Animation Movie under Autodesk Maya

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1 Abstract

Computer graphics matured over many years and played an important role in the development of engineering products like automotive and aircraft components. The current CAx (CAD/CAM/CAE) tools use computer graphics extensively, while helping in conceiving better designs with improved quality. Nowadays, engineering product development is being done concurrently and collaboratively, due to the advances in computer graphics.

This paper presents an example of computer graphis application: an animation movie. It has been done using Autodesk Maya software and applying concepts seen on lessons of Character animation (subject of Graphic Data Processing Master) such as: skeleton, skinning, muscles or dynamics.

2 Introduction

Skeletal animation is a concept that has been used in the areas of motion pictures and computer games to create realistic motion for the animation of articulated characters. Recent works ([Murray *et al.*, 2004]) has applied skeletal animation techniques from inverse kinematics and dynamics to the field of graph interaction. The motivation for this paper is to evaluate the dynamics-based technique in terms of its ability to simulate the skeletal metaphor, and to evaluate the skeletal metaphor in terms of its usefulness for graph interaction.

Nowadays, there are a significant increase in the capability for controling motion dynamics in key frame animation through skeleton control. This technique allows an animator to develop a complex motion sequence by animation a stick figure representation of an image. This control sequence is then used to drive an image sequence through the same movement. The simplicity of the stick figure image encourages a high level of interaction during the design stage. Its compatibility with the basic key frame animation technique permits skeleton control to be applied selectively to only those components of a composite image sequence that require enhancement.

On the other hand, animating articulated characters such as virtual humans is a fundamental operation in computer graphics and interactive applications. Techniques for rigging character skins by weighting vertices to an associated skeleton, or by interpolating example deformations, are widely used in video games and the computer animation industry. There are numerous reasons for their popularity: most skinning approaches are conceptually easy to understand and apply; the are capable of approximating interesting character shapes; and skinning can be hardware-accelerated on almost every commodity graphics card. However, the application of *character skinning* approaches has been almost entirely limited to objects with user-defined skeletons and rigid bones.

Finally, and because of the development of more and more accurate simulation of human character based on their anatomy has led to anatomically based modeling as the bottom-up approach for building characters from bones, muscles, and skin. So we have included a muscle model and methods for muscle constructions that allow us to easily create animatable characters. And in order to create a more realistic models, we have designed a simple cloth using basic primitives.

3 Motivation

On the previous section, we've described the differents items which has been developed in this work. We've focused on creation of a realistic movie animation.

If we think a little bit, the human body -for example- has a skeleton, muscles and skin (of course). But what's a *skeleton*? A set of bones and their joints. We can consider a bone as a segment, and a joint as a single point (or node). The bones are connected in a hierachy of frames, whose root is often the basin. Altogether, the skin is animated by *skinning*; so the skin vertices depend on the position of the skeleton.

On the other hand, the muscles can be considered as ellipsoids. That way, one ellipsoid has one origin and one insertion; and, if we want, tendons can be modeled by a new origin and a new insertion, and two small ellipsoids. But we don't need them; only a single ellipsoid.

There are various *animation techniques*: *(i)* forward kinematics or by hand; *(ii)* inverse kinematics or by hand & automatic computation issued from robotics; *(iii)* motion capture; or *(iv)* from video.

4 Implementation

In order to aim the previously explained goal, we have used only Autodesk Maya software.

4.1 Mesh

To create the mesh we've to have a good perspective view. In the graphic arts, such as drawing, is an approximate representation, on a flat surface (such as paper, or our screen), of an image as it is perceived by the eye... Now, we're always under 'Polygon' menu. The steps followed were:

1. To go to 'Mesh', 'Create Polygon tool'.
2. We're clicking the border points and finally we press 'Enter'.
3. In order to unit the extrem points, we select them and go to 'Edit Mesh', Merge.
4. Now, we create subdivisions. We've to select differnt points (under 'Vertex' edition) and go to 'Edit Mesh', 'Split Polygon Tool'.
5. To create volume, we select points and go to 'Edit Mesh', 'Extrude'.
6. To duplicate face, we go to 'Edit Mesh', 'Duplicate' and we do the mirror effect.
7. Because we want to have only one object, we select the two parts and go to 'Mesh', 'Combine'.

