

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