Interactive Control of a Non-Humanoid Character

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Abstract

This paper presents a new way to animate non-humanoid characters using human motion capture data. We wanted to develop a plugin that would be able to take streaming motion capture data and accurately map the movements to a non-humanoid character. With a Maya plugin and marker positions from a human motion capture system being streamed into Maya in real time, we are able to produce a system that animates characters of all shapes and sizes with the use of different deformers. Throughout the project, we demonstrate how effective and useful this concept can be by using a wide variety of characters such as a simple blob character, Cousin It from *The Aadams Family*, Totoro from *My Neighbor Totoro*, Gumby, and a spider.

Introduction

Animating characters is a tedious, trying process. Since everything is eyeballed by the animator, animations are not always entirely accurate or realistic. Also, it takes a long time to get every movement perfect and completely consistent throughout the entire animation. Sometimes, real time motion capture is used to help animate human characters. It is easy to transfer data from a human being to a human model, but what about the characters that are not human? Plenty of movies have non-humanoid characters acting and moving like a human such as Lemier, the Candlestick, from *Beauty and the Beast* and Bob from *Monsters vs. Aliens*. We envision a system that would take motion capture data and animate non-humanoid characters to appear human in real time.

Related Work

A paper that was just released came from Carnegie Mellon and was presented at SIGGRAPH 2010. A human actor acts like a non-humanoid character and the movement is then transferred to a model in Maya [Ariki, Hodgins, Yamane 2010]. If they wanted to animate a the lamp from Pixar, the actor would hop around to replicate how a lamp would move. When this is completed an animator animates key poses and their system is then applied to map the movements accurately. While this does work and produces fluid motions, we want to expand on this concept in two ways. For one, we'd prefer the human to act like a human and not restrict his or her movements to how the character should physically move. Also, they do not produce these results in real time, and with the method they use to animate, it's not entirely possible to incorporate real time into the animation process. However, with our plugin we are able to walk and act normally, and yet still animate the non-humanoid character in real time in a realistic way. There are also many other related works that specifically relate to what the project is to eventually become such as automated rigging [Baran and Popovic 2007], transferring movements across a set of different meshes [E.S.L. Ho et al. 2010], and retargeting motion to unknown characters [Deweese et al. 2008].

Method

We created a Maya plugin in order to accomplish the task of animating the characters in real time. We had to tackle a few obstacles in order to get this working properly. Because we were only streaming positions from marker data, we had no orientation data and no translation data. We calculated rotations using a Maya command. First we take three of the four markers that make up the pelvis and calculate the normal's of the three vectors. Then after we take the cross product of the 'up', 'side', we end up with the 'front' vector. For each frame we calculate the current position of this vector and using a Maya command, we take this information and get the angle between this position and the previous position. This will give us the angle of rotation that we need in order to rotate the character correctly. We apply it to the characters body and now it rotates with the pelvis from the motion capture data. A problem we encountered has to do with initial orientation. The character must be starting the same way that the streaming motion starts, or he will turn not face the right way. By setting his rotating him before the motion begins, we were able to fix this problem, but there is no generic way we found to accomplish this.

The next problem we came across was getting the character to translate with the streaming motion capture data. Again, the four markers that make up the pelvis were used. This time, all four marker positions were taken and the middle of the four positions was calculated. We apply the X, Y, and Z translation to the body and now the character will translate and stay where the middle of the motion capture's pelvis is.

Now these two sets of calculations will let your character rotate and translate correctly, but problems occur. Human motion capture data isn't always stable. If a marker is covered, the position of that marker will not be streamed into the system. If this occurs to one of the four markers that make up the pelvis, the character will not translate to the correct spot and its orientation may flip. We had to create a series of checks that made sure if a marker did disappear, we could estimate the correct position and orientation of the character to the best of the plugin's ability.