And the result is as we can see on the next figure 1.

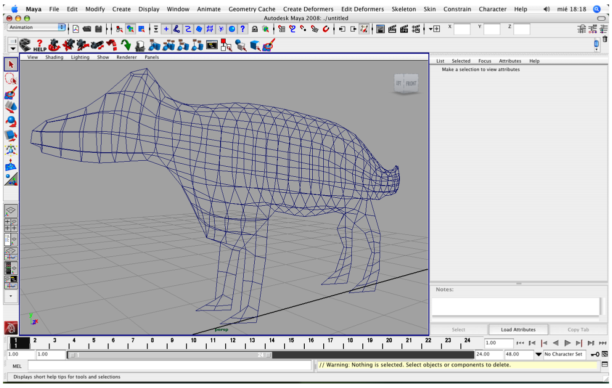

Figure 1: Dog mesh creation.

4.2 Skeleton

Skeletons are hierarchical, articulated structures that let you pose and animate bound models. A skeleton provides a deformable model with the same underlying structure as the human skeleton gives the human body.

Just like in the human body, the location of joints and the number of joints you add to a skeleton determine how the skeleton's bound model or 'body' moves.

4.2.1 Create a joint or joint chain

Obviously, before drawing joints or a joint chain, you first need a model in which to place them. So we start with the character modeled as we explained in the last section.

4.2.2 To create a a joint or joint chain

1. In the Animation menu set (press F2), select Skeleton, Joint Tool. So the Joint Tool appears...
2. In a view, click on the location in our model where we want to create a joint.
3. [1] Click again in the model where we want to create the next joint in your joint chain. A bone appears between the first and second joints.
4. Press the 'Enter' key to complete our joint chain.

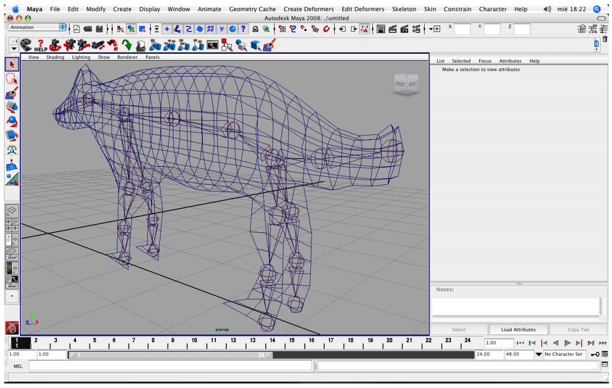

Figure 2: Dog skeleton creation.

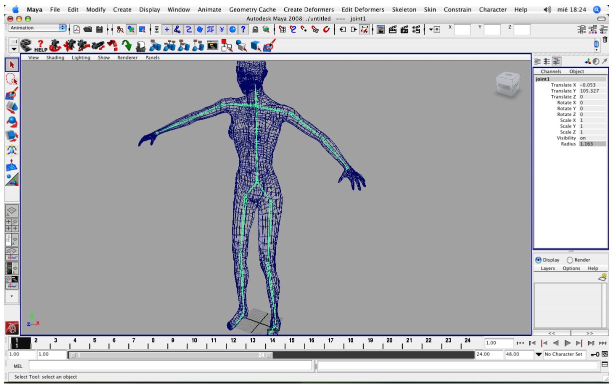

Figure 3: Female skeleton creation.

4.2.3 To bind by smooth skinning

1. Select skeleton's root joint (default name: joint1).
2. Select Skin, Bind Skin, Smooth Bind.

Maya binds the mesh to the skeleton by smooth skinning, using the default bind skin options. The mesh is now a smooth skin object. Now we can exercise the skeleton and get immediate deformation effects appropriate for the character.

[1] We can use the left mouse button to create joints and the middle mouse button to move the last placed joint.

4.2.4 To exercise skeleton

We only select the joint approximately at the center of the cylinder (for instance, joint4), and rotate it about 90 degrees.

