How can Maya muscle system be used for facial rigging?

Max Norderfeldt
June 2011

Bachelor Thesis, 15 credits, C
Computer science

Creative Computer Graphics
Examiner: Torsten Jonsson
Supervisor: Ann-Sofie Östberg
How can maya muscle system be used for facial rigging?

by

Max Norderfeldt

Faculty of Engineering and Sustainable Development
University of Gävle

801 76 Gävle, Sweden

Email:
max.norderfeldt@hotmail.com

Abstract

There are several different setups for facial rigs today, joint-based and blendshape-based are two popular examples, both of them fall in the category of geometry-based facial rigs. The goal with this dissertation is to attempt to develop a Maya muscle facial rig. Then the rig is tested to examine to see where this rig can be an improvement in relation to other rigging systems. It was possible to create a rig using the Maya muscle system. There was an attempt to reach out to the public and get some opinions but it was to weak so no real conclusions could be drawn from it. This rig was most useful when creating stylized cartoon characters. The Maya muscle rig has several substantial flaws that is weighted against several cons that reveal that this is a niche rig that is useful in some areas but should be completely avoided in the game industry.

Keywords: Maya, Muscle, Rig, Topology
# Table of content

1 Introduction.................................................................................................................................1
2 Theoretical background.............................................................................................................2
3 Implementation.............................................................................................................................3
4 Result ........................................................................................................................................5
5 Discussion....................................................................................................................................7
6 Conclusion.....................................................................................................................................9
References......................................................................................................................................10
1 Introduction

1.1 Background

Today there are several approaches to facial rigging, the most prominent are blendshape, curve and joint based facial rigging. All of these rigs need a lot of tweaking and manual work to create the result we get right away using Maya muscle system. The blendshape method requires the rigger to manually create the shapes you need to create stretch and compressions. The curve and joint based facial rigs requires the animator to animate the control for the cheek to assimilate the compression that happens when you smile and it usually have no control for the furrows or other parts of the face that compress and extend.

1.2 Problem definition

As you can see there is a lot of room for improvement in the area of facial rigging. And since its the most important part of a human with the highest demand for detail there will always be room for development. This dissertation will not lead to the absolute solution, but hopefully it will help shape the path for future research in the area of facial rigging. There as been a lot of progress in the field of rigging but it has mostly been automatisation of the body rig, this progress hasn't happened with facial rigs because it is more advanced and used to require a human eye to create a appealing result. By using Maya muscle system we require less from the rigger which gives a lot of opportunities to script the facial rigging setup so that the time of the rigger can be spent on creating custom features that are needed in the shot.

1.3 Aim

The goal of this dissertation is to find out if Maya's muscle system can be used as an alternative to the classic ways of facial rigging. And also to find out what advantages and disadvantages it have to prior rigging systems. The system will be built upon existing principles of facial rigging, such as driving handles with curves to avoid a linear animation. The unique part of this facial rig is how the face is deformed, the deformations are creates by the muscles that extend and compress in a realistic fashion.

Aside from the dissertation itself a rig will be created using the principles that is discuss in this paper. Additional to the writer's observations there will also be input from users of forums that discuss rigging

1.4 Questions at issue

The research questions are as follow:

1 Can Maya muscle system be used for facial rigging.

There are two follow up questions if the rig can be created.

2 If it can, in what fields might it be useful
3 What are its advantages and disadvantages

These research questions will form the basis for the research.
1.5 Limitations

Since the goal was to explore a new technique the writer couldn't focus on creating a photo-realistic result, instead focused was on adding muscles to the most prominent features of the face that deforms a lot, such as the cheeks and furrows. However this setup can be used for all parts of the face and this is also encouraged since we use most of our face when we create facial expressions. Other limitations the research had to cope with was a limited time-frame on modeling the 3d head that would be deform, because of this it wasn't possible create to advanced muscle shapes. This setup will only be available to Maya 2008 unlimited and up since its competitors don't have any similar tool that be can used as a replacement.

2 Theoretical background

According to Mauricio Radovan and Laurette Pretorius there are four groups that facial rigs are divided into “Image-based techniques”, “Performance-driven methods”, “Expression coding systems” and “Geometry-based approaches”. [1]

The rig system that will be discussed will fall into the category of geometry-based facial rigging., one system they talk about is using springs to create a dynamic facial rig but this system creates a very unappealing result. Another rig they talk about is finite element algorithms which can create deformations for wrinkles and furrows. Both of those rig systems are outdated so this research will instead focus on creating a rig specified to one program.