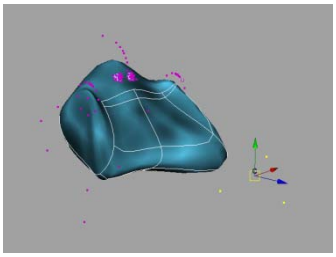

Figure 1: *Cluster Deformer*

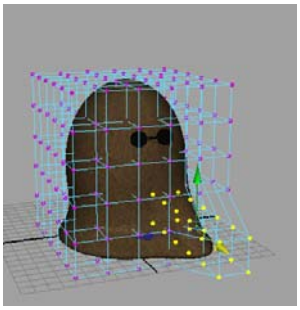

Figure 2: *Lattice Deformer*

Deformers

At this point we are getting rotation and translation of the body there is no movement in the limbs, so the animation is not very exciting. The next thing we did was figure out how to animate the limbs. Depending on the type of character, there were many different ways we could do this. If the model was modeled from NURBS, then using any of the deformers Maya provides would be acceptable. In Figure 1, the cluster deformers were used to simulate hands and feet. In Figure 2, the lattice deformer was used to simulate legs. Both of these worked surprisingly well. The lattice was especially useful when a character had nothing that could be marked as an arm or leg and the cluster deformers were great when there was an area that could be defined as a hand or foot. The cluster was also especially helpful when trying to rotate and move the head, shoulders, and waist of a character, whether it was modeled

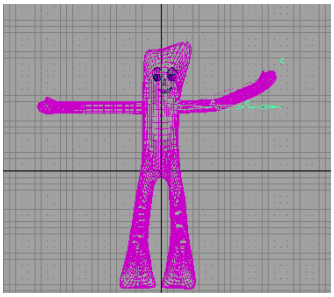

Figure 3: *Spline IK Handle*

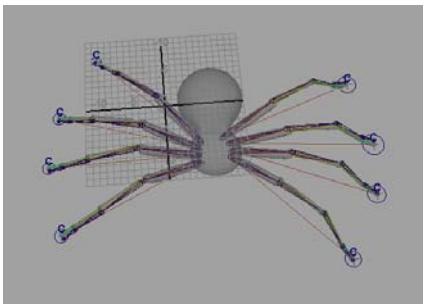

Figure 4: *IK Handle*

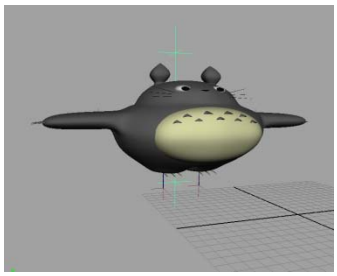

Figure 5: *Squash Deformer*

from NURBS or polygons. However, if the model was modeled from Polygons, which is the most common method, even with very careful cluster weights painted on the model, using the cluster deformer on end factors such as hands and feet will not look very natural and the character will not move as intended. To fix this problem, we decided to semi-rig our characters. We chose areas that would be considered arms and legs. Then put in joints in the proper places that was suitable to the character. These joints must be bound to certain vertices of the character's mesh so the proper limbs would be controlled. A Spline IK Handle, as in Figure 3, was then applied. This gave us a lot of control and the joints would properly follow one another throughout the rig. Another option we had, as seen in Figure 4, was to use a normal IK Handle. This is used when the movements are much more rigid, such as movements would be in a spider. After this was done clusters were applied to the Spline IK Handle, or IK handle to gain more control and then weights were painted correctly on the character. After this we had a character that could move much more naturally. We then had to constrain the clusters in a way to match the human movements. An effective way to achieve this was to map the ending cluster to the motion capture's end factors, such as the finger, or the toe. The only problems we found after this was that these characters cannot follow motions 100% accurately. For example, a character with short, stubby arms will not have the same range of motion as a human's. In order to fix this problem, we limited how far the joints can bend before the motion looks unnatural and the character starts folding in on itself. The last issue with this was the size of the character. If the character was very wide, when his legs were constrained to the positions of the feet, the legs may curve in. This is fixed by putting a sufficient offset on these constraints; however, this offset will differ from character to character and there was no generic way we found that would fix this. The last deformations added to characters dealt with the squash deformer, as seen in Figure 5. With one subtraction formula, walking and bouncing will create a small squash effect on the character. This is extremely useful for a fat character that will have some jiggle in the belly when moved, or a character with very short legs. Incorporating this secondary motion in drastically adds to the realism of the animation. After the process of choosing and constraining a deformer is completed, the character can now be animated using motion capture data in real time. All the user has to do is load the plugin and put on the suit and the non-humanoid character will follow the user's movements.