Note that smooth skinning provides a smooth deformation effect around the rotated joint. However, the creasing might be a bit too rounded for the deformation of a character's limb. For example, if we were setting up the deformation around a character's elbow, we might want the creasing to be a bit sharper at the inside angle of the bend, though still rounded around the rest of the joint. We can adjust the deformation effect with the *Paint Skin Weights Tool*.

4.2.5 To paint creasing effects

1. Select smooth shaded display mode (hotkey: press 5).

2. Select the mesh.

3. Select Skin, Edit Smooth Skin, Paint Skin Weights Tool. See Painting smooth skin point weights.

4. In the Tool Settings window, the Skin Paint tab should be displayed.

5. Note the Influence box. The Influence box lists the names all the joints.

6. Click on a joint name. For example, click joint3. In the scene, the shading indicates the joint's influence. The whiter the color, the greater the influence of the joint. Note how the joint's influence fades into black as the distance from the joint increases.

7. In the Influence box, click on another joint name. For example, click joint4.

8. Use the Paint Skin Weights Tool's brush to paint how the joints influence creasing.

4.3 Muscles

We've created muscles as simple Sphere, and then we've deformed it until we get a ellipsoid. We've only designed muscles to attach the legs & arms bones because we focuse on this parts movement.

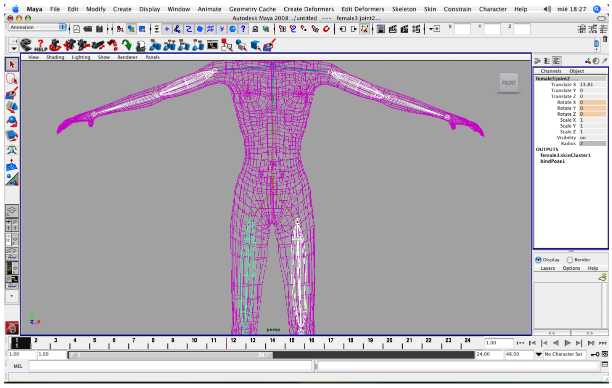

Figure 4: Female muscles creation.

Obviusly, on a movement the bone is the parent or the driver object and the muscle is the child or the driven object. To attach muscles and bones, we follow the next steps:

1. Select sphere, press 'Shift' and select bone. Then, press 'P'.

2. To animate muscle, 'Set Driven Key'.

3. Select bone and click on 'Load Driver'.

4. Select sphere and click on 'Load Driven'.

5. Press 'Key' at the original position and then move it until maximum position desired. Then, press 'Key' again.

6. Select sphere and select mesh. Go to Skin, Edit Smooth Skin, Add influence.

4.4 Animation

Finally, we haven't used dog mesh in order to create a more realistic animation. So we've got another more complex free models from the Internet whose we've used them to do the movie animation.

In Maya, we can follow two ways to do an animation; or we want to press 'Keyframe' on each desired frame, or maybe better we can use the 'Autokey' option. That last way we haven't to press any key on any frame because Maya do it automatically; in our case, this is the option. So, we only need to follow the next steps:

1. To situate on frame 1, press Autokey button.
2. For the root, select Translate (X,Y,Z) & Rotate (X,Y,Z). With right button on mouse, Breakdown selected (see figure 5 where such items appear with orange color).
3. For the rest of bones, we only select it and select only Rotate (X,Y,Z). Again press right button on mouse, Breakdown selected.
4. To situate on another frame, e.g. frame 8.
5. To move the root skeleton and move the legs. The 'Autokey' system control automatically the new position and it marks a new keyframe.

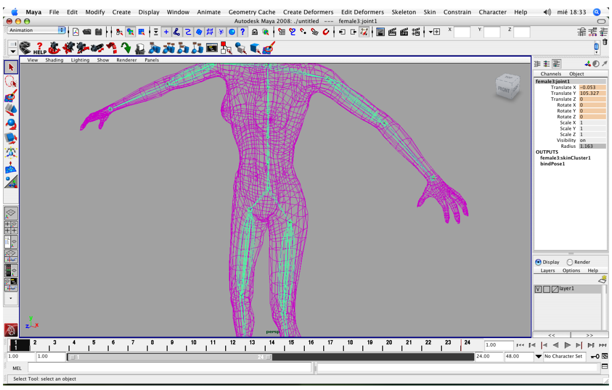

Figure 5: Selection root skeleton behaviour.