There aren't a lot of information about expression coding system and performance driven rigging approaches and since it will not be used in the rig it will be left out of the theoretical background.

Today there are a lot of facial rigs that are usually controlled by both parameterization and blendshapes who are bound by expressions to the parametrizational controls which automatically creates the furrows and wrinkles. But it misses a lot of small compression and stretch details because it would be to tedious to model each little deformation the human face can create.

2.1 Imagebased techniques

The writers of the journal “Facial Animation Based on Muscular Contraction Parameters” uses “feature points” which controls the skin of the face. And then they “fit” the points after a image which takes time but gives some freedom and creates a solid result. The main problem in this journal is that the test faces are to neutral so its hard to see if they manage to create wrinkles, furrows etc.[2]

The last journal that will be discussed creates a rig system that falls into the “Image-based techniques” group of facial rigs. The system uses 2d maps to create wrinkles and other details. One of the main problems that the writer puts forward is that the effect can look a bit off when the head is rotated but that can probably be fixed with displacement and specular maps.[3] It is a good solution if you cant change the base model to fit a geometry-based solution(the model must have polygons to support wrinkles and smile dimples.)
2.2 Geometry-based techniques

The journal “Creating a photo real digital actor: the digital Emily project” describes an interesting way to control the rig by using nurbs curves to control the blendshapes. The nurbs curves are shaped like arrows which moves in the direction of the muscles of the face. They also used soft eyes and sticky lips in their rig, soft eyes is the effect of the cornea affecting the eyelid, and sticky lips simply keeps the lips together when the jaw is down. The blendshapes are created by using a stereo camera which created a lot of small dots that the computer uses, these blendshapes have several million polygons which makes the whole work of creating the blendshapes very computer heavy. Since it uses a camera to capture the facial animation it can’t be used to create animation for animals or exaggerated animation. The creators of the journal used video to create the body but it might work with motion captured 3d figures.[4]

A similar method is presented in the journal “Extracting 3D Facial Animation Parameters from Multiview Video Clips” It uses several cameras to create blendshapes. Just like the previous journal the method that is described here requires a recorded performance. This method didn’t provide with the same amount of detail as the previous method. In this journal they didn’t change the texture depending on the facial shape which made the mouth look lifeless.[5]

The last journal takes up skinning and weight painting which will be extremely important for me to take caution on when working on the muscles. Sadly the writer goes of tangent and takes up a lot that isn’t relevant to the question at issue. He researched anatomy and how it affects how the rig would be animated which was very interesting, the face is not only muscles but also bones like the jaws and cheekbone which is very prominent[6]

3 Implementation

To really appreciate a rig you need the whole body but since this is for demo purposes only, so because of time restraints only the head was done. And since the main goal is to try out how Maya muscle system can be used to drive the deformations of a face. Some rig features that only make animation easier could be skipped since this it isn’t needed for test purposes.

3.1 Prerequisites

This rig is built upon the foundation of a popular rigging system, generally called joint based facial rigging. This base was chosen because joints can easily be converted to capsules which is the node that drives the Maya muscles. The joints are controlled by curve controls that drive the joints with constraints and/or expressions. This is considered general knowledge but if the reader want to learn how a joint based rig is setup then it is recommended that you look up the facial rigging tutorials on Digital Tutors. The control curves then moves along a CV curve so that the controls always move along the skin. As long as the reader has a basic knowledge of facial rigging and Maya unlimited 2008 or newer he should be able to recreate the result for this research project. You can see in image 1 below how the face looks before the facial rig has deformed it.
3.2 The muscles

So when you got a standard joint based rig setup, you need to add stationary joints that the muscles can attach to. For the rig to work you need to add muscles to the furrows and cheek areas. Add one muscle to each of the brow and cheek controllers, which was three on each side of the furrow and three on the cheeks, but you could work with less if you don't need that much detail. When the muscles have been built using the “Muscle builder” tool it is important to reduce the jiggle effect to an amount that suits the character (fat character jiggle more). After that the rigger should set the default, squash and stretch muscle positions, this is so that the muscle gets its form from the custom muscle shape. The most important custom muscle shape to change is the squash, it is here we can create the wrinkles. You can see in image 2 below how the brow and cheek muscles compress and stretch, the furrow muscles have a notch in them so that it creates the furrow line.