Conclusion and Results

After all of the calculations and constraints we found that we could successfully animate non-

humanoid characters using motion capture data in real time. Unfortunately, because markers can be covered when a motion capture suit is used, there are times that the movements may look awkward. At this time, apart from making checks and estimating where the markers will be, there is no other way to correct this data deficit so the character may sometimes move unnaturally during these periods. This could make some of the movements the actor can do highly restrictive. Though this is not ideal, if this fact is taken into consideration, clean looking animations can be produced. We also found that some deformers worked better on some characters than others. The lattice is useful for NURBS models that have no limbs and clusters are good for the rotating the head and NURBS models where arms and legs can be logically defined. For Polygon and NURBS modeling, Spline IK handles are useful for more bendable characters while IK handles are great for characters with a more ridged motion. The squash deformer can work on any character. While this concept makes animating very easy, most animators would probably like to have more control over animations. Even with that in mind, we believe this was a successful project that could be vastly built upon.

Future Work

There are many ways we believe we can improve upon this project. First, since we aren't able to stream rotation data, we would like to be able to find a way to successfully calculate rotations for significant body parts such as hands, feet, ankles, and knees. Then, we would like to expand this idea to a self automated program. There are so many different non-humanoid characters that it's tiresome to rig the character and edit the code for each and every one individually. To be able to have a generalized Maya plugin would make things much more efficient. This idea is toyed with in two other significant works. The video game, Spore, uses the concept of retargeting motion to unknown characters [Deweese et al. 2008]. This game successfully creates a database of movements that any character can use no matter what size or shape it is. This generalization would be extremely useful in our program so any movement could be put on any character no matter what the model looks like. Another useful paper to implement has to deal with preserving character control throughout a wide range of meshes [E.S.L. Ho et al. 2010]. No matter how long arms or other limbs are, the same motion can be applied to this character. To take this would really give the program a better way of dealing with constraints and let the characters move more naturally. If we can apply concepts like these, we want to build upon the interface we have already begun writing to run within Maya. Since we envision an automated process it would make sense to have automated rigging that was used in Baran and Popovic's research. However, we believe the user needs more control over their characters than this process would allow. Since the characters are not human, and may even be a completely made up character, only the user will truly know how the model should move. So we choose to set our program up so the user would be able to choose what part of the character should be a head, right leg, left leg, etc. Then the user would be able to choose whether the body part would be jointed (such as a leg) or non-jointed (such as the head). If non-jointed was chosen, the user has the ability to apply a cluster deformer to the model. If jointed is chosen, the user would be able to semi-rig the character however he or she chooses with the joint tool. An IK Handle or IK Spline Handle would then be chosen. When these settings are chosen, the program would automatically weight the skin and apply the correct amount of clusters to the body. All the user would have left to do is put on the motion capture suit and the animation can begin. It would be easy, efficient, and very effective. A lot of the code has already been written for this addition to the project and we would love to eventually incorporate this fully into the final project.

Acknowledgements

We would like to thank the DREU program for making this research experience possible and pairing us up with Dr. Alla Safonova. We would like to thank Dr. Safonova for choosing such an interesting project that really helped us not only learn many new programs, but for also introducing us to research. Thanks to Aline Normoyle for her guidance throughout the project and to Joe Kider for his continuous support and help in the lab. We would also like to thank the SIG Lab as a whole for having us and letting us use their resources this summer.

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