When we've finished to do the animation movie, we can add another things. At first I've decided to add a simple cloth to the bird for seeing the effect. The steps what I've followed are the next ones:

1. To create a plane of high resolution (typically 30x30, according to the size).
2. To place it above the character (bird).
3. To create the rest shape of the cloth under 'Cloth' menu.
4. To select plane, nCloth and Create nCloth.
5. To select character, nCloth and Create Passive.
6. To set simulation parameters. Timeline set to 1.
7. To select plane, Attribute Editor, Nucleus, Time Attributes, set Start Frame to 0.
8. To set PlayBack to 'Play Every Frame'.
9. To select cloth, Edit nCloth, Initial State, Set From Current.
10. To attach cloth to character.
11. To select cloth, Attribute Editor, Time Attributes, set Start Frame to 0.
12. To put the timeline to 0.
13. To select character, Shift and to select cloth.
14. Right click on mouse (not on the mesh) and select Vertex menu.
15. To press Shift and to select border vertices.
16. nConstraint, Point to Surface. That way we fix cloth to the character on the up position and cloth doesn't fall on the floor.

17. Play animation.

We can see this cloth on the next figure 6, where we can appreciate the fixed points on the top position.

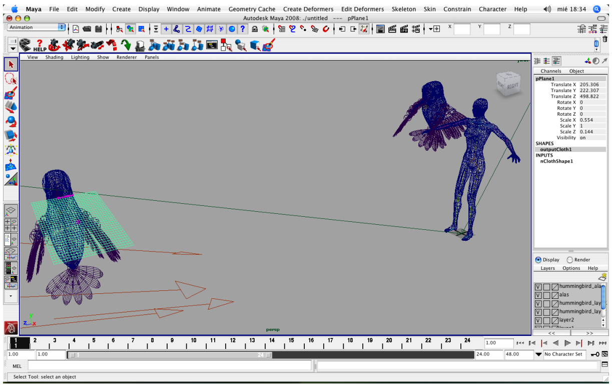

Figure 6: Cloth over bird.

On the other hand, I've added different lights to the scene. Two ambient lights and two directional lights. I'd only to go to the Create menu and Lights and then I'd to set correctly over scene.

And finally, I added some paint effects like flowers and trees. It's too easy. You go to the Window menu, General Editors and Visor. Previously, I created a plane over floor to be able to paint over it... After that, and when you want, you can scale the different plants with Attribute Editor and Global Scale option.

The final result is represented on the next figure 7. In order to see the full scene, because of the complex size of it, I'd to resize the far clip plane of the camera from 1000 to 10000 units (right side of the image).

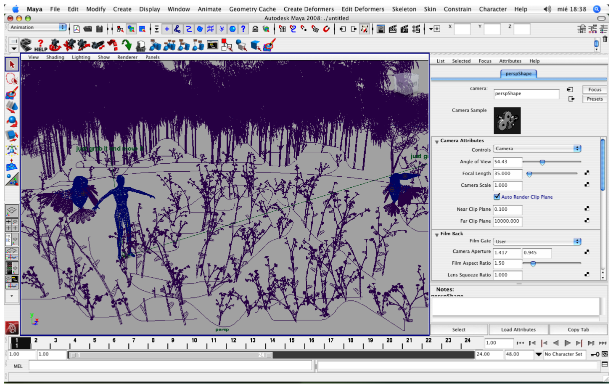

Figure 7: Final animation characters with lights, flowers and trees.

We can appreciate with more detail the light effect on the next figure 8, where scene has been full rendered from two different points. On the second one, the cloth dynamics can be appreciated better than first one.

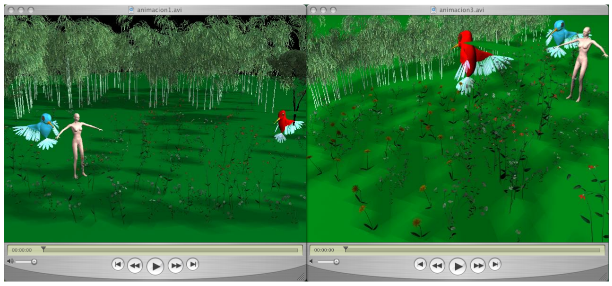

Figure 8: Final rendered animation characters with lights, flowers and trees.