You automatically get the bulge at the squash position but to add wrinkles you need to pull a few vertices inward at the right place looking at the topology to make sure...
that it deforms correctly. It is recommended that you leave the stretch pose alone but if it is a thin character it is appealing to pull the middle of the muscle in so that the character looks scrawny. But keep in mind that the forehead shouldn't stretch to thin since it will make it look boneless. This is the most time consuming part since it requires that the rigger keeps an eye on the topology of the polygon mesh since you can't deform vertices that aren't there. Fine details are very hard to add with this since you don't directly control the skin. The researcher tried to add tiny wrinkles to the lips but it wasn't possible because it was hard to create the custom muscle shape that moved the right vertices in such a narrow space.

3.3 Deformations

Most of the skin was bound to the Maya muscles, but some parts of it such as the jaw and the whole skull area where bound to joints. You could deform the jaw with the Maya muscle bones, with that you can get a nice sliding effect on the skin. This wasn't needed for this project since it doesn't have any texture on the model. With the sliding effect the jaw keeps its shape and the skin still move.

There was some troubles that emerged while setting the Maya muscle rig up. The main problem was vertices that were far from the muscle who had influence over it flickered when you moved the controls. To fix this you should give all the influence over that vertice to one joint. In this instance it worked out fine since all the troublesome vertices were close to the joints. This could be a problem if the troublesome vertices had to be deformed by the muscles. There was also several vertices that got double transformations so to solve this you have to lock the weights.

3.4 Reaching out

After the rig was done the writer created a video where he described how the rig work and the background of the research project. This video accompanied by an copy of the scene file was uploaded to Creative Crash so that it was available for critique, then a link was sent this page to forums that are dedicated to 3d and rigging. There was questions that they could answer if they wanted, but they were free to answer in any way they wanted.

4 Result

A Maya muscle based rig was created which was the main goal of this research. The rig has most of the features that was planned from the beginning of this project. It was obvious from the start that there would be some limitations since there was little time to work on the 3d modeling or texturing. The muscles deformed as they should and the controllers worked fine when animation was applied to them. The custom muscle shapes worked correctly except between the eyes where a strange ridge was created when the muscle was compressed, probably because of bad topology. In image 3 you can see how area between the brows doesn't compress as it should and the eyebrows end in an unnatural way.
There wasn’t any slowdown when animating the rig, but the playback had a low frame-rate which is extra visible with Maya muscle because it isn't possible to skip frames. To view the playback in realtime you have to cache the muscle calculations which takes some time. Another issue with the facial rig is that the forehead stretches a bit to tin, the forehead should have a custom muscle shape assigned to its stretch that is much closer to the original shape.

One of my personal goals was that the rig should have a dimple when he smiles and this was achieved. This was achieved by making sure that the polygon head had the amount of vertices needed for that deformation. This shows that most deformations are possible, but there must be a close cooperation with the 3d modeler for this to work. In image 4 you see a furrow over his brows and also the cheeks compressing which makes them bigger, you also see the smile crease folding as it should. The dimple his hard to see on this image due to the lighting.
4.1 Missed opportunities

There are several features that there wasn't enough time to test but they should be mentioned nonetheless since they can help make the job of the animator a lot easier. Jiggle is something that can looks very different depending on the movement, so a control to be able to scale the effect of jiggle would be necessary so that the rigger don't have to clean that up after the animations are complete. Ideally There should also be a control to reduce or increase how much the muscle stretch and compress. It seems impossible to achieve that without creating a copy of the mesh and have it tied to the regular joint controls and then add that as a blendshape. Sadly that would take a lot of resources and make this setup to time consuming. As long as the rigger checks with the animator so that the deformations are as the animator desires then this option isn't really needed. Since this is a very computer heavy rig a lowpoly proxy model would have helped to make this rig work better on most computers.

4.2 Community response

I got a few responses to the community outreach but non answered the questions that I asked. A community member on creative crash noted that joints is the primary tool for riggers that work with games. “if it's game/mocap animation type of rigs it will often use joints for it's simple proporties of points, game engines can use joints too. “ Today this rig have no compatibilities with game engines so the old systems will probably remain in place for now.

Another forum topic raised was about the speed of the rig. ”it's worth to mention that you should focus on speed and usebility as of the main aspects. and if you can make something simple and fast go that way. this said, rigger should know all tools that are available to him and choose what fits the needs for the project and in time. “ he brings up an interesting point, the slow speed and evaluation times are probably the biggest problem.