And at different points of time, the animation movie is as we can see on the next figure 9.

Figure 9: Final rendered animation characters with lights, flowers and trees.

5 Problems solved

Through development process I've encountered several problems. For example at first I wasn't able to design a good character; finally I haven't got a really good character, but better than the firt one, of course... The most important is to practise it.

When I finished my little character, I'd to attach it a skeleton, but my main difficult was who was father and child on the joints... Finally I understood that root is always father and the rest of bones were child of it. That way, the skeleton behaviour was logical.

After that, when I'd to create muscles I started using 'CGI_muscle', a Maya plugin to create muscles easisly. But it didn't work so I'd to create muscles manually with a simple deformed sphere. And the results are good. However, when I'd to animate it, I wasn't able to do it until I understood the *driven* and *driver* concepts.

And finally, the movie animation was too difficult. At first, I tried to do it using *Keyframes*, but when I had several characters the animation was an absolute caos; so I decided to use *Autokey*. On the other hand, the female movements were so difficult and strange, so I'd to repeat them several times. To avoid it, I tried constraints with *manipulators*, *Pole Vector*, *IK Handle Tool* and other concepts (so news to me...). But I wasn't able to move it how I wanted.

The cloth dynamics was a easy creation of the animation, although sometimes it had strange behaviours. Flowers and trees were easy to create too; I'd to paint them over floor.

6 Conclusions and future works

Realistic modeling of the human body and motion is an interesting subject in computer animation. It is also very challenging because of many parameters that the human motion involves. In this study, we have produced human motion animation using skeleton, modeling muscles, and simulating muscle deformations. We have constructed some of the human body muscles using some geometric primitives and a skeleton model which supports the muscles. The produced deformations of the muscles can be used to find the skin surface deformations by attaching a skin over the volume that is formed by the skeleton and the muscles. Muscle modeling and deformation are done for only a small subset of the muscles, because this is a tedious work. The results are realistic and can be used for the surface skin deformation. Whole body muscles can be modeled in a similar way.

References

[Burtnyk y Wein, 1976] N. Burtnyk y M. Wein. Interactive skeleton techniques for enhancing motion dynamics in key frame animation. *Comunications of the ACM, volume 19, number 10*, 1976.

[Can *et al.*, 2007] Tolga Can, Ali Orkan, y Ayca Muge. Human skeletal and muscle deformation animation using motion capture data. *Department of Computer Engineering, Ankara, Turkey*, 2007.

[James y Twigg, 2003] D. James y C. Twigg. Skinning mesh animations. *Carnegie Mellon University*, 2003.

[Kahler *et al.*, 2001] Kolja Kahler, Jorg Haber, y Hans-Peter Seidel. Geometry-based muscle modeling for facial animation. *Max-Planck-Institut fur Informatik, Stuhlsatzenhausweg 85, 66123 Saarbrucken, Germany*, 2001.

[Larboulette *et al.*, 2004] C. Larboulette, M. Cani, y B. Arnaldi. Dynamic skinning : Adding real-time dynamic effects to an existing character animation. *Gravir and Siames-Irisa*, 2004.

[Larboulette, 2008] C. Larboulette. Small maya tutorials for the mdp (character animation) class. *Graphic Data Processing Master, University Rey Juan Carlos, Madrid*, 2008.

[Larboulette, 2009] C. Larboulette. Character animation subject slides. *Graphic Data Processing Master, University Rey Juan Carlos, Madrid*, 2009.

[Murray *et al.*, 2004] C. Murray, D. Merrick, y M. Takatsuka. Graph interaction through force-based skeletal animation. *Proc. Australasian Symp. on Information Visualisation (InVis.au 2004)*, 2004.

[Murray, 2004] C. Murray. A user-based evaluation of skeletal animation techniques in graph interaction. *National ICT Australia*, 2004.

[Porcher y Thalmann, 1998] L. Porcher y D. Thalmann. Real time muscle deformations using mass-spring systems. *EPFL - Swiss Federal Institute of Technology*, 1998.