Here is another interesting quote about the rig. “if it's commercial or short animation it will again depend what character needs to do. alot of times for specific lip syncs people would still use carefully and beautifully modeled blendshapes that are predictable, fast and clean.”

The goal of this rig is to remove the need of remove the need of an artist in the rigging phase, this might be a concern when perfection is more important then speed. High budget films where each frame costs a fortune will probably stay clear of the Maya muscle facial rig since they need everything to be exactly as they want it. Which is hard with this facial rig due to the fact that the muscles calculate different each time because of its many factors.

5 Discussion

Theoretically everyone can create the Maya muscle rig but practically are several limitations. It is more computer heavy heavy then normal rigs which might be a problem where the facial rig goes out to animators who work on laptops. Both the rigger and animator need to use Maya unlimited 2008 or newer to use this rig which is troublesome since licenses are expensive. There are already a lot of riggers that use Maya muscle system to create the biceps and leg muscles, so many companies already have the foundation for the Maya muscle rig, both in software and skill.

Since the Maya muscle facial rig require the use of tools that are limited to Maya there are zero cross software integration. Which makes it hard to coordinate work pipelines that requires several different software this is especially true in games. There are always room for
automatisation in games because of their amount of content that need animation. If the Maya muscle system can be simplified to a degree where game engines could run it then maybe it can be popular in the gaming industry just like automatized lip-sync.

Since the motion capture can be done in Maya there might be some added compatibility in that area soon, especially since using the Maya muscle system for arms and legs have become quite popular. The main area of use is probably cartoonish animation where you have a lot of fleshy characters that move a lot which makes the jiggle control valuable. Sliding also helps create more appealing result in cartoonish animations since such animations usually contain more exaggerated facial expressions where the sliding of the skin helps make the character look less stale.

But even realistic animation have a lot to gain from this rigging system because of the squash and stretch effect and also the custom muscle shapes. But realistic animation usually require more fine details which are hard to accomplish using the custom muscle shapes, and sadly this is hard to fix since Maya muscle system have problems having blendshape deformers attached to them. It is important for an animator to view his animations in realtime and this is really troublesome for the Maya muscle system since the muscles takes time to evaluate. Since the muscle needs to be evaluated for each frame its hard to predict the exact result of a pose since you cant see in detail how it will turn out until you playblast the animation.

The one who will spend most time with a rig is almost always the animator so to reduce his effectivity can be very expensive in the long run. The researchers experience with animating the rig is that it works fine when creating the keyframes, and it would probably work even smoother if you were to work on a low-poly proxymodel but the evaluation time forces the animator to wait everytime he wants to preview his animation.

This rigging system definitively have a lot of vices but it only means that there is a lot of room for improvement. This wont be a standard for facial rigging in the near future but it might find some usefulness in stylized cartoonish animations in the areas of film and commercial. The setup time isn't much quicker or slower then any other rigging system so the choice of rigging system will be all about the end result.

This setup wont be perfect for every situation for example when rigging skinny characters like children. At situations like that its usually best to create a joint based rig. The Maya muscle rig is most useful when rigging heavy characters that have a lot of fat that jiggle, since that is easily added to the Maya muscles. But heavy characters also require some extra attention because large amount of fat compress in unique and interesting ways. This is done by using the “Custom muscle shape” Tool in Maya. But sadly there is no way to make the compression different. This is a problem since a heavy character will look stale if his large fat parts like the neck compresses identically each time.

In the end professionals will probably use a mix of different rigging system to create a facial rig since they all have their uses. We can only hope that this system will be used as an alternative when suitable. The observations of the researcher and those of professionals and students on rigging will determine if the reader should adopt this rigging system into his arsenal of knowledge or simply disregard it as unachievable, to costly or maybe even irrelevant.
Sadly the community outreach wasn't executed well enough to gather enough material to draw concrete conclusions. The material could at best hint on how this rigging system will be revived by professionals. It might also have reviled some flaws of this rigging system.

6 Conclusion

Using Maya muscle system to create a facial rig is definitely possible. It is mostly useful when creating rigs for cartoonish characters, which are usually found in commercials and films. The Maya muscle facial rig requires more computer resources than other facial rigs, the rig can't play at full speed before the muscles have been cached. It requires that the rigger and animator use Maya unlimited 2008 or a newer version. Squash and stretch are generated automatically, and custom muscle shapes can be added to get unique squash and stretch shapes. A lot of riggers are already familiar with the tool since it's used for biceps and leg muscles.
